PROJECT MANUAL

HVAC Modifications

Joseph P. Teasdale State Office Building

Raytown, Missouri

Designed By: Henderson Engineers
8345 Lenexa Drive
Lenexa, KS 66214

Date Issued: June 16, 2023

Project No.: O2020-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION

Facilities Management, Design & Construction

SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS

PROJECT NUMBER: 02020-01 "HVAC MODIFICATIONS – JOSEPH P. TEASDALE OFFICE BUILDING"

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

PLUMBING/MECHANICAL/ELECTRICAL

The documents intended to be authenticated by my seal are limited to:

Specifications: Division 22 all Sections.
Division 23 all Sections.
Division 26 all Sections.

Drawings Sheets: G-000, M-000, M-101, M-102, M-200, M-201, M-300, M-400, M-401, P-000, P-101, E-000, E-101, E-500.

I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part of the project.

By: _____

Kelley P. Cramm, P.E. (Div. 22 & 23)

06/16/2023

By: _____

Douglas M. Everhart, P.E. (Div. 26)

06/16/2023

TABLE OF CONTENTS

SECTION 000115 – LIST OF DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 LIST OF DRAWINGS

A. The following list of drawings is a part of the Bid Documents:

	TITLE	SHEET #	DATE	CAD #
1.	Cover Sheet	G-000	6/16/23	G-000
2.	Electrical General Notes and Legend	E-000	6/16/23	E-000
3.	Electrical Demo and Penthouse Plan	E-101	6/16/23	E-101
4.	Electrical Schedules, & One Line Diagram	E-500	6/16/23	E-500
5.	Mechanical General Notes and Legend	M-000	6/16/23	M-000
6.	Mechanical Demo and Penthouse Plan	M-101	6/16/23	M-101
7.	Mechanical Levels 2, 4 and 6 Plan	M-102	6/16/23	M-102
8.	Mechanical Details	M-200	6/16/23	M-200
9.	Mechanical Details	M-201	6/16/23	M-201
10.	Mechanical Schedules	M-300	6/16/23	M-300
11.	Mechanical Controls	M-400	6/16/23	M-400
12.	Mechanical Controls	M-401	6/16/23	M-401
13.	Plumbing General Notes and Legend	P-000	6/16/23	P-000
14.	Plumbing Roof Plan	P-101	6/16/23	P-101

END OF SECTION 000115

SECTION 001116 - INVITATION FOR BID

1.0 OWNER:

A. The State of Missouri
Office of Administration,
Division of Facilities Management, Design and Construction
Jefferson City, Missouri

2.0 PROJECT TITLE AND NUMBER:

A. HVAC Modifications
Joseph P. Teasdale State Office Building
Raytown, Missouri
Project No.: O2020-01

3.0 BIDS WILL BE RECEIVED:

A. Until: 1:30 PM, Thursday, August 31, 2023

B. **Only electronic bids on MissouriBUYS shall be accepted: https://missouribuys.mo.gov. Bidder must be registered to bid.**

4.0 DESCRIPTION:

A. Scope: This project consists of replacing the boiler, heating water pumps, supply fan, heating and cooling coils, and extending BAS for the new equipment.

B. MBE/WBE/SDVE Goals: MBE 10%, WBE 10%, and SDVE 3%**. NOTE: Only MBE/WBE firms certified by the State of Missouri Office of Equal Opportunity as of the date of bid opening, or SDVE(s) meeting the requirements of Section 34.074, RSMo and 1 CSR 30-5.010, can be used to satisfy the MBE/WBE/SDVE participation goals for this project.**

C. **NOTE: Bidders are provided new Good Faith Effort (GFE) forms on MissouriBUYS.

5.0 PRE-BID MEETING:

A. Place/Time**:** 11:00 AM, Tuesday, August 15, 2023, at Joseph P. Teasdale State Office Building, 8800 E. 63rd St., Raytown, MO.

B. Access to State of Missouri property requires presentation of a photo ID by all persons.

6.0 HOW TO GET PLANS & SPECIFICATIONS:

A. View Only Electronic bid sets are available at no cost or paper bid sets for a deposit of $100 from American Document Solutions (ADS). MAKE CHECKS PAYABLE TO: American Document Solutions. Mail to: American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433, https://www.adsplanroom.net. NOTE: Prime contractors will be allowed a maximum of two bid sets at the deposit rate shown above. Other requesters will be allowed only one bid set at this rate. Additional bid sets or parts thereof may be obtained by any bidder at the cost of printing and shipping by request to American Document Solutions at the address shown above. **Bidder must secure at least one bid set to become a planholder.**

B. **Refunds: Return plans and specifications in unmarked condition within 15 working days of bid opening to American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433. Deposits for plans not returned within 15 working days shall be forfeited.**

C. Information for upcoming bids, including downloadable plans, specifications, Invitation for Bid, bid tabulation, award, addenda, and access to the ADS planholders list, is available on the Division of Facilities Management, Design and Construction's web site: https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans.

7.0 POINT OF CONTACT:

A. Designer: Henderson Engineers, Matt Swaback, (913) 742-5742, email: matt.swaback@hendersonengineers.com

B. Project Manager: Jared Cook, (573) 690-6733, email: jared.cook2@oa.mo.gov

8.0 GENERAL INFORMATION:

A. The State reserves the right to reject any and all bids and to waive all informalities in bids. No bid may be withdrawn for a period of 20 working days subsequent to the specified bid opening time. The contractor shall pay not less than the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed, as determined by the Missouri Department of Labor and Industrial Relations and as set out in the detailed plans and specifications.

B. Bid results will be available at https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans after it is verified that at least one bid is awardable and affordable.

Very Important MissouriBUYS Instructions to Help Submit a Bid Correctly

A. The bidder shall submit his or her bid and all supporting documentation on MissouriBUYS eProcurement System. No hard copy bids shall be accepted. Go to https://missouribuys.mo.gov and register. The bidder must register and complete a profile fully with all required documents submitted prior to submitting a bid.

B. Once registered, log in.
1. Under "Solicitation" select "View Current Solicitations."
2. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8", then click "Filter Solicitation" button.
3. Select "Active Solicitations" tab.
4. To see the Solicitation Summary, click on the Project Number and the summary will open. Click each heading to open detailed information.

C. Here are simplified instructions for uploading the bid to MissouriBUYS:
1. Find the solicitation by completing Steps 1 through 4 above.
2. Select the three dots under "Actions." Select "Add New Response."
3. When the Quote box opens, give the response a title and select "OK."
4. The detailed solicitation will open. Select "Check All" for the Original Solicitation Documents, open each document, and select "Accept." If this step is not completed, a bid cannot be uploaded. Scroll to the bottom of the page and select "Add Attachments." If you do not see this command, not all documents have been opened and accepted.
5. The Supplier Attachments box will open. Select "Add Attachment" again.
6. The Upload Documents box will open. Read the instructions for uploading. Disregard the "Confidential" check box.
7. Browse and attach up to 5 files at a time. Scroll to bottom of box and select "Upload." The Supplier Attachments box will open. Repeat Steps 5 through 7 if more than 5 files are to be uploaded.
8. When the Supplier Attachments box opens again and uploading is complete, select "Done." A message should appear that the upload is successful. If it does not, go to the Bidder Response tab and select "Submit."
9. The detailed solicitation will open. At the bottom select "Close."

D. Any time a bidder wants to modify the bid, he or she will have to submit a new one. FMDC will open the last response the bidder submits. The bidder may revise and submit the bid up to the close of the solicitation (bid date and time). Be sure to allow for uploading time so that the bid is successfully uploaded prior to the 1:30 PM deadline; we can only accept the bid if it is uploaded before the deadline.

E. If you want to verify that you are uploading documents correctly, please contact Paul Girouard: 573-751-4797, paul.girouard@oa.mo.gov ; April Howser: 573-751-0053, April.Howser@oa.mo.gov ; or Mandy Roberson: 573-522-0074, Mandy.Roberson@oa.mo.gov.

F. If you are experiencing login issues, please contact Web Procure Support (Proactis) at 866-889-8533 anytime from 7:00 AM to 7:00 PM Central Time, Monday through Friday. If you try using a userid or password several times that is incorrect, the system will lock you out. Web Procure Support is the only option to unlock you! If you forget your userid or password, Web Procure Support will provide a temporary userid or password. Also, if it has been a while since your last successful login and you receive an "inactive" message, contact Web Procure (Proactis). If you are having a registration issue, you may contact Office of Administration Division of Purchasing at 573-751-3491.

IMPORTANT REMINDER REGARDING REQUIREMENT FOR OEO CERTIFICATION

A. SECTION 002113 – INSTRUCTIONS TO BIDDERS: Article 15.0, Section D1:

As of July 1, 2020, all MBE, WBE, and MBE/WBE contractors, subcontractors, and suppliers must be certified by the State of Missouri, Office of Equal Opportunity. No certifications from other Missouri certifying agencies will be accepted.

SECTION 002113 – INSTRUCTIONS TO BIDDERS

1.0 - SPECIAL NOTICE TO BIDDERS

A. If awarded a contract, the Bidder's employees, and the employees of all subcontractors, who perform the work on the project must adhere to requirements in Section 013513 – Site Security and Health Requirements as applicable per Agency.

B. The Bidder's prices shall include all city, state, and federal sales, excise, and similar taxes that may lawfully be assessed in connection with the performance of work, and the purchased of materials to be incorporated in the work. THIS PROJECT IS NOT TAX EXEMPT.

2.0 - BID DOCUMENTS

A. The number of sets obtainable by any one (1) party may be limited in accordance with available supply.

B. For the convenience of contractors, sub-contractors and suppliers, copies of construction documents are on file at the office of the Director, Division of Facilities Management, Design and Construction and on the Division's web site - https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans.

3.0 - BIDDERS' OBLIGATIONS

A. Bidders must carefully examine the entire site of the work and shall make all reasonable and necessary investigations to inform themselves thoroughly as to the facilities available as well as to all the difficulties involved in the completion of all work in accordance with the specifications and the plans. Bidders are also required to examine all maps, plans and data mentioned in the specifications. No plea of ignorance concerning observable existing conditions or difficulties that may be encountered in the execution of the work under this contract will be accepted as an excuse for any failure or omission on the part of the contractor to fulfill in every detail all of the requirements of the contract, nor accepted as a basis for any claims for extra compensation.

B. Under no circumstances will contractors give their plans and specifications to another contractor. Any bid received from a contractor whose name does not appear on the list of plan holders may be subject to rejection.

4.0 - INTERPRETATIONS

A. No bidder shall be entitled to rely on oral interpretations as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction. Every request for interpretation shall be made in writing and submitted with all supporting documents not less than five (5) working days before opening of bids. Every interpretation made to a bidder will be in the form of an addendum and will be sent as promptly as is practicable to all persons to whom plans and specifications have been issued. All such addenda shall become part of the contract documents.

B. Approval for an "acceptable substitution" issued in the form of an addendum as per Paragraph 4A above, and as per Article 3.1 of the General Conditions; ACCEPTABLE SUBSTITUTIONS shall constitute approval for use in the project of the product.

C. An "acceptable substitution" requested after the award of bid shall be approved if proven to the satisfaction of the Owner and the Designer as per Article 3.1, that the product is acceptable in design, strength, durability, usefulness, and convenience for the purpose intended. Approval of the substitution after award is at the sole discretion of the Owner.

D. A request for "Acceptable Substitutions" shall be made on the Section 006325 Substitution Request Form. The request shall be sent directly to the project Designer. A copy of said request should also be mailed to the Owner, Division of Facilities Management, Design and Construction, Post Office Box 809, Jefferson City, Missouri 65102.

5.0 - BIDS AND BIDDING PROCEDURE

A. Bidders shall submit all submission forms and accompanying documents listed in SECTION 004113 – BID FORM, Article 5.0, ATTACHMENTS TO BID by the stated time or their bid will be rejected for being non-responsive.

Depending on the specific project requirements, **the following is a GENERIC list** of all possible bid forms that may be due with bid submittals and times when they may be due. Please check for specific project requirements on the proposal form (Section 004113). ***Not all of the following bid forms may be required to be submitted.***

Bid Submittal – due before stated date and time of bid opening (see IFB):

004113	Bid Form (all pages are always required)
004322	Unit Prices Form
004336	Proposed Subcontractors Form
004337	MBE/WBE/SDVE Compliance Evaluation Form
004338	MBE/WBE/SDVE Eligibility Determination for Joint Ventures
004339	MBE/WBE/SDVE GFE Determination
004340	SDVE Business Form
004541	Affidavit of Work Authorization
004545	Anti-Discrimination Against Israel Act Certification form

B. All bids shall be submitted without additional terms and conditions, modification or reservation on the bid forms with each space properly filled. Bids not on these forms will be rejected.

C. All bids shall be accompanied by a bid bond executed by the bidder and a duly authorized surety company, certified check, cashier's check or bank draft made payable to the Division of Facilities Management, Design and Construction, State of Missouri, in the amount indicated on the bid form, Section 004113. Failure of the contractor to submit the full amount required shall be sufficient cause to reject his bid. The bidder agrees that the proceeds of the check, draft or bond shall become the property of the State of Missouri, if for any reason the bidder withdraws his bid after closing, or if on notification of award refuses or is unable to execute tendered contract, provide an acceptable performance and payment bond, provide evidence of required insurance coverage and/or provide required copies of affirmative action plans within ten (10) working days after such tender.

D. The check or draft submitted by the successful bidder will be returned after the receipt of an acceptable performance and payment bond and execution of the formal contract. Checks or drafts of all other bidders will be returned within a reasonable time after it is determined that the bid represented by same will receive no further consideration by the State of Missouri. Bid bonds will only be returned upon request.

6.0 - SIGNING OF BIDS

A. A bid from an individual shall be signed as noted on the Bid Form.

B. A bid from a partnership or joint venture shall require only one signature of a partner, an officer of the joint venture authorized to bind the venture or an attorney-in-fact. If the bid is signed by an officer of a joint venture or an attorney-in-fact, a document evidencing the individual's authority to execute contracts should be included with the bid form.

C. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.

D. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual. Corporate license number shall be provided and, if a corporation organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached. In addition, for corporate proposals, the President or Vice-President should sign as the bidder. If the signator is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signator has the legal authority to bind the corporation.

E. A bid should contain the full and correct legal name of the Bidder. If the Bidder is an entity registered with the Missouri Secretary of State, the Bidder's name on the bid form should appear as shown in the Secretary of State's records.

F. The Bidder should include its corporate license number on the Bid Form and, if the corporation is organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached to the bid form.

7.0 - RECEIVING BID SUBMITTALS

A. It is the bidder's sole responsibility to assure receipt by Owner of bid submittals by the date and time specified in the Invitation for Bid. Bids received after the date and time specified shall not be considered by the Owner.

B. Bids must be submitted through the MissouriBUYS statewide eProcurement system (https://www.missouribuys.mo.gov/) in accordance with the instructions for that system. The Owner shall only accept bids submitted through MissouriBUYS. Bids received by the Owner through any other means, including hard copies, shall not be considered and will be discarded by the Owner unopened.

C. To respond to an Invitation for Bid, the Bidder must first register with MissouriBUYS by going through the MissouriBUYS Home Page (https://www.missouribuys.mo.gov/), clicking the "Register" button at the top of the page, and completing the Vendor Registration. Once registered, the Bidder accesses its account by clicking the "Login" button at the top of the MissouriBUYS Home Page. Enter your USERID and PASSWORD, which the Bidder will select. Under Solicitations, select "View Current Solicitations." A new screen will open. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8." Under "Filter by Opp. No." type in the State Project Number. Select "Submit." Above the dark blue bar, select "Other Active Opportunities." To see the Solicitation Summary, single click the Opp. No. (Project Number) and the summary will open. Single quick click each blue bar to open detailed information. The Bidder must read and accept the Original Solicitation Documents and complete all identified requirements. The Bidder should download and save all of the Original Solicitation Documents on its computer so that the Bidder can prepare its response to these documents. The Bidder should upload its completed response to the downloaded documents as an attachment to the electronic solicitation response.

D. Step-by-step instructions for how a registered vendor responds to a solicitation electronically are provided in Section 001116 – Invitation For Bid.

E. The Bidder shall submit its bid on the forms provided by the Owner on MissouriBUYS with each space fully and properly completed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner may reject bids that are not on the Owner's forms or that do not contain all requested information.

F. No Contractor shall stipulate in his bid any conditions not contained in the specifications or standard bid form contained in the contract documents. To do so may subject the Contractor's bid to rejection.

G. The completed forms shall be without interlineations, alterations or erasures.

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

A. Bidder may withdraw his bid at any time prior to scheduled closing time for receipt of bids, but no bidder may withdraw his bid for a period of twenty (20) working days after the scheduled closing time for receipt of bids.

B. The Bidder shall modify his or her original bid by submitting a revised bid on MissouriBUYS.

9.0 - AWARD OF CONTRACT

A. The Owner reserves the right to reject any and/or all bids and further to waive all informalities in bidding when deemed in the best interest of the State of Missouri.

B. The Owner reserves the right to let other contracts in connection with the work, including but not by way of limitation, contracts for the furnishing and installation of furniture, equipment, machines, appliances and other apparatus.

C. The Owner shall award a contract to the lowest, responsive, responsible Bidder in accordance with Section 8.250, RSMo. No contract will be awarded to any Bidder who has had a contract with the Owner terminated within the preceding twelve months for material breach of contract or who has been suspended or debarred by the Owner.

D. Award of alternates, if any, will be made in numerical order unless all bids received are such that the order of acceptance of alternates does not affect the determination of the lowest, responsive, responsible bidder.

E. No bid shall be considered binding upon the Owner until the written contract has been properly executed, a satisfactory bond has been furnished, evidence of required insurance coverage, submittal of executed Section 004541, Affidavit of Work Authorization form, documentation evidencing enrollment and participation in a federal work authorization program has been received and an affirmative action plan submitted. Failure to execute and return the contract and associated documents within the prescribed period of time shall be treated, at the option of the Owner, as a breach of bidder's obligation and the Owner shall be under no further obligation to bidder.

F. If the successful bidder is doing business in the State of Missouri under a fictitious name, he shall furnish to Owner, attached to the Bid Form, a properly certified copy of the certificate of Registration of Fictitious Name from the State of Missouri, and such certificate shall remain on file with the Owner.

G. Any successful bidder which is a corporation organized in a state other than Missouri shall furnish to the Owner, attached to the Bid Form, a properly certified copy of its current Certificate of Authority to do business in the State of Missouri, such certificate to remain on file with the Owner. No contract will be awarded by the Owner unless such certificate is furnished by the bidder.

H. Any successful bidder which is a corporation organized in the State of Missouri shall furnish at its own cost to the Owner, if requested, a Certificate of Good Standing issued by the Secretary of State, such certificate to remain on file with the Owner.

I. Transient employers subject to Sections 285.230 and 285.234, RSMo, (out-of-state employers who temporarily transact any business in the State of Missouri) may be required to file a bond with the Missouri Department of Revenue. No contract will be awarded by the Owner unless the successful bidder certifies that he has complied with all applicable provisions of Section 285.230-234.

J. Sections 285.525 and 285.530, RSMo, require business entities to enroll and participate in a federal work authorization program in order to be eligible to receive award of any state contract in excess of $5,000. Bidders should submit with their bid an Affidavit of Work Authorization (Section 004541) along with appropriate documentation evidencing such enrollment and participation. Section-004541, Affidavit of Work Authorization is located on the MissouriBUYS solicitation for this project. Bidders must also submit an E-Verify Memorandum before the Owner may award a contract to the Bidder. Information regarding a E-Verify is located at https://www.uscis.gov/e-verify/. The contractor shall be responsible for ensuring that all subcontractors and suppliers associated with this contract enroll in E-Verify.

10.0 - CONTRACT SECURITY

A. The successful bidder shall furnish a performance/payment bond as set forth in General Conditions Article 6.1 on a condition prior to the State executing the contract and issuing a notice to proceed.

11.0 - LIST OF SUBCONTRACTORS

A. If required by "Section 004113 – Bid Form," each bidder must submit as part of their bid a list of subcontractors to be used in performing the work (Section 004336). The list must specify the name of the single designated subcontractor, for each category of work listed in "Section 004336 - Proposed Subcontractors Form." If work within a category will be performed by more than one subcontractor, the bidder must provide the name of each subcontractor and specify the exact portion of the work to be done by each. Failure to list the Bidder's firm, or a subcontractor for each category of work identified on the Bid Form or the listing of more than one subcontractor for any category without designating the portion of work to be performed by each shall be cause for rejection of the bid. If the bidder intends to perform any of the designated subcontract work with the use of his own employees, the bidder shall make that fact clear, by listing his own firm for the subject category. **If any category of work is left vacant, the bid shall be rejected.**

12.0 - WORKING DAYS

A. Contract duration time is stated in working days and will use the following definition in determining the actual calendar date for contract completion:

1. Working days are defined as all calendar days except Saturdays, Sundays and the following State of Missouri observed holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday, Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day.

13.0 - AMERICAN AND MISSOURI - MADE PRODUCTS AND FIRMS

A. By signing the bid form and submitting a bid on this project, the Bidder certifies that it will use American and Missouri products as set forth in Article 1.7 of the General Conditions. Bidders are advised to review those requirements carefully prior to bidding.

B. A preference shall be given to Missouri firms, corporations or individuals, or firms, corporations or individuals that maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less.

C. Pursuant to Section 34.076, RSMo, a contractor or Bidder domiciled outside the boundaries of the State of Missouri shall be required, in order to be successful, to submit a bid the same percent less than the lowest bid submitted by a responsible contractor or Bidder domiciled in Missouri as would be required for such a Missouri domiciled contractor or Bidder to succeed over the bidding contractor or Bidder domiciled outside Missouri on a like contract or bid being let in the person's domiciliary state and, further, the contractor or Bidder domiciled outside the boundaries of Missouri shall be required to submit an audited financial statement as would be required of a Missouri domiciled contractor or Bidder on a like contract or bid being let in the domiciliary state of that contractor or Bidder.

14.0 – ANTI-DISCRIMINATION AGAINST ISRAEL ACT CERTIFICATION:

A. Pursuant to section 34.600, RSMo, if the Bidder meets the section 34.600, RSMo, definition of a "company" and the Bidder has ten or more employees, the Bidder must certify in writing that the Bidder is not currently engaged in a boycott of goods or services from the State of Israel as defined in section 34.600, RSMo, and shall not engage in a boycott of goods or services from the State of Israel, if awarded a contract, for the duration of the contract. The Bidder is requested to complete and submit the applicable portion of Section 004545 - Anti-Discrimination Against Israel Act Certification with their Bid Form. The applicable portion of the exhibit must be submitted prior to execution of a contract by the Owner and issuance of Notice to Proceed. If the exhibit is not submitted, the Owner shall rescind its Intent to Award and move to the next lowest, responsive, responsible bidder.

15.0 - MBE/WBE/SDVE INSTRUCTIONS

A. Definitions:

1. **"MBE"** means a Minority Business Enterprise.

2. **"MINORITY"** has the same meaning as set forth in 1 C.S.R. 10-17.010.

3. **"MINORITY BUSINESS ENTERPRISE"** has the same meaning as set forth in section 37.020, RSMo.

4. **"WBE"** means a Women's Business Enterprise.

5. **"WOMEN'S BUSINESS ENTERPRISE"** has the same meaning as set forth in section 37.020, RSMo.

6. **"SDVE"** means a Service-Disabled Veterans Enterprise.

7. **"SERVICE-DISABLED VETERAN"** has the same meaning as set forth in section 34.074, RSMo.

8. **"SERVICE-DISABLED VETERAN ENTERPRISE"** has the same meaning as "Service-Disabled Veteran Business" set forth in section 34.074, RSMo.

B. MBE/WBE/SDVE General Requirements:

1. For all bids greater than $100,000, the Bidder shall obtain MBE, WBE and SDVE participation in an amount equal to or greater than the percentage goals set forth in the Invitation for Bid and the Bid Form, unless the Bidder is granted a Good Faith Effort waiver by the Director of the Division, as set forth below. If the Bidder does not meet the MBE, WBE and SDVE goals, or make a good faith effort to do so, the Bidder shall be non-responsive, and its bid shall be rejected.

2. The Bidder should submit with its bid all of the information requested in the MBE/WBE/SDVE Compliance Evaluation Form for every MBE, WBE, or SDVE subcontractor or material supplier the Bidder intends to use for the contract work. The Bidder is required to submit all appropriate MBE/WBE/SDVE documentation before the stated time and date set forth in the Invitation for Bid. If the Bidder fails to provide such information by the specified date and time, the Owner shall reject the bid.

3. The Director reserves the right to request additional information from a Bidder to clarify the Bidder's proposed MBE, WBE, and/or SDVE participation. The Bidder shall submit the clarifying information requested by the Owner within two (2) Working Days of receiving the request for clarification.

4. Pursuant to section 34.074, RSMo, a Bidder that is a SDVE doing business as Missouri firm, corporation, or individual, or that maintains a Missouri office or place of business, shall receive a three-point bonus preference in the contract award evaluation process. The bonus preference will be calculated and applied by reducing the bid amount of the eligible SDVE by three percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible SDVE's evaluation is less than the apparent low responsive bidder's bid, the eligible SDVE's bid becomes the apparent low responsive bid. This reduction is for evaluation purposes only, and will have no impact on the actual amount(s) of the bid or the amount(s) of any contract awarded. In order to be eligible for the SDVE preference, the Bidder must complete and submit with its bid the Missouri Service Disabled Veteran Business Form, and any information required by the form. The form is available on the MissouriBUYS solicitation for this project.

C. Computation of MBE/WBE/SDVE Goal Participation:

1. A Bidder who is a MBE, WBE, or SDVE may count 100% of the contract towards the MBE, WBE or SDVE goal, less any amounts awarded to another MBE, WBE or SDVE. (NOTE: A MBE firm that bids as general contractor must obtain WBE and SDVE participation; a WBE firm that bids as a general contractor must obtain MBE and SDVE participation; and a SDVE firm that bids as general contractor must obtain MBE and WBE participation.) In order for the remaining contract amount to be counted towards the MBE, WBE or SDVE goal, the Bidder must complete the MBE/WBE/SDVE Compliance Evaluation Form (Section 004337) identifying itself as an MBE, WBE or SDVE.

2. The total dollar value of the work granted to a certified MBE, WBE or SDVE by the Bidder shall be counted towards the applicable goal.

3. Expenditures for materials and supplies obtained from a certified MBE, WBE, or SDVE supplier or manufacturer may be counted towards the MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE assumes the actual and contractual responsibility for the provision of the materials and supplies.

4. The total dollar value of the work granted to a second or subsequent tier subcontractor or a supplier may be counted towards a Bidder's MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE properly assumes the actual and contractual responsibility for the work.

5. The total dollar value of work granted to a certified joint venture equal to the percentage of the ownership and control of the MBE, WBE, or SDVE partner in the joint venture may be counted towards the MBE/WBE/SDVE goals.

6. Only expenditures to a MBE, WBE, or SDVE that performs a commercially useful function in the work may be counted towards the MBE, WBE and SDVE goals. A MBE, WBE, or SDVE performs a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by actually performing, managing and supervising the work or providing supplies or manufactured materials.

D. Certification of MBE/WBE/SDVE Subcontractors:

1. In order to be counted towards the goals, an MBE or WBE must be certified by the State of Missouri Office of Equal Opportunity and an SDVE must be certified by the State of Missouri, Office of Administration, Division of Purchasing and Material Management or by the Department of Veterans Affairs.

2. The Bidder may determine the certification status of a proposed MBE or WBE subcontractor or supplier by referring to the Office of Equal Opportunity (OEO)'s online MBE/WBE directory (https://apps1.mo.gov/MWBCertifiedFirms/). The Bidder may determine the eligibility of a SDVE subcontractor or supplier by referring to the Division of Purchasing and Materials Management's online SDVE directory (https://oa.mo.gov/sites/default/files/sdvelisting.pdf) or the Department of Veterans Affairs' directory (https://vetbiz.va.gov/basic-search/).

3. Additional information, clarifications, etc., regarding the listings in the directories may be obtained by calling the Division at (573)751-3339 and asking to speak to the Contract Specialist of record as shown in the Supplementary Conditions (Section 007300).

E. Waiver of MBE/WBE/SDVE Participation:

1. If a Bidder has made a good faith effort to secure the required MBE, WBE and/or SDVE participation and has failed, the Bidder shall submit with its bid the information requested in MBE/WBE/SDVE Good Faith Effort (GFE) Determination form. The GFE forms are located on the MissouriBUYS solicitation for this project. The Director will determine if the Bidder made a good faith effort to meet the applicable goals. If the Director determines that the Bidder did not make a good faith effort, the bid shall be rejected as being nonresponsive to the bid requirements. Bidders who demonstrate that they have made a good faith effort to include MBE, WBE, and/or SDVE participation will be determined to be responsive to the applicable participation goals, regardless of the percent of actual participation obtained, if the bid is otherwise acceptable.

2. In determining whether a Bidder has made a good faith effort to obtain MBE, WBE and/or SDVE participation, the Director may evaluate the factors set forth in 1 CSR 30-5.010(6)(C) and the following:

   a. The amount of actual participation obtained;

   b. How and when the Bidder contacted potential MBE, WBE, and SDVE subcontractors and suppliers;

   c. The documentation provided by the Bidder to support its contacts, including whether the Bidder provided the names, addresses, phone numbers, and dates of contact for MBE/WBE/SDVE firms contacted for specific categories of work;

   d. If project information, including plans and specifications, were provided to MBE/WBE/SDVE subcontractors;

   e. Whether the Bidder made any attempts to follow-up with MBE, WBE or SDVE firms prior to bid;

   f. Amount of bids received from any of the subcontractors and/or suppliers that the Bidder contacted;

   g. The Bidder's stated reasons for rejecting any bids;

3. If no bidder has obtained any participation in a particular category (MBE/WBE/SDVE) or made a good faith effort to do so, the Director may waive that goal rather than rebid.

F. Contractor MBE/WBE/SDVE Obligations

1. If awarded a contract, the Bidder will be contractually required to subcontract with or obtain materials from the MBE, WBE, and SDVE firms listed in its bid, in amounts equal to or greater than the dollar amount bid, unless the amount is modified in writing by the Owner.

2. If the Contractor fails to meet or maintain the participation requirements contained in the Contractor's bid, the Contractor must satisfactorily explain to the Director why it cannot comply with the requirement and why failing meeting the requirement was beyond the Contractor's control. If the Director finds the Contractor's explanation unsatisfactory, the Director may take any appropriate action including, but not limited to:

    a. Declaring the Contractor ineligible to participate in any contracts with the Division for up to twelve (12) months (suspension); and/or

    b. Declaring the Contractor be non-responsive to the Invitation for Bid, or in breach of contract and rejecting the bid or terminating the contract.

3. If the Contractor replaces an MBE, WBE, or SDVE during the course of this contract, the Contractor shall replace it with another MBE, WBE, or SDVE or make a good faith effort to do so. All MBE, WBE and SDVE substitutions must be approved by the Director.

4. The Contractor shall provide the Owner with regular reports on its progress in meeting its MBE/WBE/SDVE obligations. At a minimum, the Contractor shall report the dollar-value of work completed by each MBE, WBE, or SDVE during the preceding month and the cumulative total of work completed by each MBE, WBE or SDVE to date with each monthly application for payment. The Contractor shall also make a final report, which shall include the total dollar-value of work completed by each MBE, WBE, and SDVE during the entire contract.

STATE OF MISSOURI
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION
MBE/WBE/SDVE DIRECTORIES

The MBE/WBE Directory for goods and services is maintained by the Office of Equal Opportunity (OEO) and is located at the following web address:

https://apps1.mo.gov/MWBCertifiedFirms/

The SERVICE DISABLED VETERAN ENTERPRISE (SDVE) Directories may be accessed at the following web addresses:

https://purch.oa.mo.gov/media/pdf/listing-certified-missouri-service-disabled-veteran-business-enterprises-sdves

https://veterans.certify.sba.gov/#search

State of Missouri
Construction Contract

THIS AGREEMENT is made (DATE) by and between:

Contractor Name and Address

hereinafter called the "Contractor,"

and the **State of Missouri**, hereinafter called the "**Owner**", represented by the Office of Administration, Division of Facilities Management, Design and Construction.

WITNESSETH, that the Contractor and the Owner, for the consideration stated herein agree as follows:

ARTICLE 1. STATEMENT OF WORK

The Contractor shall furnish all labor and materials and perform all work required for furnishing and installing all labor, materials, equipment and transportation and everything necessarily inferred from the general nature and tendency of the plans and specifications for the proper execution of the work for:

Project Name: **HVAC Modifications**
Joseph P. Teasdale State Office Building
Raytown, Missouri

Project Number: **O2020-01**

in strict accordance with the Contract Documents as enumerated in Article 7, all of which are made a part hereof.

ARTICLE 2. TIME OF COMPLETION

The contract performance time is **150 working days** from the transmittal date of this agreement. The contract completion date is **MONTH, DAY, YEAR**. This time includes ten (10) working days for the Contractor to receive, sign and return the contract form along with required bonding and insurance certificates. Failure of the Contractor to provide correct bonding and insurance within the ten (10) working days shall not be grounds for a time extension. Receipt of proper bonding and insurance is a condition precedent to the formation of the contract and if not timely received, may result in forfeiture of the Contractor's bid security. Work may not commence until the Owner issues a written Notice to Proceed and must commence within seven (7) working days thereafter.

ARTICLE 3. LIQUIDATED DAMAGES

Whenever time is mentioned in this contract, time shall be and is of the essence of this contract. The Owner would suffer a loss should the Contractor fail to have the work embraced in this contract fully completed on or before the time above specified. THEREFORE, the parties hereto realize in order to adjust satisfactorily the damages on account of such failure that it might be impossible to compute accurately or estimate the amount of such loss or damages which the Owner would sustain by reason of failure to complete fully said work within the time required by this contract. The Contractor hereby covenants and agrees to pay the Owner, as and for **liquidated damages, the sum of $700** per day for each and every day, Sunday and legal holidays excepted, during which the work remains incomplete and unfinished. Any sum which may be due the Owner for such damages shall be deducted and retained by the Owner from any balance which may be due the Contractor when said work shall have been finished and accepted. But such provisions shall not release the Bond of the Contractor from liability according to its terms. In case of failure to complete, the Owner will be under no obligation to show or prove any actual or specific loss or damage.

ARTICLE 4. CONTRACT SUM

The Owner shall pay the Contractor for the prompt, faithful and efficient performance of the conditions and undertakings of this contract, subject to additions, and deductions as provided herein, in current funds the sum of:

Base Bid: $

TOTAL CONTRACT AMOUNT: ($CONTRACT AMOUNT)

UNIT PRICES: The Owner accepts the following Unit Prices:

For changing specified quantities of work from those indicated by the contract drawings and specifications, upon written instructions of Owner, the following unit prices shall prevail. The unit prices include all labor, overhead and profit, materials, equipment, appliances, bailing, shoring, shoring removal, etc., to cover the finished work of the several kinds of work called for. Only a single unit price shall be given and it shall apply for either MORE or LESS work than that shown on the drawings and called for in the specifications or included in the Base Bid. In the event of more or less units than so indicated or included, change orders may be issued for the increased or decreased amount.

ARTICLE 5. PREVAILING WAGE RATE

MISSOURI PREVAILING WAGE LAW (Sections 290.210 to 290.340, RSMo): The Contractor shall pay not less than the specified hourly rate of wages, as set out in the wage order attached to and made part of the specifications for work under this contract, to all workers performing work under the contract, in accordance with sections 290.210 to 290.340, RSMo. The Contractor shall forfeit a penalty to the Owner of one hundred dollars per day (or portion of a day) for each worker that is paid less than the specified rates for any work done under the contract by the Contractor or by any subcontractor, in accordance with section 290.250, RSMo.

ARTICLE 6. MINORITY/WOMEN/SERVICE DISABLED VETERAN BUSINESS ENTERPRISE PARTICIPATION

The Contractor has been granted a waiver of the 10% MBE and 10% WBE and 3% SDVE participation goals. The Contractor agrees to secure the MBE/WBE/SDVE participation amounts for this project as follows: (OR)

The Contractor has met the MBE/WBE/SDVE participation goals and agrees to secure the MBE/WBE/SDVE participation amounts for this project as follows:

MBE/WBE/SDVE Firm: Subcontract Amt:$
MBE/WBE/SDVE Firm: Subcontract Amt:$
MBE/WBE/SDVE Firm: Subcontract Amt:$

Total $

MBE/WBE/SDVE assignments identified above shall not be changed without a contract change signed by the Owner.

The Director of the Division of Facilities Management, Design and Construction or his Designee shall be the final authority to resolve disputes and disagreements between the Contractor and the MBE/WBE/SDVE firms listed above when such disputes impact the subcontract amounts shown above.

ARTICLE 7. CONTRACT DOCUMENTS

The following documents are hereby incorporated into this contract by reference (all division/section numbers and titles are as utilized in the Project Manual published by the Owner for this Project):

1. Division 0 – Procurement and Contracting Information, including, but not limited to:
    a. Invitation for Bid (Section 001116)
    b. Instructions to Bidders (Section 002113)
    c. Supplementary Instructions to Bidders (if applicable) (Section 002213)
    d. The following documents as completed and executed by the Contractor and accepted by the Owner, if applicable:
        i. Bid Form (Section 004113)
        ii. Unit Prices (Section 004322)
        iii. Proposed Contractors Form (Section 004336)
        iv. MBE, WBE, SDVE Compliance Evaluation Form(s) (Section 004337)
        v. MBE, WBE, SDVE Eligibility Determination Form for Joint Ventures (Section 004338)

vi. MBE, WBE, SDVE Good Faith Effort (GFE) Determination Form (Section 004339)
vii. Missouri Service Disabled Veteran Business Form (Section 004340)
viii. Affidavit of Work Authorization (Section 004541)
ix. Affidavit for Affirmative Action (Section 005414)

e. Performance and Payment Bond, completed and executed by the Contractor and surety (Section 006113)
f. General Conditions (Section 007213)
g. Supplementary Conditions (Section 007300)
h. Supplementary General Conditions for Federally Funded/Assisted Construction Projects (Section 007333)
i. Wage Rate(s) (Section 007346)

2. Division 1 – General Requirements
3. All Drawings identified in the Project Manual
4. All Technical Specifications included in the Project Manual
5. Addenda, if applicable

ARTICLE 8 – CERTIFICATION

By signing this contract, the Contractor hereby re-certifies compliance with all legal requirements set forth in Section 6.0, Bidder's Certifications of the Bid Form.

Further, if the Contractor provides any "personal information" as defined in §105.1500, RSMo concerning an entity exempt from federal income tax under Section 501(c) of the Internal Revenue Code of 1986, as amended, the Contractor understands and agrees that it is voluntarily choosing to enter into a state contract and providing such information for that purpose. The state will treat such personal information in accord with §105.1500, RSMo.

By signature below, the parties hereby execute this contract document.

APPROVED:

_____
Brian Yansen, Director
Division of Facilities Management,
Design and Construction

_____
Contractor's Authorized Signature

I, Corporate Secretary, certify that I am Secretary of the corporation named above and that (CONTRACTOR NAME), who signed said contract on behalf of the corporation, was then (TITLE) of said corporation and that said contract was duly signed for and in behalf of the corporation by authority of its governing body, and is within the scope of its corporate powers.

_____
Corporate Secretary

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION

AFFIDAVIT FOR AFFIRMATIVE ACTION

PROJECT NUMBER

NAME

First being duly sworn on oath states: that

he/she is the ☐ sole proprietor ☐ partner ☐ officer or ☐ manager or managing member of

NAME

a ☐ sole proprietorship ☐ partnership ☐ limited liability company (LLC)

or ☐ corporation, and as such, said proprietor, partner, or officer is duly authorized to make this affidavit on behalf of said sole proprietorship, partnership, or corporation; that under the contract known as

PROJECT TITLE

Less than 50 persons in the aggregate will be employed and therefore, the applicable Affirmative Action requirements as set forth in Article 1.4 of the General Conditions of the State of Missouri have been met.

PRINT NAME & SIGNATURE	DATE

NOTARY INFORMATION

NOTARY PUBLIC EMBOSSER SEAL	STATE OF	COUNTY (OR CITY OF ST. LOUIS)	**USE RUBBER STAMP IN CLEAR AREA BELOW**
	SUBSCRIBED AND SWORN BEFORE ME, THIS DAY OF YEAR		
	NOTARY PUBLIC SIGNATURE	MY COMMISSION EXPIRES	
	NOTARY PUBLIC NAME (TYPED OR PRINTED)		

Bond No._____

SECTION 006113 - PERFORMANCE AND PAYMENT BOND FORM

KNOW ALL MEN BY THESE PRESENTS, THAT we _____

as principal, and _____

_____as Surety, are held and firmly bound unto the

STATE OF MISSOURI. in the sum of _____ Dollars ($)

for payment whereof the Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

WHEREAS, the Principal has, by means of a written agreement dated the _____

day of_____, 20_____, enter into a contract with the State of Missouri for

_____

_____

_____

(Insert Project Title and Number)

NOW, THEREFORE, if the Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the State of Missouri, with or without notice to the Surety and during the life of any guaranty required under the contract; and shall also faithfully perform and fulfill all undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made with or without notice to the Surety; and shall also promptly make payment for materials incorporated, consumed or used in connection with the work set forth in the contract referred to above, and all insurance premiums, both compensation and all other kinds of insurance, on said work, and for all labor performed on such work, whether by subcontractor or otherwise, at not less than the prevailing hourly rate of wages for work of a similar character (exclusive of maintenance work) in the locality in which the work is performed and not less than the prevailing hourly rate of wages for legal holiday and overtime work (exclusive of maintenance work) in the locality in which the work is performed both as determined by the Department of Labor and Industrial Relations or determined by the Court of Appeal, as provided for in said contract and in any and all duly authorized modifications of said contract that may be hereafter made, with or without notice to the Surety, then, this obligation shall be void and of no effect, but it is expressly understood that if the Principal should make default in or should fail to strictly, faithfully and efficiently do, perform and comply with any or more of the covenants, agreements, stipulations, conditions, requirements or undertakings, as specified in or by the terms of said contract, and with the time therein named, then this obligation shall be valid and binding upon each of the parties hereto and this bond shall remain in full force and effect; and the same may be sued on at the instance of any material man, laborer, mechanic, subcontractor, individual, or otherwise to whom such payment is due, in the name of the State of Missouri, to the use of any such person.

AND, IT IS FURTHER specifically provided that any modifications which may hereinafter be made in the terms of the contract or in the work to be done under it or the giving by the Owner of any extension of the time for the performance of the contract or any other forbearance on the part of either the Owner or the Principal to the other, shall not in any way release the Principal and the Surety, or either or any of them, their heirs, executors, administrators and successors, from their liability hereunder, notice to the Surety of any such extension, modifications or forbearance being hereby waived.

IN WITNESS WHEREOF, the above bounden parties have executed the within instrument this _____ day of _____, 20 ____.

AS APPLICABLE:

AN INDIVIDUAL

Name: _____

Signature: _____

A PARTNERSHIP

Name of Partner: _____

Signature of Partner: _____

Name of Partner: _____

Signature of Partner: _____

CORPORATION

Firm Name: _____

Signature of President: _____

SURETY

Surety Name: _____

Attorney-in-Fact: _____

Address of Attorney-in-Fact: _____

_____

Telephone Number of Attorney-in-Fact: _____

Signature Attorney-in-Fact: _____

NOTE: Surety shall attach Power of Attorney

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION

PRODUCT SUBSTITUTION REQUEST

PROJECT NUMBER

PROJECT TITLE AND LOCATION

CHECK APPROPRIATE BOX

☐ SUBSTITUTION PRIOR TO BID OPENING
(Minimum of (5) working days prior to receipt of Bids as per Article 4 – Instructions to Bidders)

☐ SUBSTITUTION FOLLOWING AWARD
(Maximum of (20) working days from Notice to Proceed as per Article 3 – General Conditions)

FROM: BIDDER/CONTRACTOR (PRINT COMPANY NAME)

TO: ARCHITECT/ENGINEER (PRINT COMPANY NAME)

Bidder/Contractor hereby requests acceptance of the following product or systems as a substitution in accordance with provisions of Division One of the Bidding Documents:

SPECIFIED PRODUCT OR SYSTEM

SPECIFICATION SECTION NO.

SUPPORTING DATA

☐ Product data for proposed substitution is attached (include description of product, standards, performance, and test data)

☐ Sample ☐ Sample will be sent, if requested

QUALITY COMPARISON

	SPECIFIED PRODUCT	SUBSTITUTION REQUEST
NAME, BRAND		
CATALOG NO.		
MANUFACTURER		
VENDOR		

PREVIOUS INSTALLATIONS

PROJECT	ARCHITECT/ENGINEER	
LOCATION		DATE INSTALLED

SIGNIFICANT VARIATIONS FROM SPECIFIED PRODUCT

REASON FOR SUBSTITUTION

DOES PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK?

☐ YES ☐ NO

IF YES, EXPLAIN

SUBSTITUTION REQUIRES DIMENSIONAL REVISION OR REDESIGN OF STRUCTURE OR A/E WORK

☐ YES ☐ NO

BIDDER'S/CONTRACTOR'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENT:

We have investigated the proposed substitution. We believe that it is equal or superior in all respects to specified product, except as stated above; that it will provide the same Warranty as specified product; that we have included complete implications of the substitution; that we will pay redesign and other costs caused by the substitution which subsequently become apparent; and that we will pay costs to modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning as a result of the substitution.

BIDDER/CONTRACTOR	DATE

REVIEW AND ACTION

☐ Resubmit Substitution Request with the following additional information:

☐ Substitution is accepted.

☐ Substitution is accepted with the following comments:

☐ Substitution is not accepted.

ARCHITECT/ENGINEER	DATE

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION

FINAL RECEIPT OF PAYMENT AND RELEASE

PROJECT NUMBER

KNOW ALL MEN BY THESE PRESENT THAT: hereinafter called "Subcontractor" who heretofore entered into an agreement with hereinafter called "Contractor", for the performance of work and/or furnishing of material for the construction of the project entitled

(PROJECT TITLE, PROJECT LOCATION, AND PROJECT NUMBER)

at

(ADDRESS OF PROJECT)

for the State of Missouri (Owner) which said subcontract is by this reference incorporated herein, in consideration of such final payment by Contractor.

DOES HEREBY:

1. ACKNOWLEDGE that they have been **PAID IN FULL** all sums due for work and materials contracted or done by their Subcontractors, Material Vendors, Equipment and Fixture Suppliers, Agents and Employees, or otherwise in the performance of the Work called for by the aforesaid Contract and all modifications or extras or additions thereto, for the construction of said project or otherwise.
2. RELEASE and fully, finally, and forever discharge the Owner from any and all suits, actions, claims, and demands for payment for work performed or materials supplied by Subcontractor in accordance with the requirements of the above referenced Contract.
1. REPRESENT that all of their Employees, Subcontractors, Material Vendors, Equipment and Fixture Suppliers, and everyone else has been **paid in full** all sums due them, or any of them, in connection with performance of said Work, or anything done or omitted by them, or any of them in connection with the construction of said improvements, or otherwise.

DATED this day of , 20 .

NAME OF SUBCONTRACTOR

BY (TYPED OR PRINTED NAME)

SIGNATURE

TITLE

ORIGINAL: FILE/Closeout Documents

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT,
DESIGN AND CONSTRUCTION

PAY APP NO.	PROJECT NUMBER
CHECK IF FINAL ☐**FINAL**	DATE

MBE/WBE/SDVE PROGRESS REPORT

Remit with **ALL** Progress and Final Payments

(Please check appropriate box) ☐CONSULTANT ☐CONSTRUCTION

PROJECT TITLE	
PROJECT LOCATION	
FIRM	
ORIGINAL CONTRACT SUM (Same as Line Item 1. on Form A of Application for Payment) **$**	TOTAL CONTRACT SUM TO DATE (Same as Line Item 3. on Form A of Application for Payment) **$**

THE TOTAL MBE/WBE/SDVE PARTICIPATION DOLLAR AMOUNT OF THIS PROJECT AS INDICATED IN THE ORIGINAL CONTRACT: **$**

SELECT MBE, WBE, SDVE	ORIGINAL CONTRACT PARTICIPATION AMOUNT	PARTICIPATION AMOUNT PAID-TO-DATE (includes approved contract changes)	CONSULTANT/SUBCONSULTANT OR CONTRACTOR/SUBCONTRACTOR/SUPPLIER COMPANY NAME
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	

Revised 06/2023

STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION
AFFIDAVIT – COMPLIANCE WITH PREVAILING WAGE LAW

PROJECT NUMBER

Before me, the undersigned Notary Public, in and for the County of _____

State of _____ personally came and appeared _____
(NAME)

_____ of the _____
(POSITION) (NAME OF THE COMPANY)

(a corporation) (a partnership) (a proprietorship) and after being duly sworn did depose and say that all provisions and requirements set out in Chapter 290, Sections 290.210 through and including 290.340, Missouri Revised Statutes, pertaining to the payment of wages to workmen employed on public works project have been fully satisfied and there has been no exception to the full and completed compliance with said provisions and requirements and with Wage Determination No: _____ issued by the Department of Labor and Industrial Relations, State of Missouri on the _____ day of _____ 20 __ in carrying out the contract and working in connection with _____
(NAME OF PROJECT)

Located at _____ in _____ County
(NAME OF THE INSTITUTION)

Missouri, and completed on the _____ day of _____ 20 __

SIGNATURE

NOTARY INFORMATION

NOTARY PUBLIC EMBOSSER OR BLACK INK RUBBER STAMP SEAL	STATE		COUNTY (OR CITY OF ST. LOUIS)
	SUBSCRIBED AND SWORN BEFORE ME, THIS DAY OF YEAR		**USE RUBBER STAMP IN CLEAR AREA BELOW**
	NOTARY PUBLIC SIGNATURE	MY COMMISSION EXPIRES	
	NOTARY PUBLIC NAME (TYPED OR PRINTED)		

FILE: Closeout Documents

GENERAL CONDITIONS

INDEX

A. These General Conditions apply to each section of these specifications. The Contractor is subject to the provisions contained herein.

B. The General Conditions are intended to define the relationship of the Owner, the Designer and the Contractor thereby establishing certain rules and provisions governing the operation and performance of the work so that the work may be performed in a safe, orderly, expeditious and workmanlike manner.

ARTICLE 1 – GENERAL PROVISIONS

ARTICLE 1.1 - DEFINITIONS

As used in these contract documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

1. **"COMMISSIONER":** The Commissioner of the Office of Administration.
2. **"CONSTRUCTION DOCUMENTS":** The "Construction Documents" shall consist of the Project Manual, Drawings and Addenda.
3. **"CONSTRUCTION REPRESENTATIVE:"** Whenever the term "Construction Representative" is used, it shall mean the Owner's Representative at the work site.
4. **"CONTRACTOR"**: Party or parties who have entered into a contract with the Owner to furnish work under these specifications and drawings.
5. **"DESIGNER"**: When the term "Designer" is used herein, it shall refer to the Architect, Engineer, or Consultant of Record specified and defined in Paragraph 2.0 of the Supplemental Conditions, or his duly authorized representative. The Designer may be either a consultant or state employee.
6. **"DIRECTOR"**: Whenever the term "Director" is used, it shall mean the Director of the Division of Facilities Management, Design and Construction or his Designee, representing the Office of Administration, State of Missouri. The Director is the agent of the Owner.
7. **"DIVISION":** Shall mean the Division of Facilities Management, Design and Construction, State of Missouri.
8. **"INCIDENTAL JOB BURDENS":** Shall mean those expenses relating to the cost of work, incurred either in the home office or on the job-site, which are necessary in the course of doing business but are incidental to the job. Such costs include office supplies and equipment, postage, courier services, telephone expenses including long distance, water and ice and other similar expenses.
9. **"JOINT VENTURE"**: An association of two (2) or more businesses to carry out a single business enterprise for profit for which purpose they combine their property, capital, efforts, skills and knowledge.
10. **"OWNER"**: Whenever the term "Owner" is used, it shall mean the State of Missouri.
11. **"PROJECT"**: Wherever the term "Project" is used, it shall mean the work required to be completed by the construction contract.
12. **"PROJECT MANUAL"**: The "Project Manual" shall consist of Introductory Information, Invitation for Bid, Instructions to Bidders, Bid Documents, Additional Information, Standard Forms, General Conditions, Supplemental General Conditions, General Requirements and Technical Specifications.
13. **"SUBCONTRACTOR"**: Party or parties who contract under, or for the performance of part or this entire Contract between the Owner and Contractor. The subcontract may or may not be direct with the Contractor.
14. **"WORK"**: Labor, material, supplies, plant and equipment required to perform and complete the service agreed to by the Contractor in a safe, expeditious, orderly and workmanlike manner so that the project shall be complete and finished in the best manner known to each respective trade.
15. "**WORKING DAYS**": are all calendar days except Saturdays, Sundays and the following holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday (observed), Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day (observed), Thanksgiving Day, Christmas Day.

ARTICLE 1.2 DRAWINGS AND SPECIFICATIONS

A. In case of discrepancy between drawings and specifications, specifications shall govern. Should discrepancies in architectural drawings, structural drawings and mechanical drawings occur,

architectural drawings shall govern and, in case of conflict between structural and mechanical drawings, structural drawings shall govern.

B. Specifications are separated into titled divisions for convenience of reference only and to facilitate letting of contracts and subcontracts. The Contractor is responsible for establishing the scope of work for subcontractors, which may cross titled divisions. Neither the Owner nor Designer will establish limits and jurisdiction of subcontracts.

C. Figured dimensions take precedence over scaled measurements and details over smaller scale general drawings. In the event of conflict between any of the documents contained within the contract, the documents shall take precedence and be controlling in the following sequence: addenda, supplementary general conditions, general conditions, division 1 specifications, technical division specifications, drawings, bid form and instructions to bidders.

D. Anything shown on drawings and not mentioned in these specifications or vice versa, as well as any incidental work which is obviously necessary to complete the project within the limits established by the drawings and specifications, although not shown on or described therein, shall be performed by the Contractor at no additional cost as a part of his contract.

E. Upon encountering conditions differing materially from those indicated in the contract documents, the Contractor shall promptly notify the Designer and Construction Representative in writing before such conditions are disturbed. The Designer shall promptly investigate said conditions and report to the Owner, with a recommended course of action. If conditions do materially differ and cause an increase or decrease in contract cost or time required for completion of any portion of the work, a contract change will be initiated as outlined in Article 4 of these General Conditions.

E. Only work included in the contract documents is authorized, and the Contractor shall do no work other than that described therein or in accordance with appropriately authorized and approved contract changes.

ARTICLE 1.3 - COMPLIANCE WITH LAWS, PERMITS, REGULATIONS AND INSPECTIONS

A. Since the Owner is the State of Missouri, municipal or political subdivisions, zoning ordinances, construction codes (other than licensing of trades), and other like ordinances are not applicable to construction on Owner's property, and Contractor will not be required to submit drawings and specifications to any municipal or political subdivision, authority, obtain construction permits or any other licenses (other than licensing of trades) or permits from or submit to inspections by any municipality or political subdivision relating to the construction for this project. All permits or licenses required by municipality or political subdivision for operation on property not belonging to Owner shall be obtained by and paid for by Contractor. Each Contractor shall comply with all applicable laws, ordinances, rules and regulations that pertain to the work of this contract.

B. Contractors, subcontractors and their employees engaged in the businesses of electrical, mechanical, plumbing, carpentry, sprinkler system work, and other construction related trades shall be licensed to perform such work by the municipal or political subdivision where the project is located, if such licensure is required by local code. Local codes shall dictate the level (master, journeyman, and apprentice) and the number, type and ratio of licensed tradesmen required for this project within the jurisdiction of such municipal or political subdivision.

C. Equipment and controls manufacturers and their authorized service and installation technicians that do not maintain an office within the jurisdiction of the municipal or political subdivision but are a listed or specified contractor or subcontractor on this project are exempt from Paragraph 1.3 B above.

D. The Contractor shall post a copy of the wage determination issued for the project and included as a part of the contract documents, in a prominent and easily accessible location at the site of construction for the duration of the project.

E. Any contractor or subcontractor to such contractor at any tier signing a contract to work on this project shall provide a ten-hour Occupational Safety and Health Administration (OSHA) construction safety program for their on-site employees which includes a course in construction safety and health approved by OSHA or a similar program approved by the Department of Labor and Industrial Relations which is at least as stringent as an approved OSHA program. The contractor shall forfeit as a penalty to the public body on whose behalf the contract is made or awarded, two thousand five hundred dollars plus one hundred dollars for each employee employed by the contractor or subcontractor, for each calendar day, or portion thereof, such employee is employed without the required training.

ARTICLE 1.4 - NONDISCRIMINATION IN EMPLOYMENT

A. The Contractor and his subcontractors will not discriminate against individuals based on race,

color, religion, national origin, sex, disability, or age, but may use restrictions which relate to bona fide occupational qualifications. Specifically, the Contractor and his subcontractors shall not discriminate:

1. Against recipients of service on the basis of race, color, religion, national origin, sex, disability or age.
2. Against any employee or applicant, for employment on the basis of race, color, religion, national origin, sex or otherwise qualified disability status.
3. Against any applicant for employment or employee on the basis of age, where such applicant or employee is between ages 40 and 70 and where such Contractor employs at least 20 persons.
4. Against any applicant for employment or employee on the basis of that person's status as a disabled or Vietnam-era veteran.

The Contractor and his Subcontractors will take affirmative action to insure applicants for employment and employees are treated equally without regard to race, color, religion, national origin, sex, disability, or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion and transfer; recruitment or recruitment advertising; and selection for training, including apprenticeship. The Contractor and his Subcontractors will give written notice of their commitments under this clause to any labor union with which they have bargaining or other agreements.

B. The Contractor and his subcontractors shall develop, implement, maintain and submit in writing to the Owner an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed Affidavit for Affirmative Action in the form included in the contract specifications. For the purpose of this section, an "affirmative action program" means positive action to influence all employment practices (including, but not limited to, recruiting, hiring, promoting and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between age 40 and 70), disabled and Vietnam-era veteran status, and disability. Such "affirmative action program" shall include:

   1. A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination;
   2. The identification of a person designated to handle affirmative action;
   3. The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion and discipline;
   4. The exclusion of discrimination from all collective bargaining agreements; and
   5. Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

   In the enforcement of this non-discrimination clause, the Owner may use any reasonable procedures available, including, but not limited to: requests, reports, site visits and inspection of relevant documents of contractors and subcontractors.

C. In the event of the Contractor's or his subcontractor's noncompliance with any provisions of this Article of the Contract, the Owner may cancel this contract in whole or in part or require the Contractor to terminate his contract with the subcontractor.

ARTICLE 1.5 - ANTI-KICKBACK

No employee of the division, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract or in any part hereof. No officer, employee, designer, attorney, or administrator of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the project.

ARTICLE 1.6 - PATENTS AND ROYALTIES

A. The Contractor shall hold and save the Owner and its officers, agents, servants and employees harmless from liabilities of any nature or kind, including cost and expenses, for, or on account of, any patented or unpatented invention, process, article or appliance manufactured or used in the performance of this contract, including its use by the Owner, unless otherwise specifically stipulated in the contract documents.

B. If the Contractor uses any design, device or materials covered by letters, patent or copyright,

the Contractor shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood, without exception, that the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this contract and shall indemnify the Owner for any cost, expense or damage it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

ARTICLE 1.7 - PREFERENCE FOR AMERICAN AND MISSOURI PRODUCTS AND SERVICES

A. By virtue of statutory authority a preference will be given to Missouri labor and to products of mines, forests and quarries of the state of Missouri when they are found in marketable quantities in the state, and all such materials shall be of the best quality and suitable character that can be obtained at reasonable market prices, all as provided for in Section 8.280, Missouri Revised Statutes and Cumulative Supplements.

B. Furthermore, pursuant to Section 34.076 Missouri Revised Statutes and Cumulative Supplements, a preference shall be given to those persons doing business as Missouri firms, corporations, or individuals, or which maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less. In addition, in order for a non-domiciliary bidder to be successful, his bid must be that same percentage lower than a domiciliary Missouri bidder's bid, as would be required for a Missouri bidder to successfully bid in the non-domiciliary state.

C In accordance with the Missouri Domestic Products Procurement Act Section 34.350 RSMo and Cumulative Supplements any manufactured goods or commodities used or supplied in the performance of this contract or any subcontract thereto shall be manufactured, assembled or produced in the United States, unless the specified products are not manufactured, assembled or produced in the United States in sufficient quantities to meet the agency's requirements or cannot be manufactured, assembled or produced in the United States within the necessary time in sufficient quantities to meet the contract requirements, or if obtaining the specified products manufactured, assembled or produced in the United States would increase the cost of this contract for purchase of the product by more than ten percent.

ARTICLE 1.8 - COMMUNICATIONS

A. All notices, requests, instructions, approvals and claims must be in writing and shall be delivered to the Designer and copied to the Construction Representative for the project except as required by Article 1.12 Disputes and Disagreements, or as otherwise specified by the Owner in writing as stated in Section 012600. Any such notice shall be deemed to have been given as of the time of actual receipt.

B. The Contractor shall attend on-site progress and coordination meetings, as scheduled by the Construction Representative, no less than once a month.

C. The Contractor shall ensure that major subcontractors and suppliers shall attend monthly progress meetings as necessary to coordinate the work, and as specifically requested by the Construction Representative.

ARTICLE 1.9 - SEPARATE CONTRACTS AND COOPERATION

A. The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.

B. The Contractor shall consult the drawings for all other contractors in connection with this work. Any work conflicting with the above shall be brought to the attention of the Owner's Representative before the work is performed. If the Contractor fails to do this, and constructs any work which interferes with the work of another contractor, the Contractor shall remove any part so conflicting and rebuild same, as directed by the Owner's Representative at no additional cost to the Owner.

C. Each contractor shall be required to coordinate his work with other contractors so as to afford others reasonable opportunity for execution of their work. No contractor shall delay any other contractor by neglecting to perform contract work at the proper time. If any contractor causes delay to another, they shall be liable directly to that contractor for such delay in addition to any liquidated damages which might be due the Owner.

D. Should the Contractor or project associated subcontractors refuse to cooperate with the instructions and reasonable requests of other Contractors or other subcontractors in the overall

coordinating of the work, the Owner may take such appropriate action and issue directions, as required, to avoid unnecessary and unwarranted delays.

E. Each Contractor shall be responsible for damage done to Owner's or other Contractor's property by him/her or workers in his employ through their fault or negligence.

F. Should a Contractor sustain any damage through any act or omission of any other Contractor having a contract with the Owner, the Contractor so damaged shall have no claim or cause of action against the Owner for such damage, but shall have a claim or cause of action against the other Contractor to recover any and all damages sustained by reason of the acts or omissions of such Contractor. The phrase "acts or omissions" as used in this section shall be defined to include, but not be limited to, any unreasonable delay on the part of any such contractors.

ARTICLE 1.10 - ASSIGNMENT OF CONTRACT

A. No assignment by Contractor of any amount or any part of this contract or of the funds to be received there under will be recognized unless such assignment has had the written approval of the Director and the surety has been given due notice of such assignment and has furnished written consent thereto. In addition to the usual recitals in assignment contracts, the following language must be set forth: "It is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of this contract and to claims or liens for services rendered or materials supplied for the performance of the work called for in said contract in favor of all persons, firms or corporations rendering such services or supplying such materials."

ARTICLE 1.11 - INDEMNIFICATION

A. Contractor agrees to indemnify and save harmless Owner and its respective commissioners, officers, officials, agents, consultants and employees and Designer, their agents, servants and employees, from and against any and all liability for damage arising from injuries to persons or damage to property occasioned by any acts or omissions of Contractor, any subcontractors, agents, servants or employees, including any and all expense, legal or otherwise, which may be incurred by Owner or Designer, its agents, servants or employees, in defense of any claim, action or suit.

B. The obligations of the Contractor under this paragraph shall not extend to the liability of the Designer, his agents or employees, arising out of (1) the preparation or approval of maps, drawings, opinions, reports, surveys, contract changes, design or specifications, or (2) giving of or the failure to give directions or instructions by the Designer, his agents or employees as required by this contract documents provided such giving or failure to give is the primary cause of the injury or damage.

ARTICLE 1.12 - DISPUTES AND DISAGREEMENTS

It is hereby expressly agreed and understood that in case any controversy or difference of opinion arises during construction, best efforts will be given to resolution at the field level. Should those efforts be unsuccessful, the Contractor has the right to appeal in writing, the decision of the Director's Designee to the Director at Room 730 Truman Building, P.O. Box 809, Jefferson City, Missouri 65102. The decision of the Director shall be final and binding on all parties.

ARTICLE 2 -- OWNER/DESIGNER RESPONSIBILITIES

A. The Owner shall give all orders and directions contemplated under this contract relative to the execution of the work. During progress of work the Owner will be represented at the project site by the Construction Representative and/or Designer, whose responsibilities are to see that this contract is properly fulfilled.

B. The Owner shall at all times have access to the work whenever it is in preparation or progress. The Contractors shall provide proper facilities for such access and for inspection and supervision.

C. All materials and workmanship used in the work shall be subject to the inspection of the Designer and Construction Representative, and any work which is deemed defective shall be removed, rebuilt or made good immediately upon notice. The cost of such correction shall be borne by the Contractor. Contractor shall not be entitled to an extension of the contract completion date in order to remedy defective work. All rejected materials shall be immediately removed from the site of the work.

D. If the Contractor fails to proceed at once with the correction of rejected defective materials or workmanship, the Owner may, by separate contract or otherwise, have the defects remedied or rejected. Materials removed from the site and charge the cost of the same against any monies which may be due the Contractor, without prejudice to any other rights or remedies of the Owner.

E. Failure or neglect on the part of Owner to observe faulty work, or work done which is not in accordance with the drawings and specifications shall not relieve the Contractor from responsibility

for correcting such work without additional compensation.

F. The Owner shall have the right to direct the Contractor to uncover any completed work.

1. If the Contractor fails to adequately notify the Construction Representative and/or Designer of an inspection as required by the Contract Documents, the Contractor shall, upon written request, uncover the work. The Contractor shall bear all costs associated with uncovering and again covering the work exposed.

2. If the Contractor is directed to uncover work, which was not otherwise required by the Contract Documents to be inspected, and the work is found to be defective in any respect, no compensation shall be allowed for this work. If, however, such work is found to meet the requirements of this contract, the actual cost of labor and material necessarily involved in the examination and replacement plus 10% shall be allowed the Contractor.

G. The Designer shall give all orders and directions contemplated under this contract relative to the scope of the work and shall give the initial interpretation of the contract documents.

H. The Owner may file a written notice to the Contractor to dismiss immediately any subcontractors, project managers, superintendents, foremen, workers, watchmen or other employees whom the Owner may deem incompetent, careless or a hindrance to proper or timely execution of the work. The Contractor shall comply with such notice as promptly as practicable without detriment to the work or its progress.

I. If in the Owner's judgment it becomes necessary at any time to accelerate work, when ordered by the Owner in writing, the Contractor shall redirect resources to such work items and execute such portions of the work as may be required to complete the work within the current approved contract schedule.

ARTICLE 3 -- CONTRACTOR RESPONSIBILITIES

The Contractor shall register and utilize the Owner's eBuilder digital project management system for submission of documents described in the following sections. This includes but is not limited to submittals as required by designer, payment applications, Request for Information (RFI), construction change orders, Request for Proposals (RFP), Designer Supplemental Instructions (DSI), etc.

ARTICLE 3.1 -- ACCEPTABLE SUBSTITUTIONS

A. The Contractor may request use of any article, device, product, material, fixture, form or type of construction which in the judgment of the Owner and Designer is equal in all respects to that named. Standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner and Designer that they are equal in design, strength, durability, usefulness and convenience for the purpose intended.

B. Any changes required in the details and dimensions indicated on the drawings for the substitution of products other than those specified shall be properly made at the expense of the Contractor requesting the substitution or change.

C. The Contractor shall submit a request for such substitutions in writing to the Owner and Designer within twenty (20) working days after the date of the "Notice to Proceed." Thereafter no consideration will be given to alternate forms of accomplishing the work. This Article does not preclude the Owner from exercising the provisions of Article 4 hereof.

D. Any request for substitution by the Contractor shall be submitted in accordance with SECTION 002113 - INSTRUCTIONS TO BIDDERS.

E. When a material has been approved, no change in brand or make will be permitted unless:

1. Written verification is received from the manufacturer stating they cannot make delivery on the date previously agreed, or

2. Material delivered fails to comply with contract requirements.

ARTICLE 3.2 -- SUBMITTALS

A. The Contractor's submittals must be submitted with such promptness as to allow for review and approval so as not to cause delay in the work. The Contractor shall coordinate preparation and processing of submittals with performance of construction activities.

Coordinate each submittal with fabrication, = purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

Submit four (4) copies to the Designer and additional copies as required for the subcontractors and material suppliers. Also provide copies to meet the requirements for maintenance manuals.

B. All subcontractors' shop drawings and schedules shall be submitted by the Contractor and shall bear evidence that Contractor has received, reviewed, and approved them. Any shop drawings and

schedules submitted without this evidence will be returned to the Contractor for resubmission.

C. The Contractor shall include with the shop drawing, a letter indicating any and all deviations from the drawings and/or specifications. Failure to notify the Designer of such deviations will be grounds for subsequent rejection of the related work or materials. If, in the opinion of the Designer, the deviations are not acceptable, the Contractor will be required to furnish the item as specified and indicated on the drawings.

D. The Designer shall check shop drawings and schedules with reasonable promptness and approve them only if they conform to the design concept of the project and comply with the information given in the contract documents. The approval shall not relieve the Contractor from the responsibility to comply with the drawings and specifications, unless the Contractor has called the Designer's attention to the deviation, in writing, at the time of submission and the Designer has knowingly approved thereof. An approval of any such modification will be given only under the following conditions:

1. It is in the best interest of the Owner
2. It does not increase the contract sum and/or completion time
3. It does not deviate from the design intent
4. It is without prejudice to any and all rights under the surety bond.

E. No extension of time will be granted because of the Contractor's failure to submit shop drawings and schedules in ample time to allow for review, possible resubmission, and approval. Fabrication of work shall not commence until the Contractor has received approval. The Contractor shall furnish prints of approved shop drawings and schedules to all subcontractors whose work is in any way related to the work under this contract. Only prints bearing this approval will be allowed on the site of construction

F. The Contractor shall maintain a complete file on-site of approved shop drawings available for use by the Construction Representative.

ARTICLE 3.3 – AS-BUILT DRAWINGS

A. The Contractor shall update a complete set of the construction drawings, shop drawings and schedules of all work monthly by marking changes, and at the completion of their work (prior to submission of request for final payment) note all changes and turn the set over to the Construction Representative. The updates shall show all addenda, all field changes that were made to adapt to field conditions, changes resulting from contract changes or supplemental instructions, and all locations of structures, buried installations of piping, conduit, and utility services. All buried and concealed items both inside and outside shall be accurately located as to depth and referenced to permanent features such as interior or exterior wall faces and dimensions shall be given in a neat and legible manner in a contrasting colored pencil or ink. If approved by the Designer, an electronic file format may be provided.

ARTICLE 3.4 – GUARANTY AND WARRANTIES

A. General Guaranty

1. Neither the final certificate of payment nor any provision in the contract documents nor partial use or occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with contract requirements.
2. The Contractor or surety shall remedy any defects in the work and pay for any damage to property resulting there from which shall appear within a period of one (1) year from the date of substantial completion unless a longer period is otherwise specified or a differing guaranty period has been established in the substantial completion certificate. The Owner will give notice of observed defects with reasonable promptness.
3. In case of default on the part of the Contractor in fulfilling this part of this contract, the Owner may correct the work or repair the damage and the cost and expense incurred in such event shall be paid by or recoverable from the Contractor or surety.
4. The work will be free from defects not inherent in the quality required or permitted, and that the Work will conform to the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's guaranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment

B. Extended Warranty

Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year. Where a longer

period is offered at no additional cost or called for in the specific equipment specifications, the longer period shall govern.

ARTICLE 3.5 -- OPERATION AND MAINTENANCE MANUALS

A. Immediately after equipment submittals are approved and no later than ten (10) working days prior to the substantial completion inspection, the Contractor shall provide to the Designer three (3) copies of operating instructions and service manuals, containing the following:

1. Start-up and Shut-down Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available; they may be incorporated into the operating manual for reference.
2. Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.
3. Equipment List: List of all major equipment as installed shall be prepared to include model number, capacities, flow rate, name place data, shop drawings and air and water balance reports.
4. Service Instructions: Provide the following information for all pieces of equipment.
    a. Recommended spare parts including catalog number and name of local supplier or factory representative.
    b. Belt sizes, types, and lengths.
    c. Wiring diagrams.
5. Manufacturer's Certificate of Warranty as described in Article 3.4.
6. Prior to the final payment, furnish to the Designer three (4) copies of parts catalogs for each piece of equipment furnished by him/her on the project with the components identified by number for replacement ordering.

B. Submission of operating instructions shall be done in the following manner.

1. Manuals shall be in quadruplicate, and all materials shall be bound into volumes of standard 8½" x 11" hard binders. Large drawings too bulky to be folded into 8½" x 11" shall be separately bound or folded and in envelopes, cross referenced and indexed with the manuals.
2. The manuals shall identify project name, project number, and include the name and address of the Contractor, subcontractors and manufacturers who were involved with the activity described in that particular manual.
3. Internally subdivide the binder contents with permanent page dividers, logically organized with tab titles clearly printed under reinforced laminated plastic tabs.
4. Contents: Prepare a Table of Contents for each volume, with each product or system description identified.

ARTICLE 3.6 – OTHER CONTRACTOR RESPONSIBILITIES

A. The Contractor shall keep on site, during progress of the work, a competent superintendent satisfactory to the Construction Representative. The superintendent shall represent the Contractor and all agreements made by the superintendent shall be binding. The superintendent shall carefully study and compare all drawings, specifications and other instructions and shall promptly notify the Construction Representative and Designer, in writing, any error, inconsistency or omission which may be discovered. The superintendent shall coordinate all work on the project. Any change of the superintendent shall be approved by the Construction Representative.

B. Contractor shall, at all times, enforce strict discipline and good order among his employees, and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him/her.

C. The Contractor shall supply sufficient labor, material, plant and equipment and pay when due any laborer, subcontractor or supplier for supplies furnished and otherwise prosecute the work with diligence to prevent work stoppage and insure completion thereof within the time specified.

D. The Contractor and each of his subcontractors shall submit to the Construction Representative, through the Designer such schedules of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the Owner may request concerning work performed or to be performed under this contract.

E. The Contractor, subcontractors, and material suppliers shall upon written request, give the Owner access to all time cards, material invoices, payrolls, estimates, profit and loss statements, and all other direct or indirect costs related to this work.

F. The Contractor shall be responsible for laying out all contract work such as layout of architectural, structural, mechanical and electrical work, which shall be coordinated with layouts of subcontractors

for general construction work. The Contractor is also responsible for unloading, uncrating and handling of all materials and equipment to be erected or placed by him/her, whether furnished by Contractor or others. No extra charges or compensation will be allowed as a result of failure to verify dimensions before ordering materials or fabricating items.

G. The Contractor must notify the Construction Representative at least one working day before placing concrete or burying underground utilities, pipelines, etc.

H. Contractors shall prearrange time with the Construction Representative for the interruption of any facility operation. Unless otherwise specified in these documents, all connections, alterations or relocations as well as all other portions of the work will be performed during normal working hours.

I. The Contractor shall coordinate all work so there will not be prolonged interruptions of existing equipment operation. Any existing plumbing, heating, ventilating, air conditioning or electrical disconnections necessary for the project, which affect portions of this construction or building or any other building must be scheduled with the Construction Representative to minimize or avoid any disruption of facility operations. In no case, unless previously approved in writing by the Construction Representative, shall utilities be left disconnected at the end of a work day or over a weekend. Any interruption of utilities either intentionally or accidentally shall not relieve the Contractor responsible for the interruption from the responsibility to repair and restore the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

J. Contractors shall limit operations and storage of materials to the area within the project, except as necessary to connect to existing utilities, and shall not encroach on neighboring property. The Contractor shall be responsible for repair of their damage to property on or off the project site occurring during construction of project. All such repairs shall be made to the satisfaction of the property owner.

K. Unless otherwise permitted, all materials shall be new and both workmanship and materials shall be of the best quality.

L. Unless otherwise provided and stipulated within these specifications, the Contractor shall furnish, construct, and/or install and pay for materials, devices, mechanisms, equipment, all necessary personnel, utilities including, but not limited to water, heat, light and electric power, transportation services, applicable taxes of every nature, and all other facilities necessary for the proper execution and completion of the work.

M. Contractor shall carefully examine the plans and drawings and shall be responsible for the proper fitting of his material, equipment and apparatus into the building.

N. The Contractor or subcontractors shall not overload, or permit others to overload, any part of any structure during the performance of this contract.

O. All temporary shoring, bracing, etc., required for the removal of existing work and/or for the installation of new work shall be included in this contract. The Contractor shall make good, at no cost to the Owner, any damage caused by improper support or failure of shoring in any respect. Each Contractor shall be responsible for shoring required to protect his work or adjacent property and improvements of Owner and shall be responsible for shoring or for giving written notice to adjacent property owners. Shoring shall be removed only after completion of permanent supports.

P. The Contractor shall provide at the proper time such material as is required for support of the work. If openings are required, whether shown on drawings or not, the Contractor shall see that they are properly constructed.

Q. During the performance of work the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences and other devices appropriately located on site which will give proper and understandable warning to all persons of danger of entry onto land, structure or equipment.

R. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials.

S. The Contractor shall be responsible for care of the finished work and shall protect same from damage or defacement until substantial completion by the Owner. If the work is damaged by any cause, the Contractor shall immediately begin to make repairs in accordance with the drawings and specifications. Contractor shall be liable for all damage or loss unless attributable to the acts or omissions of the Owner or Designer. Any claim for reimbursement shall be submitted in accordance with Article 4. After substantial completion the Contractor will only be responsible for damage resulting from acts or omissions of the Contractor or subcontractors through final warranty.

T. In the event the Contractor encounters an unforeseen hazardous material, the Contractor

shall immediately stop work in the area affected and report the condition to the Owner and Designer in writing. The Contractor shall not be required, pursuant to Article 4, to perform, any work relating to hazardous materials.

U. In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 4.

V. Before commencing work, Contractors shall confer with the Construction Representative and facility representative and review any facility rules and regulations which may affect the conduct of the work.

W. Project signs will only be erected on major projects and only as described in the specifications. If no sign is specified, none shall be erected.

ARTICLE 3.7 -- SUBCONTRACTS

A. Subcontractor assignments as identified in the bid form shall not be changed without written approval of the Owner. The Owner will not approve changes of a listed subcontractor unless the Contractor documents, to the satisfaction of the Owner that the subcontractor cannot or will not perform the work as specified.

B. The Contractor is fully responsible to the Owner for the acts and omissions of all subcontractors and of persons either directly or indirectly employed by them.

C. Every subcontractor shall be bound by the applicable terms and provisions of these contract documents, but no contractual relationship shall exist between any subcontractor and the Owner unless the right of the Contractor to proceed with the work is suspended or this contract is terminated as herein provided, and the Owner in writing elects to assume the subcontract.

D. The Contractor shall upon receipt of "Notice to Proceed" and prior to submission of the first payment request, notify the Designer and Construction Representative in writing of the names of any subcontractors to be used in addition to those identified in the bid form and all major material suppliers proposed for all parts of the work.

ARTICLE 4 -- CHANGES IN THE WORK

4.1 CHANGES IN THE WORK

A. The Construction Representative, without giving notice to the surety and without invalidating this contract, may order extra work or make changes by altering, adding to or deducting from the work, this contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract. A claim for extension of time caused by any change must be adjusted at the time of ordering such change. No future request for time will be considered.

B. Each Contract Change shall include all costs required to perform the work including all labor, material, equipment, overheads and profit, delay, disruptions, or other miscellaneous expenses. No subsequent requests for additional compensation including claims for delay, disruption, or reduced efficiency as a result of each change will be considered. Values from the Schedule of Values will not be binding as a basis for additions to or deductions from the contract price.

C. The amount of any adjustment in this contract price for authorized changes shall be agreed upon before such changes become effective and shall be determined, through submission of a request for proposal, as follows:

1. By an acceptable fixed price proposal from the Contractor. Breakdowns shall include all takeoff sheets of each Contractor and subcontractor. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.

2. By a cost-plus-fixed-fee (time and material) basis with maximum price, total cost not to exceed said maximum. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.

3. By unit prices contained in Contractor's original bid form and incorporated in the construction contract.

D. Overhead and Profit on Contract Changes shall be applied as follows:

1. The overhead and profit charge by the Contractor and all subcontractors shall be considered to include, but is not limited to: incidental job burdens, small truck (under 1 ton) expense, mileage, small hand tools,

warranty costs, company benefits and general office overhead. Project supervision including field supervision and job site office expense shall be considered a part of overhead and profit unless a compensable time extension is granted.

2. The percentages for overhead and profit charged on Contract Changes shall be negotiated, and may vary according to the nature, extent, and complexity of the work involved. However, the overhead and profit for the Contractor or subcontractor actually performing the work shall not exceed 14%. When one or more tiers of subcontractors are used, in no event shall any Contractor or subcontractor receive as overhead and profit more than 3% of the cost of the work performed by any of his subcontractors. In no case shall the total overhead and profit paid by the Owner on any Contract Changes exceed twenty percent (20%) of the cost of materials, labor and equipment (exclusive of Contractor or any Subcontractor overhead and profit) necessary to put the contract change work in place.

3. The Contractor will be allowed to add the cost of bonding and insurance to their cost of work. This bonding and insurance cost shall not exceed 2% and shall be allowed on the total cost of the added work, including overhead and profit.

4. On proposals covering both increases and decreases in the amount of this contract, the application of overhead and profit shall be on the net change in the cost of the work.

5. The percentage for overhead and profit to be credited to the Owner on Contract Changes that are solely decreases in the quantity of work or materials shall be negotiated, and may vary according to the nature, extent and complexity of the work involved, but in no case shall be less than ten percent (10%). If the percentage for overhead and profit charged for work added by Contract Changes for this contract has been negotiated to less than 10%, the negotiated rate shall then apply to credits as well.

E. No claim for an addition to this contract sum shall be valid unless authorized as aforesaid in writing by the Owner. In the event that none of the foregoing methods are agreed upon, the Owner may order the Contractor to perform work on a time and material basis. The cost of such work shall be determined by the Contractor's actual labor and material cost to perform the work plus overhead and profit as outlined herein. The Designer and Construction Representative shall approve the Contractor's daily time and material invoices for the work involved.

F. If the Contractor claims that any instructions involve extra cost under this contract, the Contractor shall give the Owner's Representative written notice thereof within a reasonable time after the receipt of such instructions, and in any event before proceeding to execute the work. No such claim shall be valid unless so made and authorized by the Owner, in writing.

G. In an emergency affecting the safety of life or of the structure or of adjoining property, the Contractor, without special instruction or authorization from the Construction Representative, is hereby permitted to act at their discretion to prevent such threatened loss or injury. The Contractor shall submit a claim for compensation for such emergency work in writing to the Owner's Representative.

ARTICLE 4.2 – CHANGES IN COMPLETION TIME

A. Extension of the number of work days stipulated in the Contract for completion of the work with compensation may be made when:

1. The contractor documents that proposed Changes in the work, as provided in Article 4.1, extends construction activities critical to contract completion date, OR

2. The Owner suspends all work for convenience of the Owner as provided in Article 7.3, OR

3. An Owner caused delay extends construction activities critical to contract completion (except as provided elsewhere in these General Conditions). The Contractor is to review the work activities yet to begin and evaluate the possibility of rescheduling the work to minimize the overall project delay.

B. Extension of the number of work days stipulated in the Contract for completion of the work <u>without</u> compensation may be made when:

1. Weather-related delays occur, subject to provisions for the inclusion of a specified number of "bad weather" days when provided for in Section 012100-Allowances, OR

2. Labor strikes or acts of God occur, OR

3. The work of the Contractor is delayed on account of conditions which were beyond the control of the Contractor, subcontractors or suppliers, and were not the result of their fault or negligence.

C. No time extension or compensation will be provided for delays caused by or within the control

of the Contractor, subcontractors or suppliers and for concurrent delays caused by the Owner.

D. The Contractor shall notify the Owner promptly of any occurrence or conditions which in the Contractor's opinion results in a need for an extension of time. The notice shall be in writing and shall include all necessary supporting materials with details of any resultant costs and be submitted in time to permit full investigation and evaluation of the Contractor's claim. The Owner shall promptly acknowledge the Contractor's notice and, after recommendation from the Owner's Representative and/or Designer, shall provide a decision to the Contractor. Failure on the part of the Contractor to provide such notice and to detail the costs shall constitute a waiver by the Contractor of any claim. Requests for extensions of time shall be for working days only.

ARTICLE 5 - CONSTRUCTION AND COMPLETION

ARTICLE 5.1 – CONSTRUCTION COMMENCEMENT

A. Upon receipt of the "Intent to Award" letter, the Contractor must submit the following properly executed instruments to the Owner:

1. Contract;
2. Performance/payment bond as described in Article 6.1;
3. Certificates of Insurance, or the actual policies themselves, showing that the Contractor has obtained the insurance coverage required by Article 6.2.
4. Written Affirmative Action Plans as required in Article 1.4.

Above referenced items must be received by the Owner within ten (10) working days after the effective date of the contract. If not received, the Owner may treat the failure to timely submit them as a refusal by the Contractor to accept a contract for this work and may retain as liquidated damages the Contractor's bid bond, cashier's check or certified check as provided in the Instructions to Bidders. Upon receipt the Owner will issue a "Notice to Proceed" with the work to the Contractor.

B. Within the time frame noted in Section 013200 - Schedules, following receipt of the "Notice to Proceed", the Contractor shall submit to the Owner a progress schedule and schedule of values, showing activities through the end of the contract period. Should the Contractor not receive written notification from the Owner of the disapproval of the schedule of values within fifteen (15) working days, the Contractor may consider it approved for purpose of determining when the first monthly Application and Certification for Payment may be submitted.

C. The Contractor may commence work upon receipt of the Division of Facilities Management, Design and Construction's "Notice to Proceed" letter. Contractor shall prosecute the work with faithfulness and energy, and shall complete the entire work on or before the completion time stated in the contract documents or pay to the Owner the damages resulting from the failure to timely complete the work as set out within Article 5.4.

ARTICLE 5.2 -- PROJECT CONSTRUCTION

A. Each Contractor shall submit for the Owner's approval, in reproducible form, a progress schedule showing the rate of progress and the order of the work proposed to carry on various phases of the project. The schedule shall be in conformance with the requirements outlined in Section 013200 – Schedules.

B. Contractor shall employ and supply a sufficient force of workers, material, and equipment and shall pay when due, any worker, subcontractor or supplier and otherwise prosecute the work with such diligence so as to maintain the rate of progress indicated on the progress schedule, prevent work stoppage, and insure completion of the project within the time specified.

ARTICLE 5.3 -- PROJECT COMPLETION

A. Substantial Completion. A Project is substantially complete when construction is essentially complete and work items remaining to be completed can be done without interfering with the Owner's ability to use the Project for its intended purpose.

1. Once the Contractor has reached what they believe is Substantial Completion, the Contractor shall notify the Designer and the Construction Representative of the following:
   a. That work is essentially complete with the exception of certain listed work items. The list shall be referred to as the "Contractor's Punch."
   b. That all Operation and Maintenance Manuals have been assembled and submitted in accordance with Article 3.5A.
   c. That the Work is ready for inspection by the Designer and Construction Representative. The Owner shall be entitled to a minimum of ten working

days notice before the inspection shall be performed.

2. If the work is acceptable, the Owner shall issue a Certificate of Substantial Completion, which shall set forth the responsibilities of the Owner and the Contractor for utilities, security, maintenance, damage to the work and risk of loss. The Certificate shall also identify those remaining items of work to be performed by the Contractor. All such work items shall be complete within 30 working days of the date of the Certificate, unless the Certificate specifies a different time. If the Contractor shall be required to perform tests that must be delayed due to climatic conditions, it is understood that such tests and affected equipment will be identified on the Certificate and shall be accomplished by the Contractor at the earliest possible date. Performance of the tests may not be required before Substantial Completion can be issued. The date of the issuance of the Certificate of Substantial Completion shall determine whether or not the work was completed within the contract time and whether or not Liquidated Damages are due.

3. If the work is not acceptable, and the Owner does not issue a Certificate of Substantial Completion, the Owner shall be entitled to charge the Contractor with the Designer's and Owner's costs of re-inspection, including time and travel.

B. Partial Occupancy. Contractor agrees that the Owner shall be permitted to occupy and use any completed or partially completed portions of the Project, when such occupancy and use is in the Owner's best interest. Owner shall notify Contractor of its desire and intention to take Partial Occupancy as soon as possible but at least ten (10) working days before the Owner intends to occupy. If the Contractor believes that the portion of the work the Owner intends to occupy is not ready for occupancy, the Contractor shall notify the Owner immediately. The Designer shall inspect the work in accordance with the procedures above. If the Contractor claims increased cost of the project or delay in completion as a result of the occupancy, he shall notify the Owner immediately but in all cases before occupancy occurs.

C. Final Completion. The Project is finally complete when the Certificate of Substantial Completion has been issued and all work items identified therein as incomplete have been completed, and when all administrative items required by the contract have been completed. Final Completion entitles the Contractor to payment of the outstanding balance of the contract amount including all change orders and retainage. Within five (5) working days of the date of the Certificate of Substantial Completion, the Contractor shall identify the cost to complete any outstanding items of work. The Designer shall review the Contractor's estimate and either approve it or provide an independent estimate for all such items. If the Contractor fails to complete the remaining items within the time specified in the Certificate, the Owner may terminate the contract and go to the surety for project completion in accordance with Article 7.2 or release the contract balance to the Contractor less 150% of the approved estimate to complete the outstanding items. Upon completion of the outstanding items, when a final cost has been established, any monies remaining shall be paid to the Contractor. Failure to complete items of work does not relieve the Contractor from the obligation to complete the administrative requirements of the contract, such as the provisions of Article 5.3 FAILURE TO COMPLETE ALL ITEMS OF WORK UNDER THE CONTRACT SHALL BE CONSIDERED A DEFAULT AND BE GROUNDS FOR CONTRACT TERMINATION AND DEBARMENT.

D. Liquidated Damages. Contractor agrees that the Owner may deduct from the contract price and retain as liquidated damages, and not as penalty or forfeiture, the sum stipulated in this contract for each work day after the Contract Completion Day on which work is not Substantially Complete. Assessment of Liquidated Damages shall not relieve the Contractor or the surety of any responsibility or obligation under the Contract. In addition, the Owner may, without prejudice to any other rights, claims, or remedies the Owner may have including the right to Liquidated Damages, charge the Contractor for all additional expenses incurred by the Owner and/or Designer as the result of the extended contract period through Final Completion. Additional Expenses shall include but not be limited to the costs of additional inspections.

E. Early Completion. The Contractor has the right to finish the work before the contract completion date; however, the Owner assumes no liability for any hindrances to the Contractor unless Owner caused delays result in a time extension to the contract completion date. The Contractor shall not be entitled to any claims for lost efficiencies or for delay if a Certificate of Substantial Completion is given on or before the Contract Completion Date.

ARTICLE 5.4 -- PAYMENT TO CONTRACTOR

A. Payments on account of this contract will be made monthly in proportion to the work which has been completed. Request for payment must be submitted on the Owner's forms. No other pay request will

be processed. Supporting breakdowns must be in the same format as Owner's forms and must provide the same level of detail. The Designer will, within 5 working days from receipt of the contractor's request for payment either issue a Certificate for Payment to the Owner, for such amount as the Designer determines is properly due, or notify the Contractor in writing of reasons for withholding a Certificate. The Owner shall make payment within 30 calendar days after the "Application and Certification for Payment" has been received and certified by the Designer. The following items are to be attached to the contractor's pay request:

1. Updated construction schedule
2. Certified payrolls consisting of name, occupation and craft, number of hours worked and actual wages paid for each individual employee, of the Contractor and all subcontractors working on the project

B. The Owner shall retain 5 percent of the amount of each such payment application, except as allowed by Article 5.4, until final completion and acceptance of all work covered by this contract.

C. Each payment made to Contractor shall be on account of the total amount payable to Contractor and all material and work covered by paid partial payment shall thereupon become the sole property of Owner. This provision shall not be construed as relieving Contractor from sole responsibility for care and protection of materials and work upon which payments have been made or restoration of any damaged work or as a waiver of the right of Owner to require fulfillment of all terms of this contract.

D. Materials delivered to the work site and not incorporated in the work will be allowed in the Application and Certification for Payment on the basis of one hundred (100%) percent of value, subject to the 5% retainage providing that they are suitably stored on the site or in an approved warehouse in accordance with the following requirements:

1. Material has previously been approved through submittal and acceptance of shop drawings conforming to requirements of Article 3.2 of General Conditions.
2. Delivery is made in accordance with the time frame on the approved schedule.
3. Materials, equipment, etc., are properly stored and protected from damage and deterioration and remain so - if not, previously approved amounts will be deleted from subsequent pay applications.
4. The payment request is accompanied by a breakdown identifying the material equipment, etc. in sufficient detail to establish quantity and value.

E. The Contractor shall be allowed to include in the Application and Certification for Payment, one hundred (100%) of the value, subject to retainage, of major equipment and material stored off the site if all of the following conditions are met:

1. The request for consideration of payment for materials stored off site is made at least 15 working days prior to submittal of the Application for Payment including such material. Only materials inspected will be considered for inclusion on Application for Payment requests.
2. Materials stored in one location off site are valued in excess of $25,000.
3. That a Certificate of Insurance is provided indicating adequate protection from loss, theft conversion or damage for materials stored off site. This Certificate shall show the State of Missouri as an additional insured for this loss.
4. The materials are stored in a facility approved and inspected, by the Construction Representative.
5. Contractor shall be responsible for, Owner costs to inspect out of state facilities, and any delays in the completion of the work caused by damage to the material or for any other failure of the Contractor to have access to this material for the execution of the work.

F. The Owner shall determine the amount, quality and acceptability of the work and materials which are to be paid for under this contract. In the event any questions shall arise between the parties, relative to this contract or specifications, determination or decision of the Owner or the Construction Representative and the Designer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this contract affected in any manner or to any extent by such question.

G. Payments Withheld: The Owner may withhold or nullify in whole or part any certificate to such extent as may be necessary to protect the Owner from loss on account of:

1. Defective work not remedied. When a notice of noncompliance is issued on an item or items, corrective action shall be undertaken immediately. Until corrective action is completed, no monies will be paid and no additional time will be allowed for the item or

items. The cost of corrective action(s) shall be borne by the Contractor.

2. A reasonable doubt that this contract can be completed for the unpaid balance.

3. Failure of the Contractor to update as-built drawings monthly for review by the Construction Representative.

4. Failure of the Contractor to update the construction schedule.

When the Construction Representative is satisfied the Contractor has remedied above deficiencies, payment shall be released.

H. Final Payment: Upon receipt of written notice from the Contractor to the Designer and Project Representative that the work is ready for final inspection and acceptance, the Designer and Project Representative, with the Contractor, shall promptly make such inspection. If the work is acceptable and the contract fully performed, the Construction Representative shall complete a final acceptance report and the Contractor will be directed to submit a final Application and Certification for Payment. If the Owner approves the same, the entire balance shall be due and payable, with the exception of deductions as provided for under Article 5.4.

1. Where the specifications provide for the performance by the Contractor of (certain tests for the purpose of balancing and checking the air conditioning and heating equipment and the Contractor shall have furnished and installed all such equipment in accordance with the specifications, but said test cannot then be made because of climatic conditions, such test shall may be considered as required under the provisions of the specifications, Section 013300 and this contract may be substantial Full payment will not be made until the tests have been made and the equipment and system is finally accepted. If the tests are not completed when scheduled, the Owner may deduct 150% of the value of the tests from the final payment.

2. The final payment shall not become due until the Contractor delivers to the Construction Representative:

a) A complete file of releases, on the standard form included in the contract documents as "Final Receipt of Payment and Release Form", from subcontractors and material suppliers evidencing payment in full for services, equipment and materials, as the case may require, if the Owner approves, or a consent from the Surety to final payment accepting liability for any unpaid amounts.

b) An Affidavit of Compliance with Prevailing Wage Law, in the form as included in this contract specifications, properly executed by each subcontractor, and the Contractor

c) Certified copies of all payrolls

d) As-built drawings

3. If any claim remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a claim including all costs and a reasonable attorney's fee.

4. Missouri statute requires prompt payment from the Owner to the Contractor within thirty calendar days and from the Contractor to his subcontractors within fifteen calendar days. Failure to make payments within the required time frame entitles the receiving party to charge interest at the rate of one and one half percent per month calculated from the expiration of the statutory time period until paid.

5. The value of all unused unit price allowances and/or 150% of the value of the outstanding work items, and/or liquidated damages may be deducted from the final pay request without executing a Contract Change. Any unit price items which exceed the number of units in the contract may be added by Contract Change.

ARTICLE 6 -- INSURANCE AND BONDS

ARTICLE 6.1 -- BOND

A. Contractor shall furnish a performance/payment bond in an amount equal to 100% of the contract price to guarantee faithful performance of the contract and 100% of the contract price to guarantee the payment of all persons performing labor on the project and furnishing materials in connection therewith under this contract as set forth in the standard form of performance and payment bond included in the contract documents. The surety on such bond shall be issued by a surety company authorized by the Missouri Department of Insurance to do business in the state of Missouri.

B. All Performance/Payment Bonds furnished in response to this provision shall be provided by a bonding company with a rating of B+ or higher as established by A.M. Best Company, Inc. in their most recent publication.

ARTICLE 6.2 – INSURANCE

A. The successful Contractor shall procure and maintain for the duration of the contract issued a policy or policies of insurance for the protection of both the Contractor and the Owner and their respective officers, officials, agents, consultants and employees. The Owner requires certification of insurance coverage from the Contractor prior to commencing work.

B. Minimum Scope and Extent of Coverage

1. General Liability

Commercial General Liability, ISO coverage form number or equivalent CG 00 01 ("occurrence" basis), or I-SO coverage form number CG 00 02, or ISO equivalent.

If ISO equivalent or manuscript general liability coverage forms are used, minimum coverage will be as follows: Premises/Operations; Independent Contractors; Products/Completed Operations; personal Injury; Broad Form Property Damage including Completed Operations; Broad Form Contractual Liability Coverage to include Contractor's obligations under Article 1.11 Indemnification and any other Special Hazards required by the work of the contract.

2. Automobile Liability

Business Automobile Liability Insurance, ISO Coverage form number or equivalent CA 00 01 covering automobile liability, code 1 "ANY AUTO".

3. Workers' Compensation and Employer's Liability

Statutory Workers' Compensation Insurance for Missouri and standard Employer's Liability Insurance, or the authorization to self-insure for such liability from the Missouri Division of Workers' Compensation.

4. Builder's Risk or Installation Floater Insurance

Insurance upon the work and all materials, equipment, supplies, temporary structures and similar items which may be incident to the performance of the work and located at or adjacent to the site, against loss or damage from fire and such other casualties as are included in extended coverage in broad "All Risk" form, including coverage for Flood and Earthquake, in an amount not less than the replacement cost of the work or this contact price, whichever is greater, with loss payable to Contractor and Owner as their respective interests may appear.

Contractor shall maintain sufficient insurance to cover the full value of the work and materials as the work progresses, and shall furnish Owner copies of all endorsements. If Builder's Risk Reporting- Form of Endorsement is used, Contractor shall make all reports as required therein so as to keep in force an amount of insurance which will equal the replacement cost of the work, materials, equipment, supplies, temporary structures, and other property covered thereby; and if, as a result of Contractor's failure to make any such report, the amount of insurance so recoverable shall be less than such replacement cost, Contractor's interest in the proceeds of such insurance, if any, shall be subordinated to Owner's interest to the end that Owner may receive full reimbursement for its loss.

C. Minimum Limits of Insurance

1. General Liability

Contractor

$2,000,000	combined single limit per occurrence for bodily injury, personal injury, and property damage
$2,000,000	annual aggregate

2. Automobile Liability

$2,000,000	combined single limit per occurrence for bodily injury and property damage

3. Workers' Compensation and Employers Liability

Workers' Compensation limits as required by applicable State Statutes (generally unlimited) and minimum of $1,000,000 limit per accident for Employer's Liability.

General Liability and Automobile Liability insurance may be arranged under individual policies for the full limits required or by a combination of underlying policies with the balance provided by a form-following Excess or Umbrella Liability policy.

D. Deductibles and Self-Insured Retentions

All deductibles, co-payment clauses, and self-insured retentions must be declared to and approved by the Owner. The Owner reserves the right to request the reduction or elimination of unacceptable deductibles or self-insured retentions, as they would apply to the Owner, and their respective officers, officials, agents, consultants and employees. Alternatively, the Owner may request Contractor to procure a bond guaranteeing

payment of losses and related investigations, claims administration, and defense expenses.

E. Other Insurance Provisions and Requirements

The respective insurance policies and coverage, as specified below, must contain, or be endorsed to contain the following conditions or provisions:

1. General Liability

The Owner, and its respective commissioners, officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 Additional Insured - Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance of self-insurance programs maintained by the designated additional -insured's shall be excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's general liability insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner, or for any of their officers, officials, agents, consultants or employees.

2. Automobile Insurance

The Owner, and their respective officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 - Additional Insured Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance or self-insurance programs maintained by the designated additional insured's shall be in excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's automobile insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner or for any of its officers, officials, agents, consultants or employees.

3. Workers' Compensation/Employer's Liability

Contractor's workers' compensation insurance shall be endorsed with NCCI form WC 00 03 01 A - Alternative Employer Endorsement. The Alternative Employer Endorsement shall designate the Owner as "alternate employers."

4. All Coverages

Each insurance policy required by this section of the Contract shall contain a stipulation, endorsed if necessary, that the Owner will receive a minimum of a thirty (30) calendar day advance notice of any policy cancellation. Ten (10) calendar days advance notice is required for policy cancellation due to non-payment of premium.

F. Insurer Qualifications and Acceptability

Insurance required hereunder shall be issued by an A.M. Best, "B+" rated, Class IX insurance company approved to conduct insurance business in the state of Missouri.

G. Verification of Insurance Coverage

Prior to Owner issuing a Notice to Proceed, the Contractor-shall furnish the Owner with Certificate(s) of Insurance and with any applicable original endorsements evidencing the required insurance coverage. The insurance certificates and endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. All certificates and endorsements received by the Owner are subject to review and approval by the Owner. The Owner reserves the right to require certified copies of all required policies at any time. If the scope of this contract will exceed one (1) year - or, if any of Contractor's applicable insurance coverage expires prior to completion of the work or services required under this contract -

the Contractor will provide a renewal or replacement certificate before continuing work or services hereunder. If the Contractor fails to provide documentation of required insurance coverage, the Owner may issue a stop work order and no additional contract completion time and/or compensation shall be granted as a result thereof.

ARTICLE 7 – SUSPENSION OR TERMINATION OF CONTRACT

ARTICLE 7.1 - FOR SITE CONDITIONS

When conditions at the site of the proposed work are considered by the Owner to be unsatisfactory for prosecution of the work, the Contractor may be ordered in writing to suspend the work or any part thereof until reasonable conditions exist. When such suspension is not due to fault or negligence of the Contractor, time allowed for completion of such suspended work will be extended by a period of time equal to that lost due to delay occasioned by ordered suspension. This will be a no cost time extension.

ARTICLE 7.2 - FOR CAUSE

A. Termination or Suspension for Cause:

1. If the Contractor shall file for bankruptcy, or should make a general assignment for the benefit of the creditors, or if a receiver should be appointed on account of insolvency, or if the contractor should persistently or repeatedly refuse or fail to supply enough properly skilled workers or proper materials, or if the contractor should fail to make prompt payment to subcontractors or for material or labor, or persistently disregard laws, ordinances or the instructions of the Owner, or otherwise be guilty of a substantial violation of any provision of this contract, then the Owner may serve notice on the Contractor and the surety setting forth the violations and demanding compliance with this contract. Unless within ten (10) consecutive calendar days after serving such notice, such violations shall cease and satisfactory arrangements for correction be made, the Owner may suspend the Contractor's right to proceed with the work or terminate this contract.

2. In the event the Owner suspends Contractor's right to proceed with the work or terminates the contract, the Owner may demand that the Contractor's surety take over and complete the work on this contract, after the surety submits a written proposal to the Owner and receives written approval and upon the surety's failure or refusal to do so within ten (10) consecutive calendar days after demand therefore, the Owner may take over the work and prosecute the same to completion by bid or negotiated contract, or the Owner may elect to take possession of and utilize in completing the work such materials, supplies, appliances and plant as may be on the site of the work, and all subcontractors, if the Owner elects, shall be bound to perform their contracts.

B. The Contractor and its surety shall be and remain liable to the Owner for any excess cost or damages occasioned to the Owner as a result of the actions above set forth.

C. The Contractor in the event of such suspension or termination shall not be entitled to receive any further payments under this contract until the work is wholly finished. Then if the unpaid balance under this contract shall exceed all expenses of the Owner as certified by the Director, such excess shall be paid to the Contractor; but, if such expenses shall exceed the unpaid balance as certified by the Director, the Contractor and their surety shall be liable for and shall pay the difference and any damages to the Owner.

D. In exercising Owner's right to secure completion of the work under any of the provisions hereof, the Director shall have the right to exercise Owner's sole discretion as to the manner, methods and reasonableness of costs of completing the work.

E. The rights of the Owner to suspend or terminate as herein provided shall be cumulative and not exclusive and shall be in addition to any other remedy provided by law.

F. The Contractor in the event of such suspension or termination may be declared ineligible for Owner contracts for a minimal period of twelve (12) months. Further, no contract will be awarded to any Contractor who lists in their bid form any subcontractor whose prior performance has contributed, as determined by the Owner, to a breach of a contract. In order to be considered for state-awarded contracts after this period, the Contractor/subcontractor will be required to forward acceptance reports to the Owner regarding successful completion of non-state projects during the intervening twelve (12) months from the date of default. No contracts will be awarded to a subcontractor/Contractor until the ability to perform responsibly in the private sector has been proven to the Owner.

ARTICLE 7.3 -- FOR CONVENIENCE

A. The Owner may terminate or suspend the Contract or any portion of the Work without cause at any time, and at the Owner's convenience. Notification of a termination or suspension shall be in writing

and shall be given to the Contractor and their surety. If the Contract is suspended, the notice will contain the anticipated duration of the suspension or the conditions under which work will be permitted to resume. If appropriate, the Contractor will be requested to demobilize and re-mobilize and will be reimbursed time and costs associated with the suspension.

B. Upon receipt of notification, the Contractor shall:

1. Cease operations when directed.

2. Take actions to protect the work and any stored materials.

3. Place no further subcontracts or orders for material, supplies, services or facilities except as may be necessary to complete the portion of the Contract that has not been terminated. No claim for payment of materials or supplies ordered after the termination date shall be considered.

4. Terminate all existing subcontracts, rentals, material, and equipment orders.

5. Settle all outstanding liabilities arising from termination with subcontractors and suppliers.

6. Transfer title and deliver to the Owner, work in progress, completed work, supplies and other material produced or acquire for the work terminated, and completed or partially completed plans, drawings information and other property that, if the Contract had been completed, would be required to be furnished to the Owner.

C. For termination without cause and at the Owner's convenience, in addition to payment for work completed prior to date of termination, the Contractor may be entitled to payment of other documented costs directly associated with the early termination of the contract. Payment for anticipated profit and unapplied overhead will not be allowed.

SECTION 007300 - SUPPLEMENTARY CONDITIONS

1.0 GENERAL:

A. These Supplementary General Conditions clarify, add, delete, or otherwise modify standard terms and conditions of DIVISION 0, BIDDING AND CONTRACTING REQUIREMENTS.

2.0 CONTACTS:

Designer:
Matt Swaback
Henderson Engineers
8345 Lenexa Drive, Suite 300
Lenexa, Kansas 66214
Telephone: (913) 742-5742
Email: matt.swaback@hendersonengineers.com

Construction Representative:
Ricky Howard
Division of Facilities Management, Design and Construction
836 N Scott
Belton, MO 64012
Telephone: 816-728-0385
Email: ricky.howard@oa.mo.gov

Project Manager:
Jared Cook
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
Telephone: (573) 690-6733
Email: jared.cook2@oa.mo.gov

Contract Specialist:
Paul Girouard
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65102
Telephone: (573) 751-4797
Email: paul.girouard@oa.mo.gov

3.0 NOTICE: ALL BID MATERIALS ARE DUE AT THE TIME OF BID SUBMITTAL. THERE IS NO SECOND SUBMITTAL FOR THIS PROJECT.

4.0 FURNISHING CONSTRUCTION DOCUMENTS:

A. The Owner will furnish the Contractor with approximately 5 complete sets of drawings and specifications at no charge.

B. The Owner will furnish the Contractor with approximately 5 sets of explanatory or change drawings at no charge.

C. The Contractor may make copies of the documents as needed with no additional cost to the Owner.

5.0 SAFETY REQUIREMENTS

Contractor and subcontractors at any tier shall comply with RSMo 292.675 and Article 1.3, E, of Section 007213, General Conditions.

Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MICHAEL L. PARSON, Governor

Annual Wage Order No. 30

Section 048
JACKSON COUNTY

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by
Todd Smith, Director
Division of Labor Standards

Filed With Secretary of State: **March 10, 2023**

Last Date Objections May Be Filed: **April 10, 2023**

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$68.67
Boilermaker	$38.37*
Bricklayer	$60.27
Carpenter	**$61.82**
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	$55.22
Plasterer	
Communications Technician	$60.34
Electrician (Inside Wireman)	$69.22
Electrician Outside Lineman	$59.91
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	$102.69
Glazier	$58.17
Ironworker	$68.53
Laborer	$49.56
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	$54.80
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	$61.54
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	$50.40
Plumber	$76.04
Pipe Fitter	
Roofer	$59.33
Sheet Metal Worker	$72.78
Sprinkler Fitter	$75.09
Truck Driver	$52.39
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.
**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMO Section 290.210.

Heavy Construction Rates for
JACKSON County

Section 048

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$61.98
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$87.19
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	$50.25
General Laborer	
Skilled Laborer	
Operating Engineer	$58.85
Group I	
Group II	
Group III	
Group IV	
Truck Driver	$50.18
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.

OVERTIME
and
HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of replacing the boiler, heating water pumps, the supply fan, and the heating coil and cooling coil. Installing new direct digital controls and new electrical to serve the new mechanical equipment.

1. Project Location: Joseph P. Teasdale State Office Building, 8800 E. 63rd Street, Raytown, MO 64133

2. Owner: State of Missouri, Office of Administration, Division of Facilities Management, Design and Construction, Harry S Truman State Office Building, Post Office Box 809, 301 West High Street, Jefferson City, Missouri 65102.

B. Contract Documents, dated June 16, 2023 were prepared for the Project by Henderson Engineers, 8345 Lenexa Drive, Suite 300, Lenexa KS 66214.

C. The Work consists of replacing the existing boiler and heating water pumps with new boilers and pumps and accessories, replacing the air handling unit supply fan, heating coil and cooling coil with new, installing new building differential pressure sensors and supply duct isolation dampers, new direct digital controls to serve new equipment and new electrical disconnects, conduit and conductors and boxes associated with the new mechanical equipment.

1. The Work includes demolition of:
a. Remove anode rods from hot water storage tank.
b. Remove outside air intake dampers.
c. Remove heating and cooling coils from air handling unit, and associated heating and chilled water piping. Remove cooling coil condensate drain piping.
d. Remove boiler, flue and all associated controls, and associated heating water piping and natural gas piping.
e. Remove heating hot water secondary pump and associated heating water piping, air separator and expansion tank.
f. Remove supply air fan from air handling unit, and associated VFD.
g. Remove heating hot water primary pump.
h. Remove boiler combustion air intake damper, actuator and ductwork.
i. Remove disconnects, conduit, conductors and boxes associated with the removed mechanical equipment.

2. The Work includes installation of:
a. Installation of new anode rods in hot water storage tank.
b. Installation of new outside air intake dampers and actuators.
c. Installation of new heating and cooling coils in air handling unit, and new associated heating and chilled water piping.
d. Installation of new boilers, combustion intake & flue vent piping, all associated controls, and associated new heating water piping and natural gas piping. Installation of new condensate drain piping & neutralization kits from the boilers to an existing floor drain. Installation of T&P relief piping from the boilers to an existing floor drain.

e. Installation of new heating hot water secondary pump and associated heating water piping, air separator and expansion tank.
f. Installation of new supply air fan array in the air handling unit.
g. Installation of new heating hot water primary pump.
h. Remove combustion air intake damper, actuator and ductwork.
i. Installation of new disconnects, conduit, conductors and boxes associated with the new mechanical equipment.
j. Installation of new condensate piping from the new cooling coil drain pan to an existing floor drain.
k. Installation of new direct digital controls (DDC) to serve new equipment. Installation of new building differential pressure & controls.
l. Installation of new motorized isolation dampers & actuators and DDC to serve dampers.

D. The Work will be constructed under a single prime contract.

1.3 WORK UNDER OTHER CONTRACTS

A. Separate Contract: The Owner has awarded a separate contract for performance of certain construction operations at the site. Those operations are scheduled to be substantially complete before work under this Contract begins. The separate contract includes the following:

1. Contract: A separate contract has been awarded to replace the parking deck in front of the Teasdale building.

1.4 CONTRACTOR USE OF PREMISES

A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy and use by the public.

2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

B. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period..

1.5 OCCUPANCY REQUIREMENTS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 011000

SECTION 012100 – ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Weather allowances.

C. Related Sections include the following:

1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders for allowances.
2. Division 1 Section "Unit Prices" for procedures for using unit prices.

1.3 WEATHER ALLOWANCE

A. Included within the completion period for this project are 10 "bad weather" days.

B. The Contractor’s progress schedule shall clearly indicate the bad weather day allowance as an “activity” or “activities”. In the event weather conditions preclude performance of critical work activities for 50% or more of the Contractor’s scheduled workday, that day shall be declared unavailable for work due to weather (a “bad weather” day) and charged against the above allowance. Critical work activities will be determined by review of the Contractor’s current progress schedule.

C. The Contractor’s Representative and the Construction Representative shall agree monthly on the number of “bad weather” days to be charged against the allowance. This determination will be documented in writing and be signed by the Contractor and the Construction Representatives. If there is a failure to agree on all or part of the “bad weather” days for a particular month, that disagreement shall be noted on this written document and signed by each party’s representative. Failure of the Contractor’s representative to sign the “bad weather” day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the “bad weather” day determination contained in that document.

D. There will be no modification to the time of contract performance due solely to the failure to deplete the “bad weather” day allowance.

E. Once this allowance is depleted, a no cost Change Order time extension will be executed for "bad weather" days, as defined above, encountered during the remainder of the Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012100

SECTION 012200 – UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Quantities of Units to be included in the Base Bid are indicated in Section 004322 – Unit Prices.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Unit Prices.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for procedures for using Unit Prices to adjust quantity allowances.
2. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

A. Unit Price is a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. Unit Price No. 1:

1. Description: Provide a temporary heating and cooling unit (air handling unit) to condition the building while the existing air handling unit is being renovated. The heating capacity to be 1,800 MBH and the cooling capacity to be 150 tons. Provide temporary units for a two week time period. Contractor is responsible for temporary power to serve the temporary air handling unit. The temporary installation shall meet all code requirements.

END OF SECTION 012200

SECTION 012600 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract Modifications.

B. Related Sections include the following:

1. Division 1, Section 012200 "Unit Prices" for administrative requirements for using Unit Prices.
2. Division 1, Section 013115 “Project Management Communications” for administrative requirements for communications.
3. Division 0, Section 007213, Article 3.1 "Acceptable Substitutions" for administrative procedures for handling Requests for Substitutions made after Contract award.
4. Division 0, Section 007213, Article 4.0 "Changes in the Work" for Change Order requirements.

1.3 REQUESTS FOR INFORMATION

A. In the event that the Contractor or Subcontractor, at any tier, determines that some portion of the Drawings, Specifications, or other Contract Documents requires clarification or interpretation, the Contractor shall submit a “Request for Information” (RFI) in writing to the Designer. A RFI may only be submitted by the Contractor and shall only be submitted on the RFI forms provided by the Owner. The Contractor shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed. In the RFI, the Contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached.

B. Responses to RFI shall be issued within ten (10) working days of receipt of the Request from the Contractor unless the Designer determines that a longer time is necessary to provide an adequate response. If a longer time is determined necessary by the Designer, the Designer will, within five (5) working days of receipt of the request, notify the Contractor of the anticipated response time. If the Contactor submits a RFI on a time sensitive activity on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Designer to respond to the request provided that the Designer responds within the ten (10) working days set forth above.

C. Responses from the Designer will not change any requirement of the Contract Documents. In the event the Contractor believes that a response to a RFI will cause a change to the requirements of the Contract Document, the Contractor shall give written notice to the Designer requesting a Change Order for the work. Failure to give such written notice within ten (10) working days, shall waive the Contractor’s right to seek additional time or cost under Article 4, “Changes in the Work” of the General Conditions.

1.4 MINOR CHANGES IN THE WORK

A. Designer will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Amount or the Contract Time, on ”Designer’s Supplemental Instructions” (DSI).

1.5 PROPOSAL REQUESTS

A. The Designer or Owner Representative will issue a detailed description of proposed Changes in the Work that may require adjustment to the Contract Amount or the Contract Time. The proposed Change Description will be issued using the “Request for Proposal” (RFP) form. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by the Designer or Owner Representative are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.

2. Within ten (10) working days after receipt of Proposal Request, submit a proposal for the cost adjustments to the Contract Amount and the Contract Time necessary to execute the Change. The Contractor shall submit his proposal on the appropriate Change Order Detailed Breakdown form. Subcontractors may use the appropriate Change Order Detailed Breakdown form or submit their proposal on their letterhead provided the same level of detail is included. All proposals shall include:

   a. A detailed breakdown of costs per Article 4.1 of the General Conditions.

   b. If requesting additional time per Article 4.2 of the General Conditions, include an updated Contractor's Construction Schedule that indicates the effect of the Change including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

1.6 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, the Designer or Owner Representative will issue a Change Order for signatures of Owner and Contractor on the “Change Order” form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 013100 – COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Projects including, but not limited to, the following:

1. Administrative and supervisory personnel.
2. Project meetings.

B. Related Sections include the following:

1. Division 1, Section 013200 "Schedules" for preparing and submitting Contractor's Construction Schedule.
2. Articles 1.8.B and 1.8.C of Section 007213 "General Conditions" for coordinating meetings onsite.
3. Article 5.4.H of Section 007213 "General Conditions" for coordinating Closeout of the Contract.

1.3 COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections, which depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other Contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components including mechanical and electrical.

B. Prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other Contractors to avoid

conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Startup and adjustment of systems.
8. Project Closeout activities.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.4 SUBMITTALS

A. Not applicable.

1.5 PROJECT MEETINGS

A. The Owner’s Construction Representative will schedule a Pre-Construction Meeting prior to beginning of construction. The date, time, and exact place of this meeting will be determined after Contract Award and notification of all interested parties. The Contractor shall arrange to have the Job Superintendent and all prime Subcontractors present at the meeting. During the Pre-Construction Meeting, the construction procedures and information necessary for submitting payment requests will be discussed and materials distributed along with any other pertinent information.

1. Minutes: Designer will record and distribute meeting minutes.

B. Progress Meetings: The Owner’s Construction Representative will conduct Monthly Progress Meetings as stated in Articles 1.8.B and 1.8.C of Section 007213 “General Conditions”.

1. Minutes: Designer will record and distribute to Contractor the meeting minutes.

C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of Manufacturers and Fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Designer and Construction Representative of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration including requirements for the following:

a. Contract Documents
b. Options
c. Related RFIs
d. Related Change Orders
e. Purchases
f. Deliveries
g. Submittals
h. Possible conflicts
i. Compatibility problems
j. Time schedules
k. Weather limitations
l. Manufacturer's written recommendations
m. Warranty requirements
n. Compatibility of materials
o. Acceptability of substrates
p. Space and access limitations
q. Regulations of authorities having jurisdiction
r. Testing and inspecting requirements
s. Installation procedures
t. Coordination with other Work
u. Required performance results
v. Protection of adjacent Work
w. Protection of construction and personnel

3. Contractor shall record significant conference discussions, agreements, and disagreements including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
6. Project name
7. Name and address of Contractor
8. Name and address of Designer
9. RFI number including RFIs that were dropped and not submitted
10. RFI description
11. Date the RFI was submitted
12. Date Designer's response was received
13. Identification of related DSI or Proposal Request, as appropriate

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013115 - PROJECT MANAGEMENT COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 1, Section 013300 - Submittals

C. Division 1, Section 012600 – Contract Modification Procedures

1.2 SUMMARY

A. Project Management Communications: The Contractor shall use the Internet web based project management communications tool, E-Builder® ASP software, and protocols included in that software during this project. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.
   1. Project management communications is available through E-Builder® as provided by "e-Builder®" in the form and manner required by the Owner.
   2. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited

B. Support: E-Builder® will provide on-going support through on-line help files.

C. Copyrights and Ownership: Nothing in this specification or the subsequent communications supersedes the parties' obligations and rights for copyright or document ownership as established by the Contract Documents. The use of CAD files, processes or design information distributed in this system is intended only for the project specified herein.

D. Purpose: The intent of using E-Builder® is to improve project work efforts by promoting timely initial communications and responses. Secondly, to reduce the number of paper documents while providing improved record keeping by creation of electronic document files

E. Authorized Users: Access to the web site will be by individuals who are authorized users.
   1. Individuals shall complete the E-Builder New Company/User Request Form located at the following web site: https://oa.mo.gov/facilities/vendor-links/contractor-forms.

Completed forms shall be emailed to the following email address: OA.FMDCE-BuilderSupport@oa.mo.gov.

2. Authorized users will be contacted directly and assigned a temporary user password.
3. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.

F. Administrative Users: Administrative users have access and control of user licenses and all posted items. DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE! Improper or abusive language toward any party or repeated posting of items intended to deceive or disrupt the work of the project will not be tolerated and will result in deletion of the offensive items and revocation of user license at the sole discretion of the Administrative User(s).

G. Communications: The use of fax, email and courier communication for this project is discouraged in favor of using E-Builder® to send messages. Communication functions are as follows:
   1. Document Integrity and Revisions:
      a. Documents, comments, drawings and other records posted to the system shall remain for the project record. The authorship time and date shall be recorded for each document submitted to the system. Submitting a new document or record with a unique ID, authorship, and time stamp shall be the method used to make modifications or corrections.
      b. The system shall make it easy to identify revised or superseded documents and their predecessors.
      c. Server or Client side software enhancements during the life of the project shall not alter or restrict the content of data published by the system. System upgrades shall not affect access to older documents or software.
   2. Document Security:
      a. The system shall provide a method for communication of documents. Documents shall allow security group assignment to respect the contractual parties communication except for Administrative Users. DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!
   3. Document Integration:
      a. Documents of various types shall be logically related to one another and discoverable. For example, requests for information, daily field reports, supplemental sketches and photographs shall be capable of reference as related records.
   4. Reporting:
      a. The system shall be capable of generating reports for work in progress, and logs for each document type. Summary reports generated by the system shall be available for team members.
   5. Notifications and Distribution:
      a. Document distribution to project members shall be accomplished both within the extranet system and via email as appropriate. Project document distribution to parties outside of the project communication system shall be

accomplished by secure email of outgoing documents and attachments, readable by a standard email client.

6. Required Document Types:
    a. RFI, Request for Information.
    b. Submittals, including record numbering by drawing and specification section.
    c. Transmittals, including record of documents and materials delivered in hard copy.
    d. Meeting Minutes.
    e. Application for Payments (Draft or Pencil).
    f. Review Comments.
    g. Field Reports.
    h. Construction Photographs.
    i. Drawings.
    j. Supplemental Sketches.
    k. Schedules.
    l. Specifications.
    m. Request for Proposals
    n. Designer's Supplemental Instructions
    o. Punch Lists

H. Record Keeping: Except for paper documents, which require original signatures and large format documents (greater than 8½ x 11 inches), all other 8½ x 11 inches documents shall be submitted by transmission in electronic form to the E-Builder® web site by licensed users.
    a. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier shall respond to documents received in electronic form on the web site, and consider them as if received in paper document form.
    b. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall reply or respond by transmissions in electronic form on the web site to documents actually received in paper document form.
    c. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall copy any paper document into electronic form and make same available on the web site.

I. Minimum Equipment and Internet Connection: In addition to other requirements specified in this Section, the Owner and his representatives, the Construction Manager and his representatives, the Architect and his consultants, and the Contractor and his sub-contractors and suppliers at every tier required to have a user license(s) shall be responsible for the following:

1. Providing suitable computer systems for each licensed user at the users normal work location[1] with high-speed Internet access, i.e. DSL, local cable company's Internet connection, or T1 connection.
2. Each of the above referenced computer systems shall have the following minimum system[2] and software requirements:
    a. Desktop configuration (Laptop configurations are similar and should be equal to or exceed desktop system.)
        1) Operating System: Windows XP or newer
        2) Internet Browser: Internet Explorer 6.01SP2+ (Recommend IE7.0+)
        3) Minimum Recommend Connection Speed: 256K or above
        4) Processor Speed: 1 Gigahertz and above
        5) RAM: 512 mb
        6) Operating system and software shall be properly licensed.
        7) Internet Explorer version 7 (current version is a free distribution for download). This specification is not intended to restrict the host server or client computers provided that industry standard HTTP clients may access the published content.
        8) Adobe Acrobat Reader (current version is a free distribution for download).
        9) Users should have the standard Microsoft Office Suite (current version must be purchased) or the equivalent.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable.)

END OF SECTION 013115

[1] The normal work location is the place where the user is assigned for more than one-half of his time working on this project.
[2] The minimum system herein will not be sufficient for many tasks and may not be able to process all documents and files stored in the E-Builder® Documents area.

SECTION 013200 – SCHEDULES - BAR CHART

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for a Bar Chart Schedule for the project construction activities, schedule of submittals, and schedule for testing.

PART 2 - PRODUCTS – (Not Applicable)

PART 3 - EXECUTION

3.1 SUBMITTAL PROCEDURES

A. The Contractor shall submit to the Designer, within ten (10) working days following the Notice to Proceed, a Progress Schedule including Schedule of Values showing the rate of progress the Contractor agrees to maintain and the order in which he proposed to carry out the various phases of Work. No payments shall be made to the Contractor until the Progress Schedule has been approved by the Owner.

1. The Schedule of Values must have the following line items included with the value of the item as indicated below:

   a. O&M's (Owner's Manual)

      1) $1,000,000.00 (One million) and under – 2% of the total contract amount

      2) Over $1,000,000.00 (One million) – 1% of the total contract amount

   b. Close Out Documents

      1) $1,000,000.00 (One million) and under – 2% of the total contract amount

      2) Over $1,000,000.00 (One million) – 1% of the total contract amount

   c. General Conditions

      1) No more than 10%

B. The Contractor shall submit an updated Schedule for presentation at each Monthly Progress Meeting. The Schedule shall be updated by the Contractor as necessary to reflect the current Schedule and its relationship to the original Schedule. The updated Schedule shall reflect any changes in the logic, sequence, durations, or completion date. Payments to the Contractor shall be suspended if the Progress Schedule is not adequately updated to reflect actual conditions.

C. The Contractor shall submit Progress Schedules to Subcontractors to permit coordinating their Progress Schedules to the general construction Work. The Contractor shall coordinate preparation and processing of Schedules and reports with performance of other construction activities.

3.2 CONSTRUCTION PROGRESS SCHEDULE – BAR CHART SCHEDULE

A. Bar-Chart Schedule: The Contractor shall prepare a comprehensive, fully developed, horizontal bar chart-type Contractor's Construction Schedule. The Contractor for general construction shall prepare the Construction Schedule for the entire Project. The Schedule shall show the percentage of work to be completed at any time, anticipated monthly payments by Owner, as well as significant dates (such as completion of excavation, concrete foundation work, underground lines, superstructure, rough-ins, enclosure, hanging of fixtures, etc.) which shall serve as check points to determine compliance with the approved Schedule. The Schedule shall also include an activity for the number of "bad" weather days specified in Section 012100 – Allowances.

1. The Contractor shall provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.

    a. If practical, use the same Schedule of Values breakdown for schedule time bars.

2. The Contractor shall provide a base activity time bar showing duration for each construction activity. Each bar is to indicate start and completion dates for the activity. The Contractor is to place a contrasting bar below each original schedule activity time for indicating actual progress and planned remaining duration for the activity.

3. The Contractor shall prepare the Schedule on a minimal number of separate sheets to readily show the data for the entire construction period.

4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on schedule with other construction activities. Include minor elements involved in the overall sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.

5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other required schedules and reports.

6. Indicate the Intent to Award and the Contract Substantial Completion dates on the schedule.

3.3 SCHEDULE OF SUBMITTALS

A. Upon acceptance of the Construction Progress Schedule, prepare and submit a complete schedule of submittals. Coordinate the submittal schedule with Section 013300 SUBMITTALS, the approved Construction Progress Schedule, list of subcontracts, Schedule of Values and the list of products.

B. Prepare the schedule in chronological order. Provide the following information

1. Scheduled date for the first submittal

2. Related Section number

3. Submittal category

4. Name of the Subcontractor

5. Description of the part of the Work covered

6. Scheduled date for resubmittal

7. Scheduled date for the Designer's final release or approval

C. Distribution: Following the Designer's response to the initial submittal schedule, print and distribute copies to the Designer, Owner, subcontractors, and other parties required to comply with submittal dates indicated.

1. Post copies in the Project meeting room and temporary field office.

2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

3.4 SCHEDULE OF INSPECTIONS AND TESTS

A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule with (15) days of the date established for commencement of the Contract Work. The Contractor is to notify the testing agency at least (5) working days in advance of the required tests unless otherwise specified.

B. Form: This schedule shall be in tabular form and shall include, but not be limited to, the following:

1. Specification Section number

2. Description of the test

3. Identification of applicable standards

4. Identification of test methods

5. Number of tests required

6. Time schedule or time span for tests

7. Entity responsible for performing tests

8. Requirements for taking samples

9. Unique characteristics of each service

C. Distribution: Distribute the schedule to the Owner, Architect, and each party involved in performance of portions of the Work where inspections and tests are required.

END OF SECTION 013200

SECTION 013300 – SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 1, Section 013115 "Project Management Communications" for administrative requirements for communications.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submittals required for performance of the Work including the following:

1. Shop Drawings
2. Product Data
3. Samples
4. Quality Assurance Submittals
5. Construction Photographs
6. Operating and Maintenance Manuals
7. Warranties

B. Administrative Submittals: Refer to General and Supplementary Conditions other applicable Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Construction Progress Schedule including Schedule of Values
2. Performance and Payment Bonds
3. Insurance Certificates
4. Applications for Payment
5. Certified Payroll Reports
6. Partial and Final Receipt of Payment and Release Forms
7. Affidavit – Compliance with Prevailing Wage Law
8. Record Drawings
9. Notifications, Permits, etc.

C. The Contractor is obliged and responsible to check all shop drawings and schedules to assure compliance with contract plans and specifications. The Contractor is responsible for the content of the shop drawings and coordination with other contract work. Shop drawings and schedules shall indicate, in detail, all parts of an Item or Work including erection and setting instructions and integration with the Work of other trades.

D. The Contractor shall at all times make a copy, of all approved submittals, available on site to the Construction Representative.

1.3 SUBMITTAL PROCEDURES

A. The Contractor shall comply with the General and Supplementary Conditions and other applicable sections of the Contract Documents. The Contractor shall submit, with such promptness as to cause no delay in his work or in that of any other contractors, all required submittals indicated in Part 3.1 of this section and elsewhere in the Contract Documents. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
    a. The Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

B. Each drawing and/or series of drawings submitted must be accompanied by a letter of transmittal giving a list of the titles and numbers of the drawings. Each series shall be numbered consecutively for ready reference and each drawing shall be marked with the following information:

1. Date of Submission
2. Name of Project
3. Location
4. Section Number of Specification
5. State Project Number
6. Name of Submitting Contractor
7. Name of Subcontractor
8. Indicate if Item is submitted as specified or as a substitution

1.4 SHOP DRAWINGS

A. Comply with the General Conditions, Article 3.2.

B. The Contractor shall submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

C. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings including the following information:

1. Dimensions
2. Identification of products and materials included by sheet and detail number
3. Compliance with specified standards
4. Notation of coordination requirements

5. Notation of dimensions established by field measurement

6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8½"x11" but no larger than 36"x48".

1.5 PRODUCT DATA

A. The Contractor shall comply with the General Conditions, Article 3.2.

B. The Contractor shall collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information including the following information:

a. Manufacturer's printed recommendations

b. Compliance with Trade Association standards

c. Compliance with recognized Testing Agency standards

d. Application of Testing Agency labels and seals

e. Notation of dimensions verified by field measurement

f. Notation of coordination requirements

2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

1.6 SAMPLES

A. Not applicable.

1.7 QUALITY ASSURANCE DOCUMENTS

A. The Contractor shall comply with the General Conditions, Article 3.2

B. The Contractor shall submit quality control submittals including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

C. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the Manufacturer certifying compliance with specified requirements.

1. Signature: Certification shall be signed by an officer of the Manufacturer or other individual authorized to contractually bind the Company.

D. Inspection and Test Reports: The Contractor shall submit the required inspection and test reports from independent testing agencies as specified in this Section and in other Sections of the Contract Documents.

E. Construction Photographs: The Contractor shall submit record construction photographs as specified in this Section and in other Sections of the Contract Documents.

1. The Contractor shall submit digital photographs. The Construction Administrator shall determine the quantity and naming convention at the preconstruction meeting.

2. The Contractor shall identify each photograph with project name, location, number, date, time, and orientation.

3. The Contractor shall submit progress photographs monthly unless specified otherwise. Photographs shall be taken one (1) week prior to submitting.

4. The Contractor shall take four (4) site photographs from differing directions and a minimum of five (5) interior photographs indicating the relative progress of the Work.

1.8 OPERATING AND MAINTENANCE MANUALS AND WARRANTIES

A. The Contractor shall submit all required manufacturer's operating instructions, maintenance/service manuals, and warranties in accordance with the General Conditions, Article 3.5, and Supplementary Conditions along with this and other Sections of the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REQUIRED SUBMITTALS

A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

SPEC SECTION	TITLE	CATEGORY
013200	Schedules	Construction Schedule
013200	Schedules	Schedule of Values
013200	Schedules	List of Subcontractors
013200	Schedules	Major Material Suppliers
220500	Common Work Results for Plumbing	Product Data
220500	Common Work Results for Plumbing	Certification
220515	Basic Piping Material and Methods	Product Data
220515	Basic Piping Material and Methods	Certification
220523	General Duty Valves for Plumbing Piping	Product Data
220529	Hangers and Supports for Plumbing Piping	Product Data
220523	Identification for Plumbing Piping & Equip-ment	Product Data
221300	Sanitary Drainage & Vent Piping & Specialties	Product Data
227000	Natural Gas Systems	Product Data
227000	Natural Gas Systems	Operation / Maintenance Manual
227000	Natural Gas Systems	Certification
227000	Natural Gas Systems	Test Report

230500	Firestopping Systems	Product Data
230500	Joint Sealers	Product Data
230500	Welder Certificates	Certification
230510	Basic Piping Material and Methods	Product Data
230510	Basic Piping Material and Methods	Certification
230510	Basic Piping Material and Methods	Operation / Maintenance Manual
230513	Common Motor Requirement for HVAC Equip	Product Data
230513	Common Motor Requirement for HVAC Equip	Test Report
230513	Common Motor Requirement for HVAC Equip	Operation / Maintenance Manual
230514	Variable Frequency Drives	Product Data
230514	Variable Frequency Drives	Operation / Maintenance Manual
230514	Variable Frequency Drives	Test Report
230514	Variable Frequency Drives	Warranty
230519	Meters and Gauges for HVAC Piping	Product Data
230519	Meters and Gauges for HVAC Piping	Certification
230519	Meters and Gauges for HVAC Piping	Operation / Maintenance Manual
230523	Gneral Duty Valves for HVAC Piping	Product Data
230523	Gneral Duty Valves for HVAC Piping	Warranty
230523	Gneral Duty Valves for HVAC Piping	Operation / Maintenance Manual
230529	Hangers and Supports for HVAC Piping	Product Data
230550	Vibration Isolation for HVAC	Product Data
230550	Vibration Isolation for HVAC	Test Report
230553	Identification for HVAC Piping and Equipment	Product Data
230593	Testing, Adjusting and Balancing for HVAC	Certification
230593	Testing, Adjusting and Balancing for HVAC	Test Report
230700	HVAC Insulation	Product Data
230913	Instrumentation & Contorl Devices for HVAC	Product Data
230913	Instrumentation & Contorl Devices for HVAC	Shop Drawings
230913	Instrumentation & Contorl Devices for HVAC	Operation / Maintenance Manual
230913	Instrumentation & Contorl Devices for HVAC	Warranty
230923	Direct Digital Control for HVAC	Product Data
230923	Direct Digital Control for HVAC	Shop Drawings
230923	Direct Digital Control for HVAC	Operation / Maintenance Manual
230923	Direct Digital Control for HVAC	As-Builts
230923	Direct Digital Control for HVAC	Warranty
230923	Direct Digital Control for HVAC	Test Report
232113	Hydronic Piping	Test Report
232114	Hydronic Specialties	Product Data
232114	Hydronic Specialties	Certification
232114	Hydronic Specialties	Operation / Maintenance Manual
232123	Hydronic Pumps	Product Data
232123	Hydronic Pumps	Certification
232123	Hydronic Pumps	Operation / Maintenance Manual
235100	Breeching Chimneys and Stacks	Product Data

235216	Condensing Boilers	Product Data
235216	Condensing Boilers	Shop Drawings
235216	Condensing Boilers	Test Report
235216	Condensing Boilers	Operation / Maintenance Manual
235216	Condensing Boilers	Warranty
237313	Central Station Air Handling Units	Product Data
237313	Central Station Air Handling Units	Shop Drawings
237313	Central Station Air Handling Units	Warranty
237313	Central Station Air Handling Units	Operation / Maintenance Manual
260500	Common Work Results for Electrical	Product Data
260502	Equipment Wiring Systems	Product Data
260502	Equipment Wiring Systems	Shop Drawings
260519	Low-Voltage Elec Power Cond and Cables	Product Data
260519	Low-Voltage Elec Power Cond and Cables	Test Report
260519	Low-Voltage Elec Power Cond and Cables	As-Builts
260519	Low-Voltage Elec Power Cond and Cables	Operation / Maintenance Manual
260526	Grounding and Bonding for Electrical Systems	Product Data
260526	Grounding and Bonding for Electrical Systems	Test Report
260526	Grounding and Bonding for Electrical Systems	As-Builts
260529	Hangers and Supports for Electrical Systems	Product Data
260533	Raceway and Boxes for Electrical Systems	Shop Drawings
260533	Raceway and Boxes for Electrical Systems	As-Builts
262813	Fuses	Product Data
262813	Fuses	Operation / Maintenance Manual
262816	Enclosed Switches and Circuit Breakers	Product Data
262816	Enclosed Switches and Circuit Breakers	Shop Drawings
262816	Enclosed Switches and Circuit Breakers	Certification
262816	Enclosed Switches and Circuit Breakers	Test Report
262816	Enclosed Switches and Circuit Breakers	Warranty
262816	Enclosed Switches and Circuit Breakers	As-Builts
262816	Enclosed Switches and Circuit Breakers	Operation / Maintenance Manual
262913	Enclosed Controllers	Product Data
262913	Enclosed Controllers	Shop Drawings
262913	Enclosed Controllers	Certification
262913	Enclosed Controllers	Test Report

END OF SECTION 013300

SECTION 013513.10 - SITE SECURITY AND HEALTH REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. List of required submittals:

1. Materials Safety Data Sheets for all hazardous materials to be brought onsite.
2. Schedule of proposed shutdowns, if applicable.
3. A list of the names of all employees who will submit fingerprints for a background check, and the signed privacy documents identified below for each employee.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ACCESS TO THE SITE

A. The Contractor shall arrange with Facility Representatives to establish procedures for the controlled entry of workers and materials into the work areas at the Facility.

B. The Contractor shall establish regular working hours with Facility Representatives. The Contractor must report changes in working hours or overtime to Facility Representatives and obtain approval twenty-four (24) hours ahead of time. The Contractor shall report emergency overtime to Facility Representatives as soon as it is evident that overtime is needed. The Contractor must obtain approval from Facility Representatives for all work performed after dark.

C. The Contractor shall provide the name and phone number of the Contractor's employee or agent who is in charge onsite; this individual must be able to be contacted in case of emergency. The Contractor must be able to furnish names and address of all employees upon request.

D. All construction personnel shall visibly display issued identification cards.

3.2 FIRE PROTECTION, SAFETY, AND HEALTH CONTROLS

A. The Contractor shall take all necessary precautions to guard against and eliminate possible fire hazards.

1. Onsite burning is prohibited.
2. The Contractor shall store all flammable or hazardous materials in proper containers located outside the buildings or offsite, if possible.

3. The Contractor shall provide and maintain, in good order, during construction fire extinguishers as required by the National Fire Protection Association. In areas of flammable liquids, asphalt, or electrical hazards, 15-pound carbon dioxide or 20-pound dry chemical extinguishers shall be provided.

B. The Contractor shall not obstruct streets or walks without permission from the Owner's Construction Representative and Facility Representatives.

C. The Contractor's personnel shall not exceed the speed limit of 15 mph while at the Facility unless otherwise posted.

D. The Contractor shall take all necessary, reasonable measures to reduce air and water pollution by any material or equipment used during construction. The Contractor shall keep volatile wastes in covered containers, and shall not dispose of volatile wastes or oils in storm or sanitary drains.

E. The Contractor shall keep the project site neat, orderly, and in a safe condition at all times. The Contractor shall immediately remove all hazardous waste, and shall not allow rubbish to accumulate. The Contractor shall provide onsite containers for collection of rubbish and shall dispose of it at frequent intervals during the progress of the Work.

F. Fire exits, alarm systems, and sprinkler systems shall remain fully operational at all times, unless written approval is received from the Owner's Construction Representative and the appropriate Facility Representative at least twenty-four (24) hours in advance. The Contractor shall submit a written time schedule for any proposed shutdowns.

G. For all hazardous materials brought onsite, Material Safety Data Sheets shall be on site and readily available upon request at least a day before delivery.

H. Alcoholic beverages or illegal substances shall not be brought upon the Facility premises. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

3.3 SECURITY CLEARANCES AND RESTRICTIONS

A. FMDC CONTRACTOR BACKGROUND AND ID BADGE PROCESS

1. All employees of an OA/FDMC contractor (or subcontractor performing work under an OA/FMDC contract) are required to submit a fingerprint check through the Missouri State Highway Patrol (MSHP) and the FBI enabling OA/FMDC to obtain state and national criminal background checks on the employees, unless stated otherwise in the Contractor's contract.
2. FMDC reserves the right to prohibit any employee of the Contractor from performing work in or on the premises of any facility owned, operated, or utilized by the State of Missouri for any reason.
3. The Contractor shall ensure all of its employees submit fingerprints to the Missouri State Highway Patrol and pay for the cost of such background checks. The Contractor shall submit to FMDC via email to FMDCSecurity@oa.mo.gov a list of the names of the Contractor's employees who will be fingerprinted and a signed OA/FMDC Authorization for Release of Information Confidentiality Oath for each employee. All employees of the Contractor approved by FMDC to work at a State facility must obtain a contractor ID badge from FMDC prior to beginning work on-site, unless the Director of FMDC, at the

Director's discretion, waives the requirement for a contractor ID badge. The Contractor and its employees must comply with the process for background checks and contractor ID badges found on FMDC's website at: https://oa.mo.gov/facilities/facilities-operations/security-information/fmdc-contractor-background-and-id-badge

4. Fingerprints and Authorization for Release of Information Confidentiality Oath form are valid for one (1) year and must be renewed annually. Changing or adding locations may result in additional required documentation. Certain employees may be required to be fingerprinted more frequently. OA/FMDC reserves the right to request additional background checks at any time for any reason.
5. The Contractor shall notify FMDC via email to FMDCSecurity@oa.mo.gov within 48 hours of anyone severing employment with their company.

3.4 DISRUPTION OF UTILITIES

A. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and the Facility Representative before disconnecting electric, gas, water, fire protection, or sewer service to any building.

B. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and Facility Representative before closing any access drives, and shall make temporary access available, if possible. The Contractor shall not obstruct streets, walks, or parking.

3.5 PROTECTION OF PERSONS AND PROPERTY

A. SAFETY PRECAUTIONS AND PROGRAMS

1. The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.
2. All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 292.675 RSMo.
3. In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner's Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner's Representative and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner's Representative and the Contractor. "Rendered Harmless" shall mean that levels

of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

B. SAFETY OF PERSONS AND PROPERTY

1. The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

   a. clients, staff, the public, construction personnel, and other persons who may be affected thereby;
   b. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and
   c. other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

2. The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.
3. The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.
4. When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.
5. The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in this Section caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under this Section, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.
6. The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its subcontractors of any tier.
7. The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.
8. The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident

shall be reported immediately.

9. The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.
10. The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.
11. In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.
12. The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for clients, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

END OF SECTION 013513.10

SECTION 015000 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for construction facilities and temporary controls including temporary utilities, support facilities, security, and protection.

B. Temporary utilities include, but are not limited to, the following:

1. Temporary lighting
2. Temporary heat

C. Support facilities include, but are not limited to, the following:

1. Temporary enclosures
2. Hoists and temporary elevator use
3. Waste disposal services
4. Construction aids and miscellaneous services and facilities

D. Security and protection facilities include, but are not limited to, to following:

1. Temporary fire protection
2. Environmental protection

1.3 SUBMITTALS

A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Implementation and Termination Schedule: Within (15) days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations including, but not limited to, the following:

1. Building code requirements
2. Health and safety regulations
3. Utility company regulations
4. Police, fire department, and rescue squad rules
5. Environmental protection regulations

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations". ANSI A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities".

C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of permanent service.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist onsite.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. If acceptable to the Designer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

B. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

C. Water: Provide potable water approved by local health authorities.

2.2 EQUIPMENT

A. General: Provide new equipment. If acceptable to the Designer, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

B. Water Hoses: Provide ¾" (19mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100' (30m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110 to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage rating.

E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixture where exposed to moisture.

F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.

G. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers, or a combination of extinguishers of NFPA-recommended classes for the exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each Facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.

1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.

2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

3. Obtain easements to bring temporary utilities to the site where the Owner's easements cannot be used for that purpose.

4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Designer. Neither the Owner nor Designer will accept cost or use charges as a basis of claims for Change Order.

B. Temporary Water Service: The Owner will provide water for construction purposes from the existing building system. All required temporary extensions shall be provided and removed by the Contractor. Connection points and methods of connection shall be designated and approved by the Construction Representative.

C. Temporary Electric Power Service: The Owner will provide electric power for construction lighting and power tools. Contractors using such services shall pay all costs of temporary services, circuits, outlet, extensions, etc.

D. Temporary Lighting: provide temporary lighting with local switching.

1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

E. Temporary Heating: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

1. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP gas or fuel-oil heaters with individual space thermostatic control.

2. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

F. Temporary Toilets: Use of the Owner's existing toilet facilities will be permitted, so long as facilities are cleaned and maintained in a condition acceptable to the Owner. All construction personnel will be allowed access only to those specific facilities designed by the Construction Representative. At substantial completion, restore these facilities to the condition prevalent at the time of initial use.

G. Wash Facilities: The Owner will provide wash facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

H. Drinking-Water Facilities: The Owner will provide drinking water facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.

1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.

B. Storage Facilities: The Owner will provide storage onsite as designated by the Facility Representative or the Construction Representative. Areas for use by the Contractor for storage will be identified at the Pre-Bid Meeting.

C. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.

D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and materials drying or curing requirements to avoid dangerous conditions and effects.

2. Install tarpaulins securely with incombustible wood framing and other materials. Close openings of 25SqFt (2.3SqM) or less with plywood or similar materials.

3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.

4. Where temporary wood or plywood enclosure exceeds 100SqFt (9.2SqM) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.

E. Temporary Lifts and Hoists: Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

F. Temporary Elevator Use: The Owner will allow use of elevators within the building. All construction personnel will be allowed access only to those specific elevators designated by the Construction Representative.

G. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven (7) days during normal weather or three (3) days when the temperature is expected to rise above 80°F (27°C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the Designer.

B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonable predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations".

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one (1) extinguisher on each floor at or near each usable stairwell.

2. Store combustible materials in containers in fire-safe locations.

3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.

4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

C. Permanent Fire Protection: The Project has a permanent fire-protection systemin place and in operation.

D. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1. Storage: Where materials and equipment must be stored and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

E. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.5 OPERATION, TERMINATION AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Unless the Designer requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are the Contractor's property. The Owner reserves the right to take possession of project identification signs.

2. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:

a. Replace air filters and clean inside of ductwork and housing.

b. Replace significantly worn parts and parts subject to unusual operating conditions.

c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 015000

SECTION 017400 – CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for cleaning during the Project.

B. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.

1. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator for the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

A. General

1. Retain all stored items in an orderly arrangement allowing maximum access, not impending drainage or traffic, and providing the required protection of materials.
2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the jobsite.
4. Provide adequate storage for all items awaiting removal from the jobsite, observing all requirements for fire protection and protection of the ecology.

B. Site

1. Daily, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
2. Weekly, inspect all arrangements of materials stored onsite. Re-stack, tidy, or otherwise service all material arrangements.

3. Maintain the site in a neat and orderly condition at all times.

C. Structures

1. Daily, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, sweep all interior spaces clean. "Clean" for the purposes of this paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and handheld broom.

3. In preparation for installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.

4. Following the installation of finish floor materials, clean the finish floor daily while work is being performed in the space in which finish materials have been installed. "Clean" for the purposes of this subparagraph, shall be interpreted as meaning free from all foreign material which, in the opinion of the Construction Representative, may be injurious to the finish of the finish floor material.

3.2 FINAL CLEANING

A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.

1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities including landscape development areas, of rubbish, waste material, litter, and foreign substances.

2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

3. Remove petrochemical spills, stains, and other foreign deposits.

4. Remove tools, construction equipment, machinery, and surplus material from the site.

5. Remove snow and ice to provide safe access to the building.

6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

8. Broom clean concrete floors in unoccupied spaces.

9. Vacuum clean carpet and similar soft surfaces removing debris and excess nap. Shampoo, if required.

10. Clean transparent material, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-

obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

11. Remove labels that are not permanent labels.

12. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

    a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

13. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

14. Clean plumbing fixtures to a sanitary condition free of stains, including stains resulting from water exposure.

15. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

16. Clean ducts, blowers, and coils if units were operated without filters during construction

17. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.

18. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.

19. Leave the Project clean and ready for occupancy.

C. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

D. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.

1. Where extra materials of value remain after Final Acceptance by the Owner, they become the Owner's property.

END OF SECTION 017400

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Architect.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

2. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Coordination". Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Performance and design criteria if Contractor is delegated design responsibility.
c. Operating standards.
d. Regulatory requirements.
e. Equipment function.

f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. List of cleaning agents and methods of cleaning detrimental to product.
    d. Procedures for routine cleaning
    e. Procedures for preventive maintenance.
    f. Procedures for routine maintenance.
    g. Instruction on use of special tools.

8. Repairs: Include the following:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 007213 "General Conditions".

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

D. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.

1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:

    a. Name of Contractor/Installer.
    b. Business address.
    c. Business phone number.
    d. Point of contact.
    e. E-mail address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.

    a. Produce segments to present a single significant piece of equipment per segment.
    b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

F. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION 017900

SECTION 220010 – GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP, or MEP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer’s requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon

final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2018
IMC	International Mechanical Code – 2018
IPC	International Plumbing Code – 2018
IFGC	International Fuel Gas Code – 2018
IECC	International Energy Conservation Code – 2018
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Airc Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code – 2017
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.” When ‘furnish’, ‘install’, ‘perform’, or ’provide’ is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as

required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials,

performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide welders' qualification certificates.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and the Substitution Request Form on the OA/FMDC website for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

c. Proposed substitution has received necessary approvals of authorities having jurisdiction.

d. Same warranty will be furnished for proposed substitution as for specified Work.

e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in specification 013300 – Submittals.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 1 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.

B. Owner or Owner's representative shall initial and date each section line in Table 1 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.
2. Insulation shall be effective.
3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.18 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Water: Premises are supplied with water services which may be used in this work.
2. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.
3. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, nonclogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
2. .

1.19 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting His bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.

4. Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall become his property and shall be removed by the Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Use of explosives is not permitted.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.

    a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

    b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 22.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.4 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

D. Patch around openings to match adjacent construction, including fire ratings, if applicable.

E. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.5 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.6 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days' notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 220010

SECTION 220015 – COORDINATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

END OF SECTION 220015

SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:

1. Sleeves for Plumbing penetrations.
2. Miscellaneous metals for support of Plumbing materials and equipment.
3. Joint sealers for sealing around Plumbing materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.
2. Division 26 Section “Common Work Results for Electrical” required electrical devices.
3. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 22 Section “General Plumbing Requirements”.

1. Product data for the following products:
   a. Through and membrane-penetration firestopping systems.
   b. Joint sealers.
2. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's

willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS AND MATERIALS

2.1 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.2 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.3 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

a. "Dow Corning 790," Dow Corning Corp.

b. "Silglaze II SCS 2801," General Electric Co.

c. "Silpruf SCS 2000," General Electric Co.

d. "864," Pecora Corp.

e. "Rhodia 5C," Rhone-Poulenc, Inc.

f. "Spectrem 1," Tremco, Inc.

g. "Spectrem 2," Tremco, Inc.

h. "Dow Corning 795," Dow Corning Corp.

i. "Rhodia 7B," Rhone-Poulenc, Inc.

j. "Rhodia 7S," Rhone-Poulenc, Inc.

k. "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

a. "Dow Corning 786," Dow Corning Corp.

b. "Sanitary 1700," General Electric Co.

c. "898 Silicone Sanitary Sealant," Pecora Corp.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Chem-Calk 600," Bostik Construction Products Div.

b. "AC-20," Pecora Corp.

c. "Sonolac," Sonneborn Building Products Div.

d. "Tremflex 834," Tremco, Inc.

2.4 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:

1. 3M Corp., Fire Barrier Sealant

2. Hilti

3. Owens Corning, Firestopping Insulation.

4. Pecora, AC-20 FTR

5. RectorSeal

6. Specified Technologies Inc.,

7. United States Gypsum Company SHEETROCK Firecode Compound

8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install sealants in accordance with manufacturer's installation instructions.

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.3 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.4 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.5 PENETRATIONS:

A. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

C. The Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section “Basic Piping Materials and Methods”.

END OF SECTION 220500

SECTION 220515 – BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. Refer to Division 1 and Division 22 Section “General Plumbing Requirements” for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Escutcheons
2. Dielectric Unions

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:
    a. AWI Manufacturing.
    b. Keeney Manufacturing Company
    c. Wal-Rich Corp.
    d. Jones Stephens Corp.
2. Dielectric Unions:
    a. JOMAR International
    b. Smith Cooper International
    c. Watts Regulator Co.
    d. Zurn Industries

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.

B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.

C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Sleeves:

1. Sleeve: Refer to Division 22 Section “Common Work Results for Plumbing” for sleeve materials.

2.5 WALL SLEEVES

1. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2” wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s installation instructions.

3.2 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.3 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

I. Verify final equipment locations for roughing in.

3.4 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.5 PENETRATIONS

A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Provide escutcheons for exposed pipe penetrations of interior floors, walls, ceilings and under cabinets and millwork. Use deep pattern escutcheons where required.

C. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.

2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

4. Secure waterproof membrane flashing between clamping flange and clamping ring.

5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe , using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

F. Exterior Wall Penetrations: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Cover exterior sealant with grout,

minimum ½" thick and paint grout to match exterior color, with color selection by the architect.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

G. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

3.6 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.

E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.

F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.

G. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.

H. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

I. Install dielectric flanges for piping 2-1/2" and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.

3.7 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2":

a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.

c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.8 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 220515

SECTION 220523 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes general duty valves common to most plumbing water distribution piping systems.

1. Special purpose valves are specified in individual piping system specifications.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.

B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:

1. MSS SP 67 “Butterfly Valves”
2. MSS SP 70 “Gray Iron Gate Valves, Flanged and Threaded Ends”
3. MSS SP 71 “Gray Iron Swing Check Valves, Flanged and Threaded Ends”
4. MSS SP 72 “Ball Valves with Flanged or Butt Welding Ends”
5. MSS SP 80 “Bronze Gate, Globe, Angle and Check Valves”
6. MSS SP 85 “Gray Iron Globe and Angle Valves, Flanged and Threaded Ends”
7. MSS SP 110 “Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends”
8. MSS SP 125 “Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided”

9. MSS SP 139 “Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications”

D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever handles, on quarter-turn valves 6-inch and smaller.
3. Chain-wheel operators, for valves 2-1/2-inch and larger, installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
4. Gear drive operators, on quarter-turn valves 8-inch and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.
    a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 BALL VALVES

A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

B. Cast Iron Body Ball Valves, 2-1/2" and larger: Meeting MSS SP 72, 200 CWP, lead free with FDA epoxy coating, maximum operating temperature of 140F; two piece cast iron body meeting ASTM A126 Class B with flanged ends, 304 stainless steel full port ball and shaft, ductile iron handle, FDA epoxy coating, PTFE gasket, stem seal and seat.

PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Install valves in accordance with manufacturer's installation instructions.

B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install valves in horizontal piping with stem at or above the center of the pipe.

E. Install valves in a position to allow full stem movement.

3.2 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-Inch and Smaller: Solder ends.
2. Copper Tube Sizes 2-1/2 Inch and Larger: Flange ends.

3.3 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

A. Domestic Hot and Cold Water Service

Valve Type	2" And Smaller	2-1/2" And Larger
Ball	150	200

3.4 VALVE SCHEDULE

A. Ball Valves (full port) – 2 inch and smaller:

Manufacturer	Solder Ends	Threaded Ends
Apollo (Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

3.5 APPLICATION SCHEDULE

A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Ball Valves, 2" and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.

3.6 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.7 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF SECTION 220523

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal-piping hangers and supports.

C. Anchors and fasteners.

D. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.
2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. 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. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
    a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
    b. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

e. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

a. Cooper B-Line.

b. Ferguson Enterprises/FNW.

c. PHD Manufacturing.

d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:

a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.

b. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:

a. Indoor Dry Locations: Zinc-plated steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. MANUFACTURERS

1. ASC Engineered Solutions.

2. Cooper B-Line, Inc.

3. Elite Components

4. ERICO/Michigan Hanger Co./Caddy

5. Ferguson/FNW.
6. Halfen-DEHA.
7. Hilti.
8. National Pipe Hanger Corporation.
9. PHD Manufacturing.
10. Power-Strut.
11. Unistrut.

B. Single Hangers:

1. Split Ring: Carbon steel, adjustable swivel, split ring type.
2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:
   a. ASC Engineered Solutions.
   b. Holdrite.
   c. Klo-Shure.
2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

F. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

2.3 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:

a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.

b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

B. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:

a. . Cooper B-Line.

b. Ferguson Enterprises/FNW.

c. PHD Manufacturing.

d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

g. DeWalt "Bang-It" concrete inserts.

C. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2. Self-drilling drilled flush or shell type. Size inserts to suit threaded rods.

D. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and locknuts for anchoring in place.

E. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

2.4 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

F. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install hangers and supports in accordance with manufacturer's installation instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 22 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
    a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
    b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts.

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping.

   a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.

2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used. Do not use polymer-based shields for hot piping.

   a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts.

P. Vertical Piping Risers:

1. Reference Section “Vibration Isolation for Plumbing Piping and Equipment” for piping riser supports.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

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

3.6 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:
   a. Band hanger.
   b. Swivel split ring.
   c. Clevis hanger.
2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.
4. All drainage pipe sizes: Clevis hanger.

D. Trapezes and Strut-mounted Supports:

1. All pipe sizes less than 6 inches: Two-piece clamp.
2. Pipe sizes 6 inches and greater: Roll support.

E. Wall Supports:

1. Pipe sizes 3 inches and less:
   a. Two-hole strap mounted to wall.
   b. Welded steel bracket with reinforced angle or strut.
2. Pipe sizes 4 inch and greater:
   a. U-bolt
   b. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipe sizes 4 inch and less: Pipe saddle.
2. Pipe sizes 6 inch and greater: Roll support.

END OF SECTION 220529

SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

B. Types of identification devices specified in this Section include the following:

1. Plastic Pipe Markers
2. Plastic Tape
3. Valve Tags

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

1.4 SPARE PARTS

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:

1. Advanced Graphic Engraving, LLC.
2. Brady Co.
3. Brimar Industries, Inc.
4. Craftmark.
5. Kolbi Pipe Marker Co.
6. Seton

2.2 PLUMBING IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1

B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1

C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe (or insulation).
4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

G. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.

H. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

2.4 VALVE TAGS

A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

1. Provide 1-1/2" diameter tags, except as otherwise indicated.

2. Fill tag engraving with black enamel.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.5 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Domestic cold water piping.

2. Non potable water piping

3. Condensate drain piping.

4. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine

rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Within 5 feet of each valve and control device.
2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.

B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

END OF SECTION 220553

SECTION 221300 – SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
4. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
5. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.

1.2 DEFINITIONS

A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping

C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Comply with the installation requirements for CPVC pipe and CPVC CTS tube per the Lubrizol “FlowGuard Gold and CORZAN Design and Installation Manual” and the installed manufacturer’s installation manual.

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. 2018 International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.1 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.

B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

C. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

D. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
2. Solvent: ASTM D2564.

E. PVC Pressure Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 with “solid wall” PVC meeting ASTM D1784 with cell class 12454.

1. Solvent: ASTM D2564.
2. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer’s installation instructions.

3.2 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Condensate drain piping and pumped condensate drain piping inside the building: Provide ¾” minimum size or as indicated on the drawings. Slope gravity drainage condensate piping from mechanical equipment at 1/8” per foot minimum slope. Discharge to floor receptor with air gap.

1. AHU COOLING COILS: Install Type M copper tube with wrought copper fittings with solder joints, 1” and smaller and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4” and larger.

Provide galvanic isolators as specified in Division 22 “Basic Piping Materials and Methods”.

2. BOILERS: Install PVC pressure pipe and fittings for 1” and smaller and install “solid wall” PVC Type DWV pipe and fittings for 1-1/4” and larger. Except no plastic pipe shall be installed in return air plenums.

3.3 PIPE AND TUBE JOINT CONSTRUCTION

A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."

B. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

3.4 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

H. Install condensate drains pitched down at a minimum slope of 1 to 10 for piping 3 inches and smaller.

3.5 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

1. Provide roll hangers for individual horizontal runs 100 feet or longer.

2. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size – In.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - In.
Up to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 4	10	3/8

Nom. Pipe Size In Inches.	CTS CPVC Tube Min. Rod Max. Span - Ft.	CPVC Tube Dia. - In.
1/2	3	3/8
3/4	3	3/8
1	3	3/8
1-1/4	4	3/8
1-1/2	4	3/8
2	4	3/8

1. Support all sizes of horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch.

2. Support all sizes of vertical cast iron piping every ten feet.

3. Support piping within 12" of each elbow or tee.

4. Support each P-trap.

3.6 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

   a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

   b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

   c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.

   d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1” water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.

5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.7 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

3.8 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 221300

SECTION 227000 – NATURAL GAS SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties.
2. Special duty valves.
3. Pressure regulators.

B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.
2. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.
3. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges, and mechanical sleeve seals.
4. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.
5. Division 26 Section “Common Work Results for Electrical” required electrical devices.

D. Gas pressures for systems specified in this Section are limited to medium pressure systems.

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.

C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.3 SUBMITTALS

A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

C. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

D. Test reports specified in Part 3 below.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."

C. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installation and inspections, testing, and purging of gas piping systems.
2. 2018 International Fuel Gas Code
3. 2018 Uniform Plumbing Code

D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.

E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5 SPARE PARTS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Gas Ball Valves – 2” and Smaller:

a. Apollo Valves # 77F-1XX-01

b. Hammond Valve # 8901

c. Milwaukee Valve # BA-475B

d. Nibco Inc. # T-FP 600A

e. Watts # FBV-3C

2. Gas Ball Valves – 2-1/2" to 4":

a. Apollo Valve # 77F-1XX-01

b. Hammond Valve # 8901

c. Milwaukee Valve # BA-475B

d. Nibco Inc. # T-FP 600A

3. Gas Pressure Regulators

a. American Meter Company

b. Fisher

c. Itron

d. Sensus

e. Maxitrol

4. Insect Screens

a. F.W. Webb Company

b. Groebner

c. Northtown Pipe Protection Products "BUGSCRN Series"

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.

B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

2.3 FITTINGS

A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

1. 1-1/4" and smaller shall be socket type

2. 1-1/2" and larger shall be butt weld type.

C. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.

D. Insect screens: Black steel body with 20 mesh stainless steel screen and MNPT end.

E. Gas Relief Vents: Galvanized steel body with 90 degree inlet to screened outlet, 20 mesh stainless steel screen and FNPT end.

2.4 JOINING MATERIALS

A. Joint Compound: Suitable for the gas being handled.

B. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.5 VALVES

A. Gas Ball Valves – 2" and Smaller: Full port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 600 WOG, UL listed for natural gas service.

B. Gas Ball Valves – 2-1/2" to 4": Standard port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 400 WOG, UL listed for natural gas service.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.4 PIPING INSTALLATION

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: As specified below:

1. Inaccessible Above-Ceiling Locations: Install concealed gas piping in inaccessible above-ceiling spaces without valves or unions.

2. Accessible Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction),

whether or not such spaces are used as a plenum. Valves and unions shall not be located in such spaces used as a plenum.

3. Piping In Partitions: Install concealed gas piping in hollow partitions with welded joint (subject to the approval of the authority having jurisdiction) and protect gas piping against physical damage. Install gas piping passing through partitions with no joints or unions inside the partition.

4. Concrete or Masonry Walls: Do not install gas piping in masonry or concrete walls.

5. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section “Common Work Results for Plumbing” for special sealers and materials.

E. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

F. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 22 Section “Common Work Results for Plumbing” for additional information.

G. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.

1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3” length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side outlet. Install the dirt leg a minimum of 3-1/2” above the roof or floor readily accessible to permit cleaning and emptying.

2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section “Basic Piping Materials and Methods”.

H. Use fittings for all changes in direction and all branch connections.

I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

L. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.

M. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

O. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

P. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

Q. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section “Basic Piping Materials and Methods”.

R. Joints Containing Dissimilar Metals: Provide dielectric unions for 2” and smaller and dielectric flanges for piping 2-1/2” and larger. Dielectric unions and flanges are specified in Section “Basic Piping Materials and Methods”.

S. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

T. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

U. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."

3.5 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for steel pipe 2-1/2” and larger for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
3. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual exposed runs on walls.
4. Engineered strut support system may be provided, at the contractor’s option, in lieu of individual hangers for horizontal pipes as specified in Division 22 “Hangers and Supports for Plumbing Piping”. Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.
5. Provide roll hangers for individual horizontal runs 100 feet or longer.

6. Provide roll hangers for individual horizontal runs 20 feet or longer for exposed piping installed on roofs.

7. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58 and SP-69, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size in Inches	Max Span In Feet	Min. Rod Dia. - Inches
1/2	6	3/8
3/4 to 1	8	3/8
1-1/4 to 2	10	3/8
2-1/2 to 3	10	3/8
4	10	3/8
6	10	1/2
8	10	3/4

C. Support vertical piping at every floor.

D. Support gas piping within 12" of each elbow or tee and for gas piping 2-1/2" and larger at each valve or pressure regulator.

3.6 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.

2. Align threads at point of assembly.

3. Apply thread compound for use with gas systems to the external pipe threads. Pipe thread tape is not accepted.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

D. Fusion Welded: Joints shall be made by a qualified and approved operator in accordance with Title 49, CFR, Part 192.283 and be made in accordance with pipe manufacturer's recommendations.

3.7 VALVE APPLICATIONS

A. General: The Drawings indicate valve types, locations, and arrangements.

B. Shut-off duty: Use gas cocks specified in Part 2 above.

3.8 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Installation of Gas Pressure Regulators:

1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Install line size gas cock upstream and within 6 feet of gas appliance. Install a line size union or flanged connection downstream from the gas cock to permit removal of controls. Install reducer at the gas appliance connection, if required.

B. Install stainless steel flexible gas pipe connector, of size and length as required to complete equipment hook-up of foodservice equipment. Verify appropriate length of flexible gas pipe connector for movement of the foodservice equipment for cleaning.

3.10 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION 227000

SECTION 230010 – GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon

final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2018
IMC	International Mechanical Code – 2018
IPC	International Plumbing Code – 2018
IECC	International Energy Conservation Code – 2018
IFC	International Fire Code – 2018
IFGC	International Fuel Gas Code – 2018
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code – 2017
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

   a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

   b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make do provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other

trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time , plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the

size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

M. Provide welders' qualification certificates.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form on the OA/FMDC website for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of authorities having jurisdiction.

   d. Same warranty will be furnished for proposed substitution as for specified Work.

   e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

   f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and

plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in each individual Section.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.12 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.13 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.14 PAINTING

A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Contractor; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.
2. Insulation shall be effective.
3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.

2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.

2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.

4. Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall become their property and shall be removed by the Contractor from the

premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Use of explosives is not permitted.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

B. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.

    a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

    b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.

E. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.4 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.5 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.6 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections as required in each individual Section.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, the Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 230010

SECTION 230015 – COORDINATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL" for specification of motor connections.

C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.

D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

END OF SECTION 230015

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Mechanical equipment nameplate data.
2. Concrete for bases and housekeeping pads.
3. Non-shrink grout for equipment installations.
4. Sleeves for mechanical penetrations.
5. Miscellaneous metals for support of mechanical materials and equipment.
6. Joint sealers for sealing around mechanical materials and equipment.
7. Firestopping

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 23 Section "Basic Piping Materials and Methods," for materials and methods for mechanical sleeve seals.
2. Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.
3. Division 26 Section “Common Work Results for Electrical” required electrical devices.
4. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.

1. Product data for the following products:
   a. Joint sealers.
   b. Through and membrane-penetration firestopping systems.
2. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS AND MATERIALS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.2 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted mechanical equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.

C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24” on center with a minimum of two bars each direction.

E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.

F. Concrete equipment bases and housekeeping pads shall have height as specified on the drawings or minimum height if not specified in accordance with the following table:

Equipment	Minimum Height
Furnaces, Exterior Equipment Less than or equal to 20 tons and Other Equipment Not Listed	3-1/2"
Air Handling Units w/TSP less than or equal to 3.5", Boilers (See Note 1)	3-1/2"
Chillers, Condensate Pumps, Base Mounted Pumps up to 30 HP, Air Handling Units w/TSP greater than 3.5", All Vertical Inline Pumps, (See Note 1)	5-1/2"
Base Mounted Pumps 30 HP to 75 HP (See Note 1)	7-1/4"
Base Mounted Pumps greater than 75 HP (See Note 1)	11-1/4"

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.
2. Coordinate final pad heights for air handling units with required condensate trap depths. Increase pad heights as needed to allow for unit trap height and required slope to drain.

2.3 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.4 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.5 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.6 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:

a. Dow Corning, Dowsil 790.

b. Dow Corning, Dowsil 795.

c. GE, Silglaze II SCS 2350.

d. GE, Silpruf SCS 2000.

e. Owens Corning, Energy Complete.

f. Pecora, 864 NST.

g. Tremco, Spectrem 1.

h. Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:

a. Dow Corning, Dowsil 786.

b. GE, Momentum SCS1700.

c. Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:

a. BASF, MasterSeal NP 100.

b. Pecora, DyanTrol I-XL.

c. Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:

a. Pecora, AC-20

b. Sherwin Williams 950A

c. Tremco, Tremflex 834

2.7 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.

B. Manufacturers:

1. 3M Corp., Fire Barrier Sealant.
2. Hilti.
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR.
5. RectorSeal.
6. Specified Technologies Inc., Firestop.
7. USG SHEETROCK Firecode Compound.
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.3 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.4 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.5 PENETRATIONS:

A. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

F. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All circular and oval openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section “Basic Piping Materials and Methods”. All rectangular openings through underground exterior walls shall be flanged and flashed with non-corrosive material on each side and the gap sealed with weatherproof sealant.

END OF SECTION 230500

SECTION 230510 – BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Joining materials.

B. Escutcheons.

C. Nipples.

D. Unions.

E. Dielectric unions.

F. Dielectric flanges and flange kits.

1.2 SUBMITTALS

A. Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for administrative and procedural requirements for submittals.

B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

C. Quality Assurance Submittals: Submit welders' certificates specified in Article “Quality Assurance” below.

D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer’s catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).

E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

H. As-built drawings for each piping system in electronic and PDF format.

I. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.3 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."

B. Comply with ASME B31.9 - Building Services Piping, most recent edition.

C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.

D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.

E. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.

F. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

D. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.

E. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system

in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.
2. Keeney Manufacturing Company.
3. Wal-Rich Corp.
4. Jones Stephens Corp.
5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.4 NIPPLES

A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.5 UNIONS:

A. Manufacturers:

1. Anvil International.
2. Hart Industries.
3. Mueller Streamline Co.
4. Victaulic Company of America.
5. Watts Regulator Co.
6. Approved equal.

B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

1. Malleable iron: ASME B16.39, class as specified in section “Hydronic Piping” for the piping system used.
2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section “Hydronic Piping” for the piping system used.
3. Copper: ASME B16.22 wrought copper body.
    a. For hydronic systems, provide class as specified in section “Hydronic Piping” for the piping system used.
    b. For refrigerant systems, provide pressure rating as required for the refrigerant type used.

2.6 DIELECTRIC UNIONS

A. Manufacturers:

1. Hart Industries.
2. Victaulic Company of America.
3. Watts Regulator Co.
4. Approved equal.

B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.7 DIELECTRIC FLANGES AND FLANGE KITS

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Pipeline Seal & Insulator, Inc.
4. Tampa Rubber & Gasket Co. Inc.
5. Watts Water Technologies.
6. Approved equal.

B. Full-faced gasket with same outside diameter and bolt hole arrangement as the flange. Conform to ANSI B16.5. Pressure rating of 200 psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.

C. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

D. Flanges: Cast bronze meeting ASTM B584, class 125 solder type or cast iron meeting ASTM A536, class 125 threaded type for low pressure service, bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.

D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

J. Verify final equipment locations for roughing in.

K. Use fittings for all changes in direction and all branch connections.

L. Remake leaking joints using new materials.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Piping Protection:

1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.3 PENETRATIONS

A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section “Common Work Results for HVAC” for additional penetration requirements.

B. Above Grade Concrete or Masonry Penetrations:

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.

   a. Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

   b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

   c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

      1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

      2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

   d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

C. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron sleeves, extend top of sleeve minimum 1 inch above finish floor. Size sleeve for minimum 1/2 inch annular space between pipe and sleeve.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant.

4. Secure waterproof membrane flashing between clamping flange and clamping ring.

5. Extend bottom of sleeve below floor slab as required and secure underdeck clamp to hold sleeve rigidly in place.

D. Interior Penetrations of Non-Fire-Rated Walls:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

E. Fire / Smoke Rated Floor and Wall Assemblies:

1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing.

3.4 PIPE JOINT CONSTRUCTION

A. Threaded Joints:

1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full inner diameter.
3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.
4. Align threads at point of assembly.
5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.
6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.
7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.

B. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Align flanges surfaces parallel.
4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
5. Use suitable lubricants on bolt threads.
6. Tighten bolts gradually and uniformly using torque wrench.

C. Welded Joints:

1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
2. Damaged Welds: Do not use pipe sections that have cracked or open welds.

D. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
    1. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
    2. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
5. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
6. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
7. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
8. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
9. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

B. Joints for other piping materials are specified within the respective piping system Sections.

3.5 UNIONS

A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

3.6 DIELECTRIC UNIONS

A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
    1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
    1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
    2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

3.7 DIELECTRIC FLANGES AND FLANGE KITS

A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
    1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
    1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.

C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

E. Provide full face gasket with pressure rating equal to system served.

F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.8 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION 230510

SECTION 230513 – COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

F. Capacitors.

1.2 REFERENCE STANDARDS

A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings; most recent edition.

B. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; most recent edition.

C. NEMA MG 1 – Motors and Generators; most recent edition.

D. NFPA 70 – National Electrical Code; most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.3 SUBMITTALS

A. Conform with the submittal procedures in Division 01.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 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.

1.6 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof except where noted otherwise.
2. Design for continuous operation in 104 degrees F 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. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

D. 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.

E. 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 flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.

C. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.

2.4 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.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.5 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. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 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.

L. Sound Power Levels: To NEMA MG 1.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.

4. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer's recommendations.

5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.

    a. Relay shall have manual reset.

    b. Provide alarm contact with automatic reset overloads.

O. Part Winding Start, Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.

Q. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.7 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.
5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM (Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	84	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	88.5	73
10	1200	256T	90.2	74
15	1200	284T	90.2	77
20	1200	286T	91	78
25	1200	324T	91.7	74
30	1200	326T	92.4	78
40	1200	364T	93	77
50	1200	365T	93	79
60	1200	404T	93.6	82
75	1200	405T	93.6	80
100	1200	444T	94.1	80
125	1200	444T	94.1	84
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
10	1800	215T	89.5	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91.7	85
30	1800	286T	92.4	88
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	88
75	1800	365T	94.1	88
100	1800	404T	94.1	83
125	1800	405T	94.5	86
150	1800	444T	95	85
200	1800	445T	95	85
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85

HP	RPM (Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86
15	3600	215T	89.5	89
20	3600	254T	90.2	89
25	3600	256T	91	92
30	3600	284T	91	91
40	3600	286T	91.7	92
50	3600	324T	92.4	89
60	3600	326T	93	91
75	3600	364T	93	88
100	3600	365T	93	88

END OF SECTION 230513

SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges and fittings.

B. Thermometers and thermometer wells.

C. Test plugs.

1.2 REFERENCE STANDARDS

A. - Pressure Gauges and Gauge Attachments; 2013.

B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; 2007.

C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.

D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

F. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Provide schedule that indicates the following for each manufactured component:

1. Model or figure number.
2. Use.
3. Rating.
4. Operating range.
5. Total range.
6. Calibrated performance curves, certified where indicated.
7. Figure number.
8. Location.
9. Accessories.

C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.

D. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.

1.4 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:

1. Ametek, U.S. Gauge Div.
2. Ashcroft Dresser Industries Instrument Div.
3. Dwyer Instruments, Inc.
4. H.O. Trerice Co.
5. Marsh Instrument Co., Unit of General Signal.
6. Marshalltown Instruments, Inc.
7. Miljoco Corp.
8. Weiss Instruments, Inc.
9. Weksler Glass Thermometer Corp.
10. WIKA Instruments Corp.
11. Winters Instruments.

B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.

C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.

D. Size: 4-1/2 inch diameter.

E. Lens: Clear glass.

F. Stem: Brass for separable socket, length to suit installation.

G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

H. Accuracy: Plus or minus 1 percent of range span.

I. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.2 PRESSURE GAUGE TAPPINGS

A. Manufacturers: Same as pressure gauge manufacturers.

B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.

C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.

D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc.
2. H.O. Trerice Co.
3. Marsh Instruments, Inc.
4. Miljoco Corp.
5. Weiss Instruments, Inc.
6. Weksler Glass Thermometer Corp.
7. Winters Instruments.

B. Thermometers - Adjustable Angle:

1. Description: Red- or blue-appearing non-toxic liquid in glass tube; ASTM E1.
2. Adjustable Joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
3. Case: Cast aluminum with enamel finish.
4. Size: 9 inch scale.
5. Window: Clear Lexan.
6. Stem: Brass, copper-plated steel, or aluminum for separable socket, length to suit installation.
7. Scale: Progressive, satin-faced, non-reflective aluminum, with permanently etched markings.
8. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
9. Calibration: Degrees F.

2.4 DIAL THERMOMETERS

A. Thermometer – Direct Mount, Bimetal Actuated:

1. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Marshalltown Instruments, Inc.

d. Miljoco Corp.

e. Tel-Tru Manufacturing Co., Inc.

f. Weiss Instruments, Inc.

g. Weksler Glass Thermometer Corp.

h. Winters Instruments.

2. Description: Dial type, ASTM E1 bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer.

3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

4. Case: Stainless steel with front or rear recalibration.

5. Size: 5 inch diameter dial.

6. Lens: Clear glass, hermetically sealed.

7. Stem: Stainless steel for separable socket. Length to suit installation.

8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

B. Thermometers – Direct Mount, Vapor Actuated:

1. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Miljoco Corp.

d. Weiss Instruments, Inc.

e. Weksler Glass Thermometer Corp.

f. Winters Instruments.

2. Description: Dial type vapor or liquid actuated; ASTM E1; copper bulb, copper or phosphor bronze bourdon tube, white with black markings and black pointer.

3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

4. Case: Drawn steel, cast aluminum, or stainless steel.

5. Size: 4-1/2 inch diameter dial.

6. Lens: Clear glass.

7. Stem: Brass, copper-plated steel, or aluminum for separable socket. Length to suit installation.

8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

C. Thermometers – Remote Reading:

2. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Miljoco Corp.

d. Tel-Tru Manufacturing Co., Inc.

e. Weiss Instruments, Inc.

f. Weksler Glass Thermometer Corp.

g. Winters Instruments.

2. Description: Dial type vapor or liquid actuated; ASTM E1; white with black markings and black pointer.

3. Case: Drawn steel, cast aluminum, or stainless steel.

4. Size: 4-1/2 inch diameter dial.

5. Lens: Clear glass.

6. Bulb: Copper for separable socket for liquids, averaging element for air.

7. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

8. Capillary: Copper or bronze double-braided capillary for separable socket. Length to suit installation, minimum 5 feet.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS

A. Thermowell Socket: ASTM A536 ductile iron, brass, or stainless steel, compatible with adjacent piping to eliminate dielectric corrosion, with separable socket for thermometer stems and 2 inch extension for insulated piping, pressure rated to match piping system design pressure, with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.

2. MG Piping Products Co.

3. Peterson Equipment Co., Inc.

4. Sisco, A Spedco, Inc. Co.

5. Watts Regulator.

B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.

C. Core Material:

1. Neoprene core for temperatures up to 200 degrees F.

2. Nordel core for temperatures up to 350 degrees F.

3. Viton core for temperatures up to 400 degrees F.

D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges 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. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

I. Provide instruments with scale ranges selected according to service with largest appropriate scale.

J. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

K. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

L. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULE

A. Pressure Gages, Location and Scale Range:

1. Location: Install device at inlet and outlet of each of the following:
    a. Headers to central equipment.
    b. Pumps. Provide silicone damping gauge.
    c. Boilers.
    d. After major coils. Reference details on plans.
    e. Expansion tanks.
    f. Pressure reducing valves.
2. Scale Range:
    a. Vacuum: 30 inches Hg to 15 psig.
    b. All fluids: 2 times operating pressure.

B. Pressure Gage Tappings, Location:

1. Control valves 3/4 inch & larger – inlets and outlets.
2. Major coils – inlets and outlets.
3. Boiler – inlets and outlets.

C. Stem Type Thermometers, Location and Scale Range:

1. Location: Install device at inlet and outlet of each of the following:
    a. Headers to central equipment.
    b. Boilers.
    c. Hydronic zone supply and return.
    d. After major coils. Reference details on plans.
    e. Thermal storage tank.
2. Scale Range:
    a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions
    b. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.

D. Thermometer Sockets, Location:

1. Control valves 1 inch & larger - inlets and outlets.

E. Dial Thermometers, Location and Scale Range:

1. Each supply air zone, minus 32 to 150 degrees F.
2. Outside air, minus 32 to 150 degrees F.

3. Return air, minus 32 to 150 degrees F.
4. Mixed air, minus 32 to 150 degrees F.

END OF SECTION 230519

SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Applications.

1. General duty valves common to most mechanical piping systems.
2. Special purpose valves are specified in individual piping system specifications.

B. General requirements.

C. Ball valves.

D. Butterfly valves.

E. Check valves.

1.2 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene diene monomer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Tetrafluoroethylene.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.

C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.4 QUALITY ASSURANCE

A. Manufacturer:

1. Obtain valves for each valve type from a single manufacturer.
2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.

B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:

1. ASME B31.9 for building services piping.
2. ASME B31.1 for power piping.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
2. Protect valve parts exposed to piped medium against rust and corrosion.
3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:

1. Maintain valve end protection and protect flanges and specialties from dirt.
    a. Provide temporary inlet and outlet caps.
    b. Maintain caps in place until installation.
2. Store valves in shipping containers and maintain in place until installation.
    a. Store valves indoors in dry environment.
    b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:

1. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

2.2 APPLICATIONS

A. Provide the following valves for the applications if not indicated on Drawings:

1. Throttling (Hydronic): Butterfly, Ball.
2. Isolation (Hydronic): Butterfly, Ball.
3. Dead-End: Butterfly and Ball.

B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

C. Required Valve End Connections for Non-Wafer Types:

1. Steel Pipe:
   a. 2 NPS and Smaller: Threaded ends.
   b. 2-1/2 NPS and Larger: Grooved or flanged ends.
2. Copper Tube:
   a. 2 NPS and Smaller: Threaded or solder-joint valve ends.
      1) Exception: Solder ends not acceptable for hot water or steam pipe.
   b. 2-1/2 NPS and Larger: Grooved or flanged ends.

D. Chilled Water Valves:

1. 2 NPS and Smaller:
   a. Minimum Class: 125.
   b. Body: Bronze.
   c. Allowable Valve Types:
      1) Ball: Two piece. Forged brass body is acceptable to bronze body.
         a) Brass components.
      2) Lift check.
      3) Swing check.
2. 2-1/2 NPS and Larger:
   a. Minimum Class: 125.
   b. Body: Cast iron, except as noted below.
   c. Allowable Valve Types:
      1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, forged brass, carbon steel, or stainless steel body.
         a) Brass components.

2) Butterfly: Ductile iron body.

3) Lift check.

4) Swing check.

E. Heating Hot Water Valves:

1. 2 NPS and Smaller:

a. Minimum Class: 125.

b. Body: Bronze.

c. Allowable Valve Types:

1) Ball: Two piece. Forged brass body is acceptable to bronze body.

a) Brass components.

2) Lift check.

3) Swing check.

2. 2-1/2 NPS and Larger:

a. Minimum Class: 125.

b. Body: Cast iron, except as noted below.

c. Allowable Valve Types:

1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, forged brass, carbon steel, or stainless steel body.

a) Brass components.

2) Butterfly: Ductile iron body.

3) Lift check.

4) Swing check.

2.3 GENERAL REQUIREMENTS

A. Mechanically Joined General Duty Valves:

1. Contractor shall not use mechanically joined general duty valves for hydronic piping in lieu of welded, threaded or flanged valves.

B. Valve Pressure and Temperature Ratings: No less than rating indicated as required for system pressures and temperatures.

C. Valve Sizes: Match upstream piping unless otherwise indicated.

D. Valve Stem Design:

1. Rising stem or rising outside screw and yoke stems.

2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.

E. Valve Actuator Types:

1. Gear Actuator: Quarter-turn valves 8 NPS and larger.

2. Handwheels: Valves other than quarter-turn types.

3. Hand Lever: Quarter-turn valves 6 NPS and smaller, vinyl-covered.

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

F. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:

1. Gate Valves: Rising stem.

2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: Extended neck.

4. Memory Stops: Fully adjustable after insulation is installed.

G. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.

2. Flanges: ASME B16.1 for cast iron.

3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5 for steel, ASME B16.24 for bronze.

4. Solder Joint Connections: ANSI B16.18.

5. Grooved End Connections: AWWA C606.

H. General ASME Compliance:

1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.

2. Power Piping Valves: ASME B31.1.

3. Building Services Piping Valves: ASME B31.9.

I. Bronze Valves:

1. Fabricate from dezincification resistant material.

2. Copper alloys containing more than 15 percent zinc are not permitted.

J. Valve Bypass and Drain Connections: MSS SP-45.

K. Source Limitations: Obtain each valve type from a single manufacturer.

2.4 BRONZE BALL VALVES

A. Two Piece, Class 150, bronze trim, for valves 2 inch and smaller:

1. Comply with MSS SP-110.

2. CWP Rating: 600 psi.

3. Body: Bronze, ASTM B584.

4. Trim: Bronze.

5. Ends: Threaded or solder joint.
6. Seats and Seals: PTFE.
7. Stem: Blowout-proof.
8. Ball: Full port, chrome plated brass.
9. Operator: Vinyl-covered steel handle.

B. Three Piece, Class 150, bronze trim, for valves 2-1/2 inch to 3 inch:
1. Comply with MSS SP-110.
2. CWP Rating: 600 psig.
3. Body: Bronze, ASTM B584.
4. Trim: Bronze.
5. Ends: Threaded or solder joint.
6. Seats and Seals: PTFE.
7. Stem: Blowout-proof.
8. Ball: Full port, chrome plated brass.
9. Operator: Vinyl-covered steel handle.

2.5 IRON BUTTERFLY VALVES

A. Lug type: Bi-directional dead-end service without downstream flange.
1. Comply with MSS SP-67, Type I.
2. CWP Rating: 200 psig and 250 psig.
3. Body Material: ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat and Seal: EPDM.
6. Disc: Aluminum-bronze, stainless steel, or one-piece Nylon-coated ductile iron.
7. Operator:
a. Size 2-1/2 through 6 inches: Lever operator, 10 position minimum, with locks and stops.
b. Size 8 inch and larger: Gear type with position indicator.

2.6 BRONZE SWING CHECK VALVES

A. Class 125:
1. Comply with MSS SP-80, Type 3.
2. CWP Rating: 200 psig.
3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
4. Body: Bronze, ASTM B62.
5. Ends: Threaded or solder joint.

6. Disc: PTFE.

B. Class 150:

1. Comply with MSS SP-80, Type 3.
2. CWP Rating: 300 psig.
3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
4. Body: Bronze, ASTM B62.
5. Ends: Threaded.
6. Disc: PTFE.

2.7 IRON, FLANGED END SWING CHECK VALVES

A. Class 125, 200 psig CWP.

1. Comply with MSS SP-71, Type I.
2. Design: Horizontal swing, clear or full waterway, capable of being refitted and ground while valve remains in the line.
3. Body: Cast iron with bolted bonnet in accordance with ASTM A126, Class B.
4. Ends: Flanged.
5. Trim: Bronze.
6. Disc Holder: Bronze face ring and seat ring.
7. Disc: Bronze or ductile iron.
8. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. If valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Locate valves for easy access. Provide access doors and fire rated access doors as required.

C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

E. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

F. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

G. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

H. Install valves in a position to allow full stem movement.

I. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

J. Valves with soldered end connections:

1. Use solder with a melting point as follows:

a. Below 840 degrees F for gate, globe, and check valves.

b. Below 421 degrees F for ball valves.

K. Install check valves where necessary to maintain direction of flow as follows:

1. Swing Check: Install horizontal maintaining hinge pin level.

2. Orient plate-type into horizontal or vertical position, between flanges.

3.3 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

3.4 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.5 VALVE SCHEDULE

A. Bronze Ball Valves – 2 inch and smaller, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

Manufacturer	Threaded Ends	Solder Ends
Apollo	77C-140	77C-240
Hammond	8301A	8311A
Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

B. Bronze Ball Valves - 2-1/2 inch to 3 inch, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

Manufacturer	Threaded Ends	Solder Ends
Apollo	82-100	82-200
Hammond	8604	8614
Milwaukee	BA-300	BA-350
Nibco	T-595-Y	S-595-Y
Watts	LFB6080G2	LFB6081G2

C. Iron Butterfly Valves, 200 psig CWP:

Manufacturer	Series
Apollo	LD141
Bray	30/31
Crane Center Line	44
Keystone	222
Nibco	LD-2000
Stockham	LD-712 & 722
Watts	BF-03
Milwaukee	ML
Hammond	6411

D. Bronze Swing Check Valves:

Manufacturer	Class 125 Threaded	Class 125 Solder	Class 150 Threaded	Class 200 Threaded
Apollo	163T	163S	164T	169T
Crane	41TF	--	141TF	36
Hammond	IB940	--	IB946	IB944
Jenkins	4037J	--	4475TJ	4449J
Milwaukee	509-T	1509-T	510-T	508
Nibco	T-413-Y	S-413-Y	T-433-Y	T-453-B
Powell	578	--	--	560Y
Stockham	B-320-T	B-310-T	B322	B-345

E. Iron Flanged End Swing Check Valves:

Manufacturer	Class 125	Class 250
Apollo	910F	920F
Crane	373	39E
Hammond	IR1124	IR322
Jenkins	587J	339RJ
Milwaukee	F2974	F2970
Nibco	F-918-B	F-968-B
Powell	559	--
Stockham	G-931	F-947

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal piping hangers and supports.

C. Saddles and shields.

D. Vertical piping clamps.

E. Anchors and fasteners.

F. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

1.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.

3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

4. 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. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

a. Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

b. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

a. Cooper B-Line.

b. Ferguson Enterprises/FNW.

c. PHD Manufacturing.

d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-58, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:

a. Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

b. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:

a. Indoor Dry Locations: Zinc-plated steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.
2. ASC Engineered Solutions.
3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy
6. Ferguson/FNW.
7. Halfen-DEHA.
8. Hilti.
9. National Pipe Hanger Corporation.
10. PHD Manufacturing.
11. Power-Strut.
12. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
2. Split Ring: Carbon steel, adjustable swivel, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:
   a. ASC Engineered Solutions.
   b. Holdrite.
   c. Klo-Shure.
2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Spring Hangers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

H. Pre-Insulated Supports:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell.

c. ASC Engineered Solutions

d. Buckaroos, Inc.

e. Cooper B-Line, Inc.

f. Pipe Shields, Inc.

2. General Construction and Requirements:

a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.

b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

c. Waterproof calcium silicate insulation shall conform to ASTM C795.

d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.

e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.

3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Manufacturers:

a. Armacell.

b. ASC Engineered Solutions.

c. Cooper B-Line, Inc.

d. Elite Components.

e. ERICO/Michigan Hanger Co./Caddy

f. Ferguson/FNW.

g. Halfen-DEHA.

h. Hilti.

i. National Pipe Hanger Corporation.

j. PHD Manufacturing.

k. Power-Strut.

l. Unistrut.

2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.

B. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.

2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.

4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
≤ 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
≤ 2	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Plastic Saddles and Shields:

1. Manufacturers:

a. Armacell.

b. Eaton.

c. Hydra-Zorb.

d. PHD Manufacturing.

e. Zsi Foster.

2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Halfen-DEHA.
4. Hilti.
5. ERICO/Michigan Hanger Co.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Power-Strut.
9. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:
   a. Hydra-Zorb; Titan Riser Clamp.
   b. National Pipe Hanger.
   c. Pipe Hangers, Inc.
2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.5 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:
    a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
    b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:
    a. Cooper B-Line.
    b. Ferguson Enterprises/FNW.
    c. PHD Manufacturing.
    d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

g. DeWalt “Bang-It” concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2. Self-drilling drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

1. Provide clamps with hardened steel cup-point set screws and locknuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Section “Vibration Isolation for HVAC Piping and Equipment” for vibration isolation anchors.

2.6 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

I. Provide vibration isolators at hangers and supports where specified in Section "Vibration Isolation for HVAC".

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Section "HVAC Insulation" for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

    a. Uninsulated Copper Pipe: Install with plastic galvanic isolators

    b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section "HVAC Insulation".

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamp to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".

    a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert.

2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

    a. If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation".

3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.

   a. Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.

4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

P. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for piping riser supports.

3.4 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

I. Grouting: Place grout under supports for piping and equipment.

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

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

3.6 FIELD QUALITY CONTROL

A. Examine support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.7 PIPE HANGER AND SUPPORT SCHEDULE

A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.

B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

C. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:

   a. Band hanger.

   b. Swivel split ring.

   c. Clevis hanger.

2. Cold and Hot pipe sizes 2 inches and greater where pipes are in stationary position: Clevis hanger.

3. Cold and Hot pipe sizes 2 inches and greater for pipes in the following locations: Roll support hanger.

   a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.

   b. Between anchor locations shown on the drawings.

D. Trapezes and Strut-mounted Supports:

1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

E. Wall Supports:

1. Pipe sizes 3 inches and less:

   a. Two-hole strap mounted to wall.

   b. Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inch and greater:

   a. U-bolt.

   b. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipes in stationary position: Pipe saddle.

2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.

END OF SECTION 230529

SECTION 230550 – VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration-isolated equipment support bases.

C. Vibration isolators.

1.2 COORDINATION

A. Contractor's Responsibility:

1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.

2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.

4. Coordinate the work with other trades to provide additional framing and materials required for installation.

5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

6. Sequencing:

a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:

1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.

2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.

3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.

4. Guarantee specified isolation system deflection.

5. Select and size vibration isolators to not exceed the recommended loading of the isolators.

6. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.

7. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.

B. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.
2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
3. Itemized list of deficiencies.
4. Vibration Isolation System Schedule.
5. For each isolator containing steel springs, record the following:
   a. Size.
   b. Uncompressed height.
   c. Design static deflection.
   d. Measured static deflection.

1.4 QUALITY ASSURANCE

A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.

C. Maintain at the project site a copy of each reference document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Caldyn, California Dynamics Corp.

B. Kinetics Noise Control.

C. Mason Industries, Inc.

D. Vibration Eliminator Co., Inc.

E. Vibration Mounting and Controls.

F. Vibro-Acoustics.

2.2 VIBRATION ISOLATION REQUIREMENTS

A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

B. Select vibration isolators to provide the static deflection as specified in Part 2 “Products” unless otherwise specified for the application listed in Part 3 “Execution.”

C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.

D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.

E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.

F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.

J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.

K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.

L. Vibration Isolator Assemblies with Steel Springs:

1. Housed or caged spring isolators are not acceptable.
2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.

M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.

1. Exterior applications:
   a. Springs: Cadmium-plated and neoprene coated.
   b. Nuts and bolts: Cadmium plated.
   c. Other metal mounting parts: Hot-dip galvanized.
2. Interior applications: Painted.

2.3 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. Concrete Inertia Base (Type CIB):

1. Description: Engineered steel forms into which concrete is poured, with integrated motor slide base, isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer. Where anchor bolt locations fall in concrete, reinforcing steel forms shall include drilled members with sleeves welded below the steel to accept bolts. Height saving steel brackets shall be used in all mounting locations.
2. Size: Beam depth equal to 10 percent of the longest span of the base, 6 inches minimum but not more than 12 inches. Size to accommodate incoming pipe suction diffuser or elbow supports.
3. Mass: Minimum of 1.5 times weight of isolated equipment.
4. When the concrete base is "T" shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
5. The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.
6. Type CIB: Mason Industries Type KSL or approved equal.

2.4 VIBRATION ISOLATORS

A. Ribbed Neoprene “Waffle” Pads (Type WP):

1. Assembly: Single ribbed or crossed double ribbed elastomer in-shear pads, in one or more layers separated and bonded to a minimum 1/4 inch thick galvanized steel shim plate as required to provide selected deflection.
2. Thickness: Each layer 5/16 inch thick.
3. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.05 inches.
4. Type WP: Mason Industries Type W, Type WSW, or approved equal.

B. Neoprene and Cotton Duck Pads (Type DP):
1. Assembly: Neoprene and cotton duck construction, 12 Plys per 1/2 inch thickness.
2. Selection: Thickness or multiple pads in series as required to limit maximum loading to 500 psi and static deflection of 0.1 inches.
3. Type DP: Mason Industries Type HL, or approved equal.

C. Double Deflecting Neoprene Mounts (Type DDNM):
1. Assembly: Laterally stable, double deflecting, neoprene encapsulated mount with bolt holes for attachment to supporting structure.
2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
3. Type DDNM: Mason Industries Type ND or approved equal.

D. Restrained Neoprene Mounts (Type RNM)
1. Assembly: Restrained neoprene mounting element encapsulated in a metal housing to prevent bulging of the neoprene element with bolt holes for attachment to supporting structure. Assembly shall be designed to provide isolation in tension, shear or compression.
2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.25 inches.
3. Type RNM: Mason Industries Type RBA or approved equal.

E. Steel Spring Neoprene Mounts (Type SPNM):
1. Assembly: Single or multiple free-standing and laterally stable steel springs without a housing.
    a. Light capacity base: Molded elastomeric neoprene load plate.
    b. Heavy capacity base: Springs welded to the load plate assembly furnished with integral elastomeric pad.
    c. Leveling Device: Rigidly connected to equipment or frame.
2. Selection:
    a. Minimum static deflection for equipment mounted on grade slabs shall be 1 inch unless specified otherwise.
    b. Minimum static deflection for equipment mounted above grade (suspended) slabs shall be 2 inches unless specified otherwise.
3. Type SPNM: Mason Industries Type SLFH or approved equal.

F. Constrained Steel Spring Neoprene Mounts (Type CSNM):

1. Assembly: Single or multiple free-standing and laterally stable steel springs assembled into a factory-fabricated housing with integral leveling device and stops to limit vertical movement of the isolated equipment during a temporary weight reduction. Include rigid blocking to support equipment during rigging to maintain identical installed and operating heights of the isolator. Housing shall maintain a minimum clearance of 1 inch around restraining bolts and the spring so as not to interfere with the spring operation.

    a. Leveling Device: Rigidly connected to equipment or frame. Limit stops shall provide minimum 1/4 inch clearance between housing and isolator base plate under normal operation.

    b. Equipment Wind Loading Applications: Provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene mounting sleeve.

2. Base: Minimum 1/4 inch thick neoprene pad under housing.

3. Selection: Minimum static deflection of 2 inches unless specified otherwise.

4. Type CSNM: Mason Industries Type SLR or approved equal.

G. Neoprene Bushing (Type NR):

1. Assembly: Neoprene restraint, rubber-in-shear bushings for lightweight, suspended equipment supported from structure with all-thread rod and angle iron or Unistrut.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.15 inches.

3. Type NR: Mason Industries Type HMIB or approved equal.

H. Double Deflection Neoprene Hangers ((Type DDNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator. Neoprene isolator shall prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function.

    a. Housing: Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches.

3. Type DDNH: Mason Industries Type HD or approved equal.

I. Spring and Neoprene Hanger (Type SPNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.

    a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection:

a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.

b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.

3. Type SPNH: Mason Industries Type 30N or approved equal.

J. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.

K. Flexible Connectors:

1. Pipe: Refer to Section "Hydronic Piping Specialties."

2. Duct: Refer to Section "Air Duct Accessories."

L. Pipe Riser Anchor (Type PRA)

1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene. Anchor shall include tapped hole on the top plate for bolt attachment to riser clamp. Anchor shall allow for all-directional movement.

2. Selection: Static deflection of 0.1 inches, maximum allowable load on the isolation material shall not exceed 500 psi.

3. Type PRA: Mason Industries Type ADAH or approved equal.

M. Pipe Riser Guide (Type PRG):

1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene with set screw to prevent lateral movement. Guide shall include tapped hole on the top plate for bolt attachment to riser clamp.

2. Type PRG: Mason Industries Type VSGH or approved equal.

N. Riser Suspension Anchor (Type PRSA):

1. Assembly: Steel hanger box containing laterally stable steel spring with integral deflection scale, adjustment plate, and nut. Housing shall include tapped hole at the top for hanger rod attachment.

2. Selection: Minimum static deflection of 4 inches.

3. Type PRSA: Mason Industries Type HES or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation shall not be approved.

C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.

D. Secure fasteners according to manufacturer's recommended torque settings.

E. Support piping, ductwork, conduit, and mechanical equipment from the building structure. Do not support from other equipment, piping, or ductwork.

F. Install isolators to prevent short-circuiting of the isolation.

G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.

H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.

I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

3.3 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. All floor-mounted equipment shall be erected on housekeeping pads. Refer to Section "Common Work Results for HVAC" for concrete housekeeping pad requirements.

B. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.

C. Set steel bases for one inch clearance between housekeeping pad and base.

D. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.

E. Adjust equipment to be level.

F. Verify no material is left to short-circuit the isolator.

G. Type CMB:

1. Provide flexible duct connector using a foam rubber gasket to seal against the unit bottom.

2. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope on roof equipment support bases.

3.4 INSTALLATION OF VIBRATION ISOLATORS

A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal-to-metal contact.

B. Spring Isolators:

1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.
3. Locate isolation hangers at the top of hanger rods.
4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.
5. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.

C. Isolating Pipe Anchors:

1. Weld anchor base to support steel or bolt base plate to structure. Weld or bolt pipe clamp or bracket to anchor.

3.5 EQUIPMENT ISOLATION

A. Boilers:

1. All Applications: Housekeeping pad base, Type WP isolation continuous along support.

B. Inline Pumps:

1. Pump supported in-line with piping: Provide vibration isolators on the piping per the article "Pipe Isolation" below.
2. Pump supported independent of piping:
   a. Provide flexible connectors on each side of pump. The vertical load shall be carried by the supports, not by the flexible couplings.
   b. Floor Mounted, Slab-on-Grade: Provide housekeeping pad with Type WP or Type DP, type as required to support weight of pump and components, isolation continuous along support.
   c. Floor Mounted, Suspended Slab:
      1) 5 hp and smaller: Housekeeping pad with Type WP isolation continuous under support.
      2) Greater than 5 hp: Housekeeping pad under Type CIB base, Type SPNM isolation with 0.75 inch static deflection.
   d. Suspended: Type SPNH isolation with 2 inch static deflection.

C. Base-mounted Pumps:

1. Slab-on-Grade:
   a. Less than 50 hp: Housekeeping pad.
   b. 50 hp or Greater: Housekeeping pad under Type CIB base, Type SPNM isolation with 0.75 inch static deflection.
2. Suspended Slab (3 hp and less): Housekeeping pad base, Type DDNM isolation with 0.5 inch static deflection.

3. Suspended Slab (Between 3 hp and 50 hp): Housekeeping pad under Type CIB base, Type SPNM isolation with 1 inch static deflection.

4. Suspended Slab (50 hp or greater): Housekeeping pad under Type CIB base, Type SPNM isolation with 2 inch static deflection.

5. Minimum Type CIB Thickness:

Motor Size	Thickness
HP to 7.5 HP	6 inches
HP to 50 HP	8 inches
HP to 100 HP	12 inches

D. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

3.6 PIPING ISOLATION

A. Provide isolation supports on the following HVAC pipe:

1. Piping within 50 feet of the following connected rotating equipment. Provide Type SPNH or SPNM isolators. The first three isolators both upstream and downstream of equipment shall have a static deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.

   a. Chillers.

   b. Pumps with motors greater than 5 hp.

   c. Base mounted air handling units with fan motors greater than 5 hp and no internal isolation.

2. Piping within 20 feet of the following suspended equipment: Provide Type SPNH isolators. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.

   a. Pipes connected without flexible connectors to suspended equipment that is installed with spring vibration isolators.

   b. Pipes connected without flexible connectors to suspended in-line pumps.

B. Provide flexible connectors for piping system connections on equipment side of shutoff valves for all pumps, mechanical equipment supported or suspended by spring isolators, and where indicated on Drawings.

C. Provide resilient diagonal mountings or other approved devices as required to limit piping motion due to equipment startup or shut down to a maximum of 1/8 inch.

D. Where supplementary steel is required to support pipes, size the supplementary steel so that maximum deflection between supports does not exceed 0.08 inches. Isolate the supplementary steel from building structure using the same isolator required for the pipe. Rigidly suspend or support the pipe from the supplementary steel.

E. Provide pre-compressed hanger rod isolators for all pipes greater than 12 inch diameter and all supplementary steel supports used for the large pipe. Factory set the pre-compression at 75 percent of rated deflection.

F. Where isolated pipe 8 inch and larger is supported from exposed steel beams, use welded channel beam attachments located directly under the web of the beam. For piping 6 inch and smaller, beam clamps may be used in lieu of welding, subject to approval of beam clamp selection.

G. Vertical Piping Riser Supports:

1. Do not exceed pipe stresses allowed by ASME B31.9.

2. Provide multiple supports along riser so that each isolator support is loaded for 50 psi maximum. Provide tapped hole in top of support for rigid attachment of pipe riser clamp to support.

3. Riser Supports: Pipe clamp on top of Type DP or Type WP.

3.7 DUCT ISOLATION

A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

3.8 FIELD QUALITY CONTROL

A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION 230550

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Engraved plastic-laminate signs.

1.2 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:

1. Valve tag number.
2. Piping system and system abbreviation as shown on tag.
3. Location of valve (room or space).
4. Variations for identification (if any).
5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
6. Valve manufacturer's name and model number.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Advanced Graphic Engraving, LLC.

B. Brady Corporation.

C. Brimar Industries, Inc.

D. Craftmark.

E. Industrial Safety Supply Co., Inc.

F. Kolbi Pipe Marker Co.

G. MIFAB, Inc.

H. Seton Identification Products, a Tricor Direct Company.

2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.

2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.

C. Control Panels: Nameplates.

D. Instrumentation: Tags.

E. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.

F. Piping: Pipe Markers.

G. Pumps: Nameplates or engraved plastic laminate signs.

H. Relays: Tags.

I. Small-sized Equipment: Tags.

J. Tanks: Nameplates or engraved plastic laminate signs.

K. Valves: Tags. Ceiling tacks are acceptable where located above a lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

L. Water Treatment Devices: Nameplates or engraved plastic laminate signs.

M. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.

2. Equipment service.

3. Design capacity.

4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.

C. Letter Color: White.

D. Letter Height: 1/4 inch.

E. Background Color:

1. Cooling equipment: Green.

2. Heating equipment: Yellow.

F. Plastic: Conform to ASTM D709.

2.4 TAGS

A. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.

B. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum or finished hardwood frame, covered with SSB-grade sheet glass. Provide frame and mounting screws for removable mounting.

D. Letter Height:

1. System Abbreviation: Minimum 1/4 inch.

2. Valve Number: Minimum 1/2 inch.

2.5 PIPE MARKERS

A. Semi-rigid 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.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.

1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).

C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.

D. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.

E. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.

F. Color:

1. Conform to ASME A13.1.

2. Heating, Cooling, and Boiler Feedwater: Green with white letters.

G. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.6 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.

2. Equipment service.

3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer's instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags on piping 3/4 inch diameter and smaller.

E. Install in clear view and align with axis of piping.

F. Identify service, flow direction, and pressure.

3.3 PIPING IDENTIFICATION

A. General: Install identification on the most obviously visible portion of the pipe from the point of access.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. Pipes less than 6 inches diameter (including insulation):, Provide full-band pipe markers with 360 degree coverage.

D. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.

E. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:

1. Within 5 feet of each valve, tee, and control device.
2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of equipment outlets and other points of origination and termination.
6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

3.4 VALVE IDENTIFICATION

A. Provide a tag on each valve, cock, and control device. Exclude check valves, valves within factory-fabricated equipment, HVAC terminal devices, and similar rough-in connections of end-use fixtures and units.

B. Mount valve tag chart and schedule frame in mechanical room, or where indicated on plans. If not indicated, mount where directed by Engineer. Where more than one mechanical room is included on the project, mount framed copies of valve tag chart and schedule in each mechanical room.

3.5 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.
2. To inform operator of operational requirements.
3. To indicate safety and emergency precautions.
4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:

1. Less than 2 feet: Minimum 1/4 inch.
2. Up to 6 feet: Minimum 1/2 inch.
3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General testing, adjustment, and balancing requirements.

B. Pre-testing, adjustment, and balancing of existing air systems.

C. Testing, adjustment, and balancing of air systems.

D. Testing, adjustment, and balancing of hydronic systems.

E. This section excludes:

1. Testing boilers and pressure vessels for compliance with safety codes;
2. Specifications for materials for patching mechanical systems;
3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
4. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the major or entire fluid flow of the system.

I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

A. Qualifications:

1. Submit qualifications of TAB agency.

2. Submit qualifications of TAB supervisor.

B. Certified TAB Reports:

1. General:

a. Submit within two weeks after completion of testing, adjusting, and balancing.

b. Revise TAB plan to reflect actual procedures and submit as part of final report.

c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be handwritten, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:

a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.

b. The report reflects an accurate representation of how the systems have been installed.

c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.

d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.

4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:

a. General Information and Summary

1) Include project name, location, altitude, and date.

2) Identify TAB agency, contractor, owner, architect, and engineer.

3) Include addresses, contact names, and telephone numbers.

4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.

5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.

b. Air Systems

c. Hydronic Systems

d. Temperature Control Systems

5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.

6. Units of Measure: Report data in I-P (inch-pound) units only.

1.4 QUALITY ASSURANCE

A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.

C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.

2. Staff the project at all times by qualified personnel.

3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.

4. Certified by one of the following Certification Associations:

a. AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.

b. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

c. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.

D. TAB Supervisor and Technician Qualifications:

1. Certified by the same organization as TAB agency.

2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

E. Pre-Qualified TAB Agencies:

1. AccuTech

2. Doyle Field Services.

3. Precisionaire of the Midwest.

4. Pro Balance.

5. Total Air Balance.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.

B. Test, adjust, and balance the air systems before hydronic systems.

C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.

D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.

F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.

G. 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.

H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Motors and bearings are lubricated.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly and belts have tension.
8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Volume dampers are installed at locations needed for balancing the air systems.

11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
14. Hydronic systems are flushed, filled, and vented.
15. Hydronic systems are tested for leaks.
16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
17. Pumps are rotating correctly.
18. Proper strainer baskets are clean and in place.
19. Service and balance valves are open.
20. Expansion tanks are not air bound and have appropriate charge.
21. Air vents are operating freely.

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.

3.3 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.
1. Verify all instruments have been calibrated.
2. Furnish instruments as recommended by the manufacturer for the TAB application.
3. Furnish instruments that are best suited to the function being measured.
4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

C. Hydronic Systems: Balance to within plus or minus 5 percent of design flow.

3.5 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.
2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. TAB Contractor:

1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. For variable air volume systems: Open automatic air dampers to full design position to simulate a design day. Measure and record the operating speed and airflow of each fan system for full load conditions.
8. Report on the results of the measurements taken and any deficiencies.

C. Mechanical Contractor:

1. .
2. Report on the operating condition of the equipment and any deficiencies.

3.7 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Check filters for cleanliness.

B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

C. Verify volume dampers are installed at locations needed for balancing the air systems.

D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

E. Determine best locations in main and branch ductwork for most accurate duct traverses.

F. Place outlet dampers in the fully open position.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

H. Lubricate all motors and bearings.

I. Check fan belt tension.

J. Check fan rotation.

K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.

M. Measure air quantities at air inlets and outlets.

N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.

P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.

V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.

W. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

X. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
2. Operate supply fan at design speed and measure the outdoor airflow.
3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.
4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.
5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.8 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Open valves to fully open position. Close coil bypass valves.

B. Remove and clean all strainers.

C. Check pump rotation.

D. Clean and set automatic fill valves for required system pressure.

E. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

F. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

G. Set temperature controls so all coils are calling for full flow.

H. Check operation of automatic bypass valves.

I. Check and set operating temperatures of chillers to design requirements.

J. Lubricate all motors and bearings.

K. Adjust water systems to provide required or design quantities.

L. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on correlated flow from temperature and pressure gauges across the heat transfer elements in the system.

M. 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.

N. Affect system balance with automatic control valves fully open to heat transfer elements.

O. Affect 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.

P. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

Q. Record the necessary information for optimizing pump operation as defined on the control's drawings. Give this information to the controls contractor for building automation system programming.

END OF SECTION 230593

SECTION 230700 – HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping Insulation.

B. Equipment Insulation.

1.2 RELATED REQUIREMENTS

A. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, pipe saddles, and high-density insulation inserts.

1.3 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

C. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.

D. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.

E. Exposed: Insulation that is visible from the occupied space.

F. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.

G. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.

H. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.4 SUBMITTALS

A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.

B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, store in original wrapping.

1.7 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

2.1 PIPING INSULATION MATERIALS

A. Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. Johns Manville.

b. Knauf Insulation.

c. Owens Corning.

2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.

a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.

b. Minimum Service Temperature: 0 degrees F

c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.

d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.

3. Factory Applied Jacket: ASTM C1136, Type I.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.

b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.

c. Color: White.

B. Cellular Glass:

1. Manufacturers:

a. Owens Corning.

2. Insulation: ASTM C552, Type II, Grade 6, rigid closed glass cells pre-formed for the application.

a. K-value: ASTM C518 or C177, maximum 0.34 at 75 degrees F.

b. Minimum Service Temperature: Minus 450 degrees F.

c. Maximum Service Temperature: 800 degrees F.

d. Density: Minimum 6.12 pounds per cubic feet.

C. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell LLC.

c. K-Flex USA.

2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.

a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

b. Minimum Service Temperature: Minus 297 degrees F

c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

3. Factory Applied Jacket:

a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.

2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.

4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2) Vapor Retarder perms	Insulation Permeability, 4.0 or greater perm-in. (Note 2) Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

H. High Density Insulation Billets:

1. Calcium Silicate: ASTM C533 and C795.

2. Flexible elastomeric: ASTM C534, Type 1.

2.2 EQUIPMENT INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. CertainTeed Corp.

b. Johns Manville.

c. Knauf Insulation.

d. Owens Corning.

2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.

a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.

b. Minimum Service Temperature: Minus 20 degrees F

c. Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.

d. Density: Minimum 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch lap.

b. Color: White.

B. Flexible Removeable and Reusable Blanket Insulation:

1. Manufacturers:

a. Auburn Manufacturing.

b. Thermal Energy Products.

c. Thermaxx Jackets

d. Approved equal.

2. Insulation: ASTM C553, Type V, flexible, noncombustible.

a. Comply with ASTM C1695.

b. K-value: ASTM C518 or C177, maximum 0.37 at 100 degrees F.

c. Minimum Service Temperature: 32 degrees F

d. Maximum Service Temperature: 500 degrees.

C. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. Johns Manville.

b. Knauf Insulation.

c. Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.

b. Minimum Service Temperature: 0 degrees F

c. Maximum Service Temperature: 450 degrees.

d. Density: Minimum 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.

b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.

c. Color: White.

D. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.

b. Armacell LLC.

c. K-Flex USA.

2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.

a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

b. Minimum Service Temperature: Minus 40 degrees F

c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

E. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.

2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymerics 3040, or equal.

3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.

4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that

has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.3 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

3.4 PIPING SYSTEM INSULATION INSTALLATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Cold Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC

Piping & Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Secure all-service jacket with self-sealing longitudinal laps.

6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.

2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.

3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.

4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.

5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.

6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.

7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.

8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.

10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

3.5 PIPING SYSTEM INSULATION SCHEDULE

A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Hot piping within radiation enclosures or unit cabinets.
2. Cold piping within unit cabinets provided piping is located over drain pan.
3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil.
4. Chiller emergency refrigerant vent piping.
5. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

D. Cold Piping (40 degrees F (4.4 degrees C) to 60 degrees F):

1. Service:
   a. Chilled water supply and return piping.
   b. Air conditioner condensate drain piping.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
   a. Cellular glass.
   b. Flexible elastomeric.

E. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):

1. Service:
   a. Heating hot water supply and return piping.
2. Acceptable Insulation:
   a. Mineral fiber.
   b. Cellular glass.

3.6 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250		4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200		3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150		2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125		1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100		1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75		0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50		0.5	1.0	1.0	1.0	1.5

Notes:

1. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
2. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
   a. T = minimum insulation thickness (in.),
   b. r = actual outside radius of pipe (in.),
   c. t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
   d. K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
   e. k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
3. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
4. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
5. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.7 PIPING JACKET SCHEDULE

A. Exposed piping within mechanical rooms (below 10 feet):

1. Semi-rigid PVC.

B. Exposed piping within mechanical rooms (above 10 feet):

1. Semi-rigid PVC.

3.8 EQUIPMENT INSULATION INSTALLATION

A. Install insulation subsequent to painting, testing, and acceptance of tests.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Protect insulation to prevent puncture and other damage.

D. Exposed Equipment: Locate insulation and cover seams in least visible locations.

E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

F. Do not apply insulation to equipment, breechings, or stacks while hot.

G. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.

H. Provide neatly beveled edge at interruptions of insulation.

I. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.

J. Stagger insulation joints for both single- and double-layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

K. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

L. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

M. Hot Equipment:

1. Insulate entire system, including flanges and unions.

2. Provide jacket, with or without vapor barrier, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

3.9 EQUIPMENT INSULATION SCHEDULE

A. Omit Insulation on the following:

1. Boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplates.

2. Factory pre-insulated equipment.

B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.

C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

D. Hot Equipment:

1. Service:

a. Hot water storage tanks.

b. Hot water buffer tanks.

c. Hot water expansion tanks, air separators, and piping accessories.

d. Hot water pumps.

2. Acceptable Insulation:

a. Flexible Mineral Fiber:

1) 2 inch thick for all applications.

b. Rigid Mineral Fiber:

1) 2 inch thick for all applications.

3.10 EQUIPMENT JACKET SCHEDULE

A. Omit jacketing on equipment pre-insulated and jacketed from the factory.

B. Interior Equipment (all except flexible elastomeric insulation):

1. Canvas.

END OF SECTION 230700

SECTION 230913 – INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Control panels.

B. Control valves.

C. Control dampers.

D. Operators.

E. Input/Output sensors and transmitters.

F. Output control devices.

G. Power Supplies.

1.2 DEFINITIONS

A. BAS: Building Automation System.

B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

C. Cv: Design Valve Flow Coefficient.

D. DDC: Direct Digital Control.

E. EPDM: Ethylene Propylene Diene Monomer.

F. High voltage: 50 volts or higher.

G. Low voltage: Below 50 volts.

H. PTFE: Polytetrafluoroethylene.

I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

1.3 CONTRACTOR RESPONSIBILITIES

A. Reference Division 23 Section “Electrical Coordination for Mechanical Equipment” for contractor responsibilities.

B. BAS Contractor:

1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.

2. Low voltage control wiring.

3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.

4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).

5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.

6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.

7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.

8. Perform startup and demonstration services as specified in Section "Direct Digital Control for HVAC".

C. Sheet Metal Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.

2. Access doors where and as required.

D. Mechanical Contractor:

1. Installation of immersion wells.

2. Installation of flow switches.

3. Installation of automatic control valves.

4. Installation of pressure tappings and associated shut-off cocks.

5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.4 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Schedule for control valves and actuators, including the following:

1. Tag.

2. Quantity.

3. Model number.

4. Equipment served.

5. Flow at project design conditions.

6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.

7. Pressure differential drop across valve at project design flow conditions and selected Cv.

8. Maximum close-off pressure.

9. Valve Configuration (2-way/3-way).

10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).

11. Valve Size.

12. Line Size.

13. Valve Type.

14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)

15. Torque required to close valve at pump shutoff head.

16. Selected actuator maximum torque output.

E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

F. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.

D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.6 WARRANTY

A. Correct defective Work within a one year period after Substantial Completion.

B. Existing Equipment Warranty: Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, valves, actuators, devices, sensors, transmitters, and thermostats that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system startup and demonstration.

C. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS

A. New Products: None.

B. Existing Products: None.

2.2 CONTROL PANELS

A. Construction:

1. Panel shall be UL 508A listed.
2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
3. NEMA 4X utility enclosure for outdoor or wash-down applications.
4. Provide common keying for all panels.

2.3 CONTROL VALVES

A. General:

1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Each valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.
2. Pressure Ratings:
   a. Valve body and packing rated to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e. chilled water, steam, hot water, etc.).
      1) Minimum pressure class [125][150][250][300] psig.
   b. Two-way modulating valves and their operators shall have close-off pressure ratings exceeding the dead-head condition of the pump in the system it serves.
   c. Two-way modulating valves with equal percentage flow characteristics and their operators shall be rated to safely operate within a differential pressure range between 2 and 50 psi across the valve without cavitating.
3. Sizing:
   a. Hydronic Systems:
      1) Two-Position: Line size or sized using a pressure differential of 1 psi. Size butterfly valves using the 90 degree flow coefficient (Cv).
      2) Modulating: Select valves with an appropriate flow coefficient (Cv) to achieve a minimum design valve authority of 0.5 relative to the total pressure drop of the piping branch the valve controls. Calculate Cv based on the larger of the following:
         a) 5-psig pressure drop at the design flow rate specified in the Schedules.

b) Twice the equipment design pressure drop as specified in the Schedules unless otherwise noted:

c) Valve shall not be less than 1/2 Inch in size.

d) Size butterfly valves using the 60 degree of full open flow coefficient (Cv).

4. Flow Characteristics:

a. Hydronic Service:

1) Two-way valves: Equal percentage characteristic.

2) Three-way valves: Linear characteristic.

5. End Connections:

a. Reference the Control Valve Schedule in Part 3 for allowable end connections by pipe material.

b. Carbon steel and stainless steel valves shall comply with ASME B16.34.

c. Comply with ASME B16.10 for face-to-face and end-to-end dimensions.

d. Threads:

1) Comply with ASME B1.20.1.

2) Comply with ASME B16.4 for cast iron.

3) Comply with ASME B16.15 for cast copper alloys, including bronze and brass.

e. Flanges:

1) Comply with ASME B16.5 for steel.

2) Comply with ASME B16.1 for cast iron

3) Comply with ASME B16.24 for cast copper alloys, including bronze and brass.

f. Grooved Fittings:

1) Water services to 230 deg F and 250 psig.

B. Globe Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size and end connection by application.

2. Construction:

a. Up to 2 inches: Class 150, ASTM B62 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.

1) Bronze body and bonnet shall conform to ASTM B62 up to pressure class 150. Conform to ASTM B61 for pressure class 200 and higher.

b. Over 2 Inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.

1) Iron body and bonnet shall conform to ASTM A126, class B.

c. Bonnet:

1) Bronze body, Class 125: Threaded type.

2) Bronze body, Class 150 or higher: Union type.

3) Iron body: Bolted type.

d. Disc Material:

1) PTFE.

2) Stainless steel.

e. Stem: Outside screw and yoke. Include extension for insulation.

f. Two-piece brass packing gland assembly, non-asbestos composition packing.

3. Rangeability: Minimum 50:1.

4. Leakage:

a. Up to 1-1/4 Inch: Minimum ANSI Class III per ANSI/FCI 70-2.

b. 1-1/2 Inch and Larger: Minimum ANSI Class IV per ANSI/FCI 70-2.

5. Design and Testing:

a. MSS SP-80 for bronze.

b. MSS SP-85 for cast iron.

C. Ball Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.

2. Construction:

a. Body:

1) Bronze conforming to ASTM B61, B62, and B584.

2) Forged brass with or without nickel plating conforming to ASTM B283.

3) Cast carbon conforming to ASTM A216.

4) Cast iron according to ASTM A126.

5) Stainless steel conforming to ASTM A351.

b. Up to 2 inches: Two-piece construction

c. 2-1/2 inch to 3 inch: Three-piece construction.

d. Stainless steel, blowout proof stem. Include extension for insulation.

e. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.

3. Ball: Full port with characterized insert comprised of the following material:

a. Stainless steel.

b. Chrome-plated.

c. Nickel-plated.

4. Rangeability: Minimum 50:1.

5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2.

6. Design and Testing:

   a. MSS SP-72 for flanged ends.

   b. MSS SP-110 for threaded and grooved ends.

D. Butterfly Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.

2. Construction:

   a. Body: Lug ends suitable for connecting to ASME B16.5 flanges, or grooved ends.

      1) Cast iron according to ASTM A126.

      2) Ductile iron according to ASTM A536.

      3) Cast steel according to ASTM A216.

   b. Disc:

      1) Aluminum bronze.

      2) Stainless steel.

      3) One-piece nylon coated ductile iron disc. Nylon coated discs are not allowed for open loop condenser water systems.

   c. Stem: 416 Stainless steel. Include extension for insulation.

   d. Replaceable PTFE or EPDM seats and seals.

3. Rangeability: Minimum 20:1.

4. Leakage: Minimum ANSI Class IV, per ANSI/FCI 70-2.

5. Design and Testing: MSS SP-67 for Class 150 and MSS SP-68 for pressure classes above 150.

E. Manufacturers:

1. Belimo.

2. Bray.

3. Danfoss.

4. Fisher Controls.

5. Griswold Controls.

6. Honeywell.

7. Johnson Controls, Inc.

8. Kele.

9. Schneider Electric.

10. Siemens.

11. Victaulic (Tour & Andersson).

2.4 CONTROL DAMPERS

A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.

B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.

C. Performance: Test in accordance with AMCA 500-D.

1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:

a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.

1) Maximum velocity of 1,500 feet per minute.

2) Maximum Full-open air pressure drop of 0.1 inches W.C.

b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.

2. Leakage:

a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.

b. Motorized dampers for other applications shall be Class II leakage.

D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 20 gauge for round dampers.

3. For aluminum frames, use 1/8 inch thick material.

4. All damper frames shall have a flange for duct mounting.

5. Reference Part 3 Execution for application of the material type.

E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 16 gauge for round dampers.

3. For aluminum blades, use 1/8 inch thick material.

4. The blades shall be suitable for the air velocities to be encountered in the system.

5. Dampers longer than the maximum blade length shall be fabricated in sections.

6. Reference Part 3 Execution for application of the material type.

F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.

1. Installed along the top and bottom of the frame and on all mating surfaces.

G. Jamb Seals: Spring stainless steel.

1. Installed inside the frame sides.

H. Shaft Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze.

2. Graphite impregnated nylon sleeve with thrust washers at bearings.

3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.

4. Molded synthetic bearings.

I. Linkage Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze

2. Graphite impregnated nylon.

J. Maximum Pressure Differential: 6 inches wg.

K. Temperature Limits: -40 to 200 degrees F.

L. Manufacturers:

1. Greenheck.

2. CESCO.

3. Pottorff.

4. Nailor.

5. Ruskin.

M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

2.5 OPERATORS

A. General:

1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.

a. Reference Part 3 for Damper Operator Voltage Schedule.

2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.

3. Construction:

a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

4. Field Adjustment:

   a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

   b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.

6. Modulating Actuators:

   a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.

   b. Control Input Signal:

      1) Three Point, Tristate, or Floating Point: Clockwise and counterclockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

      2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.

      3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.

   c. Programmable Multi-Function:

      1) Control Input, Position Feedback, and Running Time: Factory or field programmable.

      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

      3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

7. Position Feedback:

   a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

   b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

   c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.

8. Integral Overload Protection:

   a. Provide against overload throughout the entire operating range in both directions.

b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

9. Attachment:

a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.

b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.

10. Temperature and Humidity:

a. Temperature: Suitable for operating temperature range encountered by application.

b. Humidity: Suitable for humidity range encountered by application, non-condensing.

11. Enclosure:

a. Suitable for ambient conditions encountered by application.

b. NEMA 4 for indoor wash-down or wet locations.

c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.

d. Provide actuator enclosure with heater and control where required by application.

12. Stroke Time:

a. Coordinate with stroke time indicated on the control drawings.

b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.

B. Damper Operators:

1. Controls contractor shall size damper operator.

2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.

3. Fail Positions:

a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.

1) Return air damper, normally open.

2) Outside air damper, normally closed.

3) Exhaust/Relief air damper normally closed.

b. Operator shall fail in place for all other applications not listed under spring return.

C. Valve Operators

1. Sizing: Select operator with sufficient torque capacity to operate the valve under all conditions and to guarantee tight shut-off of as specified against system pressure encountered.

a. Operators for Hydronic Control Valves: Capable of closing valve against system pump dead head.

2. Fail Positions:

a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection.

1) Pre-heat coil, normally open.

2) Other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage, reference control drawing points list for normal position.

b. Operator shall fail in place for all other applications not listed under spring return.

D. Manufacturers:

1. Damper Operators:

a. Belimo.

b. Honeywell.

c. Johnson Controls.

d. Schneider Electric (Invensys).

e. Siemens.

2. Valve Operators:

a. Belimo.

b. Bray.

c. Danfoss.

d. Fisher Controls.

e. Honeywell.

f. Johnson Controls.

g. Schneider Electric (Invensys).

h. Siemens.

2.6 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

1. Performance Requirements:

a. Device must be compatible with project DDC controllers.

b. Elements used shall be general-purpose type.

c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.

1) Transmitters and transducers shall have offset and span adjustments.

2) Shock and vibration shall not harm the transmitter or transducer.

3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.

d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.

3. Input Power: Low voltage, nominal 24 Vdc.

B. Temperature Sensors:

1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.

2. Performance Requirements:

a. Thermistor:

1) Accuracy (All): Plus/minus 0.36 degrees F minimum.

2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degrees F minimum.

4) Heat Dissipation Constant: 2.7 mW per degree C.

5) Drift: 0.04 degree F after 10 years within temperature range.

b. RTD:

1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.

a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.

b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.

c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degree F.

4) Drift: 0.04 degrees F after 10 years within temperature range.

c. Sensing Range:

1) Provide limited range sensors if required to sense the range expected for a respective point.

d. Wire Resistance:

1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.

3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

4. Temperature Averaging Elements:

a. Use on duct sensors for ductwork 10 sq ft or larger.

b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.

c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.

5. Insertion Elements:

a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.

b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.

c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.

C. Pressure Transmitters:

1. Space Static Pressure:

a. Type: Bi-directional, fixed range.

b. Performance Characteristics:

1) Accuracy: Plus/minus 0.5 percent of full scale.

2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.

4) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.

c. Construction:

1) Sensing Port Wall Mounting: Wall plate with integral sensor, sized to fit standard single gang electrical box. Back of sensor plate fitted with union fitting for tubing connection.

2) Sensing Port Ceiling Mounting: Round plate with union fitting for tubing connection.

3) Sensor Element: Variable capacitance sensor technology.

4) Sensor Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.

D. Equipment Operation Sensors:

1. Status Inputs for Airside Equipment:

a. Type: Fixed range differential pressure switch with adjustable setpoint.

b. Performance Characteristics:

1) Range: Not greater than two times the design fan static pressure.

c. Construction:

1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.

2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.

3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.

2. Status Inputs for Hydronic Equipment:

a. Differential Pressure Switch: Fixed range type with adjustable setpoint.

1) Range: Not greater than two times the design equipment differential pressure.

2) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.

3) Contact Type: Single-pole, single-throw (SPST). Provide double-throw contacts to meet additional alarms required.

b. Flow Switch:

1) Thermal dispersion flow switch enclosed in insertion device, of material suitable for fluid encountered and magnetic setpoint coordinated with the desired flow rate.

a) Range: Sensitivity suitable for the maximum and minimum design flow rates of the system in which it is installed.

b) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered, with LED status indicators for visual switch indication.

c) Contact Type: Automatic reset upon regain of flow.

3. Status Inputs for Electric Motors:

a. Analog Current Transducer:

1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.

2) Performance Characteristics:

a) Accuracy: Plus/minus 2 percent of selected range.

b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.

c) Analog output signal: Generate a proportional control signal relative to the amount of current through the primary bus cables.

3) Construction:

a) 24 V or Self-powered (passive).

b) Provide with integral command relay.

c) Device shall accept overcurrent up to twice its trip into range.

d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.

b. Binary Current Sensing Relay:

1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.

2) Self-powered (passive) with solid-state circuitry and a dry contact output.

3) Adjustable trip point.

4) Contact Type: Single-pole, double-throw (SPDT).

5) LED indicating the on or off status.

6) A conductor of the load shall be passed through the window of the device.

7) Device shall accept overcurrent up to twice its trip into range.

2.7 OUTPUT CONTROL DEVICES

A. Control Relays:

1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.

2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.

3. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator.

4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.

B. Fan Speed Controllers:

1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

2.8 POWER SUPPLIES

A. Reference Division 23 Section “Direct Digital Controls for HVAC” for DC power supply requirements.

B. Control power transformers shall meet NEMA/ANSI standards.

C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.

D. Connected load on the transformer shall not exceed 80 percent of the transformer’s rated capacity.

E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.

F. Performance Characteristics:

1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.

G. Provide a disconnect switch for each transformer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 EXISTING EQUIPMENT

A. Pneumatic Equipment: Where equipment is allowed to be reused for project scope as indicated on the drawings, verify the integrity and proper operation of equipment prior to reuse.

B. Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper applications to the installation are the responsibility of the contractor. The wire shall be properly identified and tested. Unused or redundant wiring that remains in place shall be identified as such.

C. Local Control Panels: The contractor may reuse any existing local control panels to locate new equipment. All redundant equipment within these panels shall be removed. Panel

face cover shall be patched to fill all holes caused by removal of unused equipment or replaced with new.

D. Repair: Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, notify the engineer immediately.

E. Temperature sensor wells: The contractor may reuse any existing wells in piping for temperature sensors. The wells shall be modified as required for proper fit of new sensors.

F. Indicator Gauges: Where these devices remain and are not removed, recalibrate and ensure reasonable accuracy.

G. Unless otherwise noted, salvage, recondition, and reuse the following devices:

1. Room thermostats.
2. Electronic sensors and transmitters.
3. Controller and auxiliary electronic devices.
4. Damper actuators, linkages, and appurtenances.
5. Control valves.

H. Patch holes and finish to match existing walls.

3.3 INSTALLATION

A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

B. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
3. Install all equipment in readily accessible locations.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Install all products in accordance with manufacturer's instructions.

C. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
2. Provide thermistor type temperature sensors for temperature ranges between minus 30 degrees F to 230 degrees F. Provide RTD type temperature sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.

3. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

4. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

5. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.

6. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.

7. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.

8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

9. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.

10. Differential air static pressure.

    a. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building. Pipe the high-pressure port to a location suitable to sense common building pressure or as indicated on the drawings.

        1) Panel mount the transducer adjacent to its associated building automation system controller. Provide an independent manometer gauge next to transducer for calibration.

    b. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

    c. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

    d. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

11. Adjust flow switch to meet sensitivity required to ensure minimum flow through the equipment.

12. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.

    a. Install devices to meet ADA requirements unless otherwise noted on the plans.

13. Mount freeze protection thermostats using flanges and element holders.

a. Install thermostat completely across the surface the thermostat serves.

14. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

15. Provide separable sockets for liquids and flanges for air bulb elements.

16. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

17. Install shutoff valves in the high- and low-pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.

D. Control Valves:

1. Do not install brass valves in open-loop systems.

2. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

3. Install flanges or unions to allow valve removal and installation.

4. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.

5. Valve Orientation:

a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.

b. Install valves in a position to allow full stem movement.

c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

6. Provide valves with position indicators where sequenced with other controls.

7. Tag valves in accordance with Division 23 Section, "Identification for HVAC Piping and Equipment."

E. Control Dampers:

1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.

2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

3. Clearance:

a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

4. Service Access:

   a. Dampers and actuators shall be accessible for visual inspection and service.

   b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories.".

5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.

6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

8. Provide isolation (two position) dampers of parallel blade construction.

9. Provide opposed blade damper configuration for all other applications.

10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

F. Operators:

1. Mount and link control damper actuators according to manufacturer's instructions.

   a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.

   b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

   c. Provide all mounting hardware and linkages for actuator installation.

2. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.

3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.

G. Control Panels:

1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.

2. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for

instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.

H. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

I. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

3.4 MAINTENANCE

A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.5 STARTUP AND DEMONSTRATION

A. Control Dampers and Valves:

1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.

5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

3.6 DAMPER SCHEDULE

Service	Ruskin Model	Material
Outside, Exhaust and Relief		
Air Control, Stairway and Shaft Vents	CD-50	Aluminum
All Other	CD-356	Galvanized Steel

3.7 DAMPER OPERATOR VOLTAGE SCHEDULE

Service	Voltage
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

3.8 CONTROL VALVE SCHEDULES

A. Allowable Valve Type and Size by Control Application:

	Control Application	
Valve Type	Modulating	Two-Position
Globe	≤ 4 in	≤ 2 in
Characterized Ball	≤ 4 in	≤ 4 in
Butterfly	> 4 in	≥ 2-1/2 in

B. Allowable Valve Body Material by Service Application:

Valve Body	Service Application	
Material	Closed Loop	Open Loop
Bronze	Allowed	Allowed
Brass	Allowed	Not Allowed
Iron	Allowed	Allowed
Stainless Steel	Allowed	Allowed

C. Allowable End Connection by System Material:

1. Copper Tube:
   a. 2-1/2 Inch and smaller: Threaded ends.
2. Steel Pipe:
   a. 2 Inch and Smaller: Threaded.
   b. 2-1/2 Inch and Larger:
      1) Flanged.
      2) Grooved ends for water systems.

D. Allowable End Connection by Size Schedule:

	End Connection Type		
Valve Type	Threaded	Flanged	Grooved
Globe	≤ 2-1/2 in	≤ 4 in	n/a
Characterized Ball	≤ 2-1/2 in	≤ 3 in	n/a
Butterfly	n/a	≥ 2-1/2 in	≥ 2-1/2 in

END OF SECTION 230913

SECTION 230923 – DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Description.

B. Operator Interface.

C. Controllers.

D. Electrical Control Power Wiring and Low Voltage Wiring.

E. Local Area Network.

F. System Software.

G. Controller Software.

1.2 REFERENCE STANDARDS

A. ANSI/CEA 709.1.D - Control Network Protocol Specification; 2014.

B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; most current edition.

C. IEEE C37.90.1 – IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus, most current edition.

D. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits, most current edition.

E. ISO 7498 – Information Processing Systems – Open System Interconnection – Basis Reference Model, International Standards Organization, most current edition.

F. NEMA – National Electrical Manufacturers Association.

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

1.3 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. Coordinate routing of DDC power wiring and conduits requiring a fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of DDC power wiring and conduits requiring a fire-resistive protective assembly include, but are not limited to:

1. Wiring for Emergency Power systems.
2. Smokeproof Enclosure Pressurization systems.
3. Smoke Control systems.
4. Smoke Removal systems.
5. Fire service and Occupant Evacuation Elevator systems.

1.4 DEFINITIONS

A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.

A. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).

B. BAS: Building Automation System.

C. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.

D. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

E. DDC: Direct Digital Control.

F. EMT: Electrical Metallic Tubing

G. High voltage: 50 volts or higher.

H. IP: Internet Protocol.

I. LAN: Local Area Network.

J. VLAN: Virtual Local Area Network.

K. Low voltage: Below 50 volts.

A. NiCS: Niagara Compatibility Statement license.

L. OSI: Open System Interconnection

M. PC: Personal Computer.

N. PICS: Protocol Implementation Conformance Statement.

O. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.5 CONTRACTOR RESPONSIBILITIES

A. Reference the following sections for additional contractor responsibilities and coordination:

1. Division 23 Section “Electrical Coordination for Mechanical Equipment.”
2. Division 23 Section “Commissioning for HVAC.”
3. Division 23 Section “Instrumentation and Control Devices for HVAC.”

B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.6 SUBMITTALS

A. Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for submittal procedures.

B. General:

1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.

1. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.

C. Product Data:

1. Submit manufacturer technical data for each system component and software module required for a complete installation.

2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.

2. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.
3. Submit the PICS for each BACnet device used in the BAS.
4. Submit the NiCS for each type of Niagara station in the BAS.

D. Power and Communication Wiring Transient Protection:

1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.
2. Testing shall include power and communication trunk wiring.
3. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1based on the stated position of ANSI and IEEE.

E. Shop Drawings:

1. Submit a trunk cable schematic showing locations of all programmable control units, controllers, and workstations, with associated network wiring.
   a. Indicate equipment served by each controller on the diagram.
   b. Indicate switches, power requirements to each controller, and daisy chained controllers.

1. Submit detailed schematic control drawings for each controlled device and equipment.

    c. Reference all control components to manufacturer make and model number.

    d. Include all control and power wiring with termination point (controller and terminal number).

    e. Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").

    f. Include default position (e.g., N.O., N.C., etc.) for all components where applicable.

    g. Clearly differentiate between existing components and new components.

a. Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.

b. The use of “typicals” will be allowed where appropriate.

2. Submit detailed drawings for each individual BAS distributed controller.

    a. Include controller identification.

    b. Include components included in the controller.

    c. Include numbering of terminals and communications ports.

    d. List connected data points, including connected control unit and input device.

    e. Include type of cable connected to each terminal port.

    f. Identify specific field devices wired to each terminal including identification of each field device and application.

    g. Clearly differentiate between existing controllers and new controllers.

    h. Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.

    i. Indicate method of connecting controller to equipment supplied by others and to existing communications networks.

    j. Indicate device instance and network number.

3. Submit floor plans that indicate the following:

    a. Location of all new BAS distributed controllers and control panels.

    b. Routing of all new building level network communications wiring not located in mechanical and electrical rooms.

    c. Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.

    d. Location of building system connection to Owner’s campus wide data network.

4. Submit methods and materials used to integrate into existing networks.

5. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.

2. Submit system identification nomenclature.

    a. Nomenclature shall be consistent throughout the network and consistent with any existing networks that are integrated. If not defined, nomenclature shall be similar to the point names shown on the drawings.

    b. Object name and ID number shall be unique within a control device.

    c. Control device instance name and ID number shall be unique within the network.

    d. Network number shall be unique for each unique electrical segment in the BAS.

6. Indicate system graphics indicating monitored systems, data (connected and calculated) and operator notations.

    a. Submit example graphic visualizations and screenshots for the BAS. At a minimum, submit examples for major HVAC equipment components, including chillers, boilers, air handling units, fan coil units, heat pumps, fans, etc.

    b. Font size and type shall be manufacturer standard.

    c. Provide graphics demonstration package in a format as desired by the Owner.

7. Indicate description and sequence of operation of operating, user, and application software.

F. System Analytics Database: Submit a database interface plan to Owner.

1. Plan shall demonstrate the look of the BAS interface.

2. Include example graphics of proposed trending functionality and archive functionality.

3. Plan shall be approved by Owner to meet their intent for accessibility and user-friendliness.

G. Controller Manual Download Schedule:

1. Submit a schedule of controllers which cannot automatically download changes to its application program (e.g., schedules, setpoints, etc.) from the integrated BAS and require manual download of changes via local connection of service laptop by maintenance staff. Include the following information in the schedule:

    a. Building name.

    b. Room name of controller location.

    c. Equipment served by controller.

H. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittals data in final "Record Documents" form.

3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.

J. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.

K. Operation and Maintenance Data:

1. Include maintenance data and recommended spare parts list for digital control equipment and control components.
2. Include trouble-shooting maintenance guides.
3. Include interconnection wiring diagrams showing complete field installed systems with identified and numbered system components and devices.
4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.
7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.
8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner’s name and registered with manufacturer.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. BACnet devices used in the BAS shall be BTL listed according to its device profile.

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

E. Installer Qualifications: Company specializing in performing the work of the type specified and with minimum documented experience as follows:

1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.
2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years’ experience within their appropriate trades.

F. Additional BAS Contractor Requirements:

1. Personnel, Coverage and Response Capabilities: The BAS Contractor shall have a fully staffed office with service technicians and systems engineers within a 50 mile radius of the project location.

2. Emergency Service: The BAS Contractor shall have an established 24 hour emergency service organization. A dedicated telephone number shall be provided to the Owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS Contractor.

3. Parts Stocking: The BAS Contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least $100,000 per year over the last five years.

1.8 WARRANTY

A. Refer to Division 01 for additional project warranty requirements.

B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of 1 year after Substantial Completion and system acceptance.

C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start data and period.

E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

F. Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, wiring, and controllers that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system commissioning.

G. Provide five year manufacturer's warranty for field programmable micro-processor based units.

H. Special warranty on instrumentation:

1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.9 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.

C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:
1. Graphics.
2. Record drawings.
3. Database.
4. Application programming code.
5. Documentation.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS

A. New Products: None.

B. Existing Products: None.

2.2 MANUFACTURERS

A. Corporate Edition Products: The following manufacturers and product lines shall be manufacturer's most current vintage and of open protocol design. Corporate editions shall be based on manufacturer developed software.
1. Johnson Controls, Metasys.

B. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, building controllers, custom application controllers, and application specific controllers. All other products specified under Division 23 Section "Instrumentation and Control Devices for HVAC" need not be manufactured by the above manufacturers.

2.3 SYSTEM DESCRIPTION

A. General:
1. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.

2. System design is based on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

3. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

4. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.

5. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.

6. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

B. Local Area Network:

1. The BAS shall be set up using a VLAN connection into the Owner's internet or enterprise intranet. The VLAN shall be digitally separate from all other networks and shall share a common physical cabling backbone. Coordinate with the Owner to configure Ethernet and IP router switches to accommodate the VLAN.

C. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.

1. Application/Network Layer:

a. BACnet protocol complying with ASHRAE Standard 135.

2. Physical/Data Link Layer:

a. Hard-wired type:

1) Ethernet according to ISO 8802-2 protocol.

2) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.

3. Communication between operator workstation(s) and building controller(s):

a. Ethernet.

4. Communication between building controller(s) and application specific and custom application controllers:

a. MS/TP.

b. PTP.

D. Web Services Enabled Network:

1. The network shall be capable of being accessed remotely over the internet via a virtual link according to Internet Protocol.

2. System software shall be based on a client/server architecture, designed around the open standards of web technology. The BAS server shall be accessed using a web

browser over the BAS network, Owner's LAN, and remotely over the Internet (through the Owner's LAN).

3. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming. Connection shall be browser agnostic.

4. Software applications shall be designed and optimized for hand-held device interface (e.g., tablets, smart phones, etc.). Interface shall grant visibility and control access, at a minimum, to the following data: Summary, Alarm, Setpoints, Status, Schedule, and Trending.

E. Network Integration:

1. The BAS network shall be integrated with other automation networks controlled by the Owner. Coordinate with the Owner's information technology (IT) department for networks that shall be integrated.

2. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation. Coordinate communication protocol with each automation system specified.

3. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.

4. Interoperable networks shall be capable of automatically downloading application program changes.

5. For integrated networks that cannot automatically download application program changes, provide a link to the Controller Manual Download Schedule, as defined in the submittals section of Part 1 on the BAS front end summary page

F. Network Interoperability:

1. Provide communication between control units over local area network (LAN).

2. Communication services over the LAN shall result in operator interface and value passing that is transparent to the network architecture as follows:

a. Connection of an operator interface device to any one controller on the network shall allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.

b. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform network value passing.

2.4 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.
2. The operator interface shall be capable of command entry, information and alarm management, database management, access of all system data, and be independent of hardware technology.

B. Building Controllers

1. General:
    a. Input Power Requirements: 24Vac.
    b. Manage global strategies by one or more, independent, standalone, microprocessor-based controllers.
    c. Provide sufficient memory to support controller's operating system, database, and programming requirements.
    d. Share data between networked controllers.
    e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
    f. Utilize real-time clock for scheduling.
    g. Continuously check processor status and memory circuits for abnormal operation.
    h. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
    i. Communication with other network devices to be based on assigned protocol.
    j. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.
2. Communication:
    a. Perform routing when connected to a network of custom application and application specific controllers.
    b. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.
        1) Port shall be USB type.
3. Anticipated Environmental Ambient Conditions:
    a. Outdoors and/or in Wet Ambient Conditions:
        1) Mount within NEMA 4X waterproof enclosures.
        2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.
    b. Conditioned Space:
        1) Mount within NEMA 1 dustproof enclosures.
        2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:
    a. Use for interrogating and editing data.
    b. System security password prevents unauthorized use.
    c. If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.
5. Provisions for Serviceability:
    a. Diagnostic LEDs for power, communication, and processor.
    b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
    a. Maintain operation at 90 to 110 percent of nominal voltage rating.
    b. Perform orderly shutdown below 80 percent of nominal voltage.
    c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
    d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
8. Surge and Transient Protection:
    a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
    b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

C. Custom Application Controllers
1. General:
    a. Input Power Requirements: 24Vac.
    b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
    c. Share data between networked, microprocessor-based controllers.
    d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
    e. Utilize real-time clock for scheduling.
    f. Continuously check processor status and memory circuits for abnormal operation.
    g. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

h. Communication with other network devices to be based on assigned protocol.

i. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

a. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention.

d. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

D. Application Specific Controllers

1. General:

a. Input Power Requirements: 24Vac.

b. Not fully user programmable, microprocessor-based controllers dedicated to control specific equipment.

c. Customized for operation within the confines of equipment served.

d. Provide sufficient memory to support controller's operating system, database, and programming requirements.

e. Communication with other network devices to be based on assigned protocol.

1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

f. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

2. Communication:

a. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory. In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

E. Input/Output Interface

1. Hardwired inputs and outputs shall tie into the BAS through building, custom application, or application specific controllers.
2. All Input/Output Points:
    a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
    b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
    c. Universal-type inputs or outputs configurable between binary and analog are acceptable.
3. Binary Inputs:
    a. Allow monitoring of On/Off signals from remote devices.
    b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
    c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
    a. Allow for monitoring of low voltage 0 to 10 Vdc, 4 to 20 mA current, or resistance signals (thermistor, RTD).
    b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
    a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
    b. Outputs provided with three position (On/Off/Auto) override switches.
    c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
    a. Monitoring signal provides a 0 to 10 Vdc or a 4 to 20 mA output signal for end device control.
    b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
    c. Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:

   a. Coordinate two binary outputs to control three-point, floating type, electronic actuators without feedback.

   b. Limit the use of three-point, floating devices to the following zone and terminal unit control applications:

      1) VAV terminal units.

      2) Duct mounted heating coils.

      3) Zone dampers.

      4) Radiant devices.

   c. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.5 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Power Wiring: Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.

B. Power and Communication Wiring Transient Protection:

1. Comply with IEEE C62.41.2.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.

3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.

   a. For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the individual communications and input/output terminations for each automatic temperature control system controller.

   b. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

C. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.

2. Limit connected loads to 80 percent of rated capacity.

3. Match DC power supply to current output and voltage requirements.

4. Supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.

5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.

6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.

7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.

9. Line voltage units UL recognized, and CSA approved.

D. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.

2. Minimum surge protection attributes:

a. Dielectric strength of 1000 volts minimum.

b. Response time of 10 nanoseconds or less.

c. Transverse mode noise attenuation of 65 dB or greater.

d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

E. Input/Output Control Wiring

1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.

2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.

3. Control wiring not installed in conduit shall be UL rated for plenum installation.

4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.

6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.

7. Binary control function wiring shall be a minimum of number 18 gauge.

8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.

9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.

10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.

11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.

F. Splices: Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.

G. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

H. Relays

1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2. Solid State Relays (SSR):

a. Input/output isolation: Greater than 10 E^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.

b. Contact Life: 10 x 10 E^6 operations or greater.

c. Ambient Temperature Range: Minus 20 to +140 degrees F.

d. Input impedance: Not be less than 500 ohms.

e. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

3. Contactors:

a. Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.

b. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets.

c. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.6 SYSTEM SOFTWARE

A. General:

1. Provide all necessary system software to form a complete operating system for all operator interface devices.

2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.

3. System software display language: English.

B. Device Profile: BACnet devices shall Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:

1. Operator workstation: BACnet Advanced Workstation (B-AWS).

2. Building Controller: BACnet Building Controller (B-C).

3. Advanced Application Controller: BACnet Advanced Application Controller (B-AAC).

4. Application Specific Controller: BACnet Application Specific Controller (B-ASC).

C. Software Programming:

1. Provide programming for the system and adhere to the sequences of operation provided. Provide actions for all possible situations. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Provide text-based, graphic-based, and parameter-based programming where appropriate.

D. Operating System:

1. Concurrent, multi-tasking capability.
2. Common Software Applications Supported:
    a. Microsoft Windows and Microsoft Office Suite.
    b. Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.
3. Acceptable Operating Systems: Most recent version of operating system.

E. System Graphics:

1. Color type, saved in an industry-standard format such as BMP, JPEG, PNG, or GIF.
2. Allow simultaneous display for comparison and monitoring of system status.
3. Web based graphics shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X, Java Virtual Machine, and Adobe Flash).
4. Animate displayed objects by shifting image files of objects based on object status.
5. Functionality: Provide method for operator with password to perform the following:
    a. Move between, change size, and change location of graphic displays.
    b. Modify on-line.
    c. View a summary of the most important data for each controlled zone or piece of equipment.
    d. View a summary of the most important global data for the project, including but not limited to date, day of week, time, outdoor dry bulb temperature, and humidity.
    e. Use point-and-click navigation between graphic screens.
    f. Edit setpoints and other specified parameters.
    a. Edit equipment names and numbers.
    b. Edit room names and numbers.
    g. Indicate areas or equipment in an alarm condition using color or other visual indicator.

h. Add, delete, or change dynamic objects consisting of:

1) Analog and binary values.

2) Dynamic text.

3) Static text.

4) Animation files.

i. Display graphic file, text, and dynamic object data together on a single graphic. Display all measured and commanded data, setpoints, calculated values, and input and output control points with appropriate engineering units associated with each system schematic.

j. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

k. Dynamic Data Displays shall be capable of including point data from multiple ASC's.

6. Include at least one graphic for each of the following:

a. Each piece of equipment.

b. Occupied zone.

c. Hydronic system (chilled water, condenser water, hot water, steam, heat pump, etc.)

d. Floor plan displays of the building. Indicate summary conditions for each floor.

e. Indicate thermal comfort on floor plan using dynamic colors to represent zone temperature relative to zone setpoint.

3. Graphic Tree Structure:

f. Structure graphic system tree to allow access to individual graphic screens from a macro to a micro level.

g. Allow each level of graphic direct access to the graphic screen above and below the graphic screen in the system tree.

h. Allow direct access to the main summary graphic screen/map from any individual graphic screen.

7. Sequence of Operation Graphics:

a. Display the complete Sequence of Operation or include a link to a separate text file that contains the sequence of operation, as submitted by the Contractor and approved by the Engineer with each system schematic view. The Sequence of Operation text shall be in a separate frame above, below, or to the side of the graphic as appropriate for the graphic size and content.

8. Custom Graphics Generation Package:

a. Allow operator to create, delete, modify, and save custom graphic files and displays. File format of graphics shall be compatible with BAS software.

b. Web-based Graphics: HTML graphics to support web browser compatible formats.

c. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components with which custom graphics may be built. Standard components include but are not limited to

1) Air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.).

2) Complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.).

3) Hydronic system components (e.g., chillers, boilers, pumps, piping, valves, etc.).

4) Electrical symbols.

d. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following

1) Define symbols.

2) Position and size symbols.

3) Define background screens.

4) Define connecting lines and curves.

5) Locate, orient and size descriptive text.

6) Define and display colors for all elements.

7) Establish correlation between symbols or text and associated system points or other displays.

8) Capture or convert graphics from AutoCAD.

e. Graphical displays shall be capable of representing a group of objects. Groups shall be capable of representing any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the building.

4. Standard HVAC Graphics Library: Furnish a complete library of standard HVAC equipment graphics and standard symbols for ancillary equipment in a file format compatible with the graphics generation package program. Graphics shall include, but not be limited to, the following:

a. HVAC Equipment:

1) Chillers.

2) Boilers.

3) Air Handlers.

4) Terminal HVAC Units.

5) Fan Coil Units.

6) Unit Ventilators.

7) Heat Exchangers.

b. Ancillary Equipment:

1) Fans.

2) Pumps.

3) Coils.

4) Valves.

5) Piping.

6) Dampers.

7) Ductwork.

F. Workstation System Applications:

1. General Application Functions:

a. All applications shall be capable of being executed automatically without the need for operator intervention and shall be flexible enough to allow user customization.

b. Allow BAS configuration and future changes or additions by operators with password protection.

c. Execute configured processes defined by the user to automatically perform calculations and control routines.

d. Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

1) Any system-measured point data or status

2) Any calculated data

3) Any results from other processes

4) Boolean logic operators (and, or)

e. Process Triggers: Configured processes may be triggered based on any combination of the following:

1) Time of day

2) Calendar Date

3) Other processes

4) Events (e.g., point alarms)

f. Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASC's. In addition, a single process shall be able to issue commands to points in any and all other ASC's on the local network.

2. Network Configuration:

a. Allow for configuration of the BAS network.

b. Provide alarm when a break in communication between devices is detected.

c. Enable the operator to add, delete, or modify the following:

1) Building controllers and ASC’s.

2) Points of any type, point parameters, and tuning constants.

d. Provide automatic reconfiguration if any station is added or lost.

3. Save and Restore:

a. Automatic System Database Save and Restore Functions:

1) Store current database copy of each Building Controller on hard disk or server.

2) Backup database on a user adjustable frequency basis. Default frequency shall be monthly.

3) Automatically update upon change in any system panel.

4) In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

b. Manual System Database Save and Restore Functions by Operator with Password Clearance:

1) Save database from any system panel.

2) Clear a panel database.

3) Initiate a download of a specified database to any system panel.

4. On-line Help:

a. Include context-sensitive system to assist operator in operation and editing.

b. Include topics available for all applications.

c. Include relevant screen data provided for particular screen display.

d. Include additional help via hypertext.

5. Security:

a. Require username and password for Operator log-on to view, edit, add, or delete data.

b. Include selectable system security for each operator. Support a minimum of five levels of access:

1) Level 1 = Read-only data access and display.

2) Level 2 = Level 1 + scheduling.

3) Level 3 = Level 2 + operator overrides and commands.

4) Level 4 = Level 3 + database generation and modification.

5) Level 5 = Level 4 + Audit trail management.

6) Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined as accessible for the user.

7) Support a minimum of 4 passwords at each Building Controller.

c. Allow system supervisor to set passwords and security levels for all other operators.

d. Allow operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

e. Include automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

f. Store all system security data in encrypted format.

g. Log all user actions and store data for audit with permission access by system administrator only.

1) Include the modified system.

2) Include the value modified.

3) Include the time of modification.

6. System Diagnostics:

a. Operations Automatically Monitored:

1) Workstations.

2) Printers.

3) Network connections.

4) Building management panels.

5) Controllers.

b. Device failure is annunciated to the operator.

7. Alarm Management:

a. Allow alarm prioritizing to minimize nuisance reporting and to speed operator response to critical alarms.

1) Provide a minimum of three, user definable priority levels.

2) Enable users to manually inhibit alarm reporting for each point.

3) Enable users to manually inhibit nuisance alarm reporting for maintenance or repair work that is scheduled to be performed.

4) Enable user to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

5) Allow alarm prioritization to lock out or circumvent other alarms that may be generated as a result of primary alarm.

b. Prohibit interference with the ability of the system software to report alarms by either operator activity at the local I/O device, or communications with other system controllers on the network.

c. Allow all system objects that are configurable to "alarm in" and "alarm out" of normal state.

d. Configurable Objects:

1) Alarm limits.

2) Alarm limit differentials.

3) States.

4) Reactions for each object.

5) Alarm delay.

e. Alarm Messages:

1) Descriptor: English language. Acronyms or mnemonics for objects in alarm are not acceptable.

2) Recognizable Features:

a) Source.

b) Location.

c) Nature.

d) Time and Date.

e) Alarm message box to more fully describe the alarm condition or direct operator response.

f) Each Alarm messages shall be assignable to any point in the BAS. Alarm messages shall be assignable to multiple points.

a) Notification of an alarm override.

f. Configurable Alarm Reactions by Workstation and Time of Day:

1) Logging.

2) Printing.

3) Starting programs.

4) Displaying messages.

5) Phone text message.

6) Email.

7) Providing audible annunciation.

8) Displaying specific system graphics.

8. Custom Trend Logs:

a. Maintain trend information for minimum 365 days.

b. Definable for any data object in the system including interval, start time, and stop time.

1) Resolution: Interval periods shall be adjustable down to one minute.

2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.

c. Trend Data:

1) Sampled and stored on the building controller panel.

2) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.

3) Archivable on hard disk or server.

4) Retrievable for use in reports, spreadsheets and standard database programs.

5) Protected and encrypted format to prevent manipulation or editing of historical data and event logs.

d. Trend Graph Display:

1) Group Trend Time Series Plots:

a) Provide user-selectable Y-axis points.

b) Provide user editable titles, point names, and Y-axis titles.

c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.

2) X-Y Trend Plots:

a) User selectable X and Y trend inputs.

b) User editable titles, point names, and X and Y-axis titles.

c) User selectable time period options:

i) 1-day 24-hour period.

ii) 1-week 7-day period.

iii) 1-month period with appropriate days for the month selected.

iv) 1-year period.

v) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.

vi) User selectable display up to 6 plots per screen in 2 columns.

3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.

4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.

5) Zoom: Software shall allow zoom-in function for detailed examination of trends.

e. Numeric Value Display: Software shall display value of any sample on a trend when picked.

9. Alarm and Event Log:

a. View all system alarms and change of states from any system location.

b. List events chronologically.

c. List alarm priority.

c. Allow operator with proper security to acknowledge and clear alarms. Log operator and time when alarm is acknowledged.

d. Archive alarms not cleared by operator to the workstation.

10. Object, Property Status, and Control:
    a. Provide a method to view, edit if applicable, the status of any object and property in the system.
    b. Status Available by the Following Methods:
        1) Menu.
        2) Graphics.
        3) Custom Programs.
11. Clock Synchronization:
    a. The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.
    b. The system shall automatically adjust for daylight savings and standard time, if applicable.
12. Reports and Logs:
    a. Reporting Package:
        1) Allow operator to select, modify, or create reports.
        2) Definable as to data content, format, interval, and date.
        3) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
        4) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.
        5) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
        6) Allow printing on operator command or specific time(s).
    b. Standard Report Format Options:
        1) Objects with current values.
        2) Global modification values.
        3) Current alarms not locked out.
        4) Disabled and overridden objects, points and variables.
        5) Objects in manual or automatic alarm lockout.
        6) Objects in alarm lockout currently in alarm.
        7) Objects currently in override status.
        8) Objects in Schedules
            a) Daily.
            b) Weekly.
            c) Holiday.
        9) Logs:
            a) Alarm History.

b) System messages.

c) System events.

d) Trends.

c. Custom Report Format Options:

1) Daily.

2) Weekly.

3) Monthly.

4) Annual.

5) Time and date stamped.

6) Title.

7) Facility name.

8) Point Groups.

a) User-selectable.

b) Group may be comprised of specific points, group of equipment objects, group of groups, or for the entire facility without restriction due to the hardware configuration of the BAS.

13. Global Modify:

a. Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.

b. Allow each common type of equipment to be excluded or included within the global editing process.

c. Display status information on all similar points in one global report.

d. Allow modification of the following:

1) Individual data point edited.

2) List of all points within the category.

3) Global change field.

4) Copy feature to assist in downloading the new changes.

5) Verification that all changes were completed.

e. Include a change-all feature to change all selections.

f. Prevent acceptance of changes until an accept icon is acknowledged.

G. Workstation Applications Editors:

1. Provide editing software for each system application at the PC workstation.

2. Edited applications shall be automatically downloaded and executed at the controller panel.

3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.

5. System definition and modification procedures shall not interfere with normal system operation and control.

6. Provide consistent text-based displays of all system point and system applications.

7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

8. Full screen editor for each application shall allow operator to view and change:

    a. Configuration.

    b. Name.

    c. Control parameters.

    d. Set points.

    e. Schedules.

9. Scheduling:

c. Allow scheduling down to the zone or room level.

    a. Monthly calendar indicates schedules, holidays, and exceptions.

    b. Allows several related objects to be grouped, scheduled, and copied to other objects or dates.

    c. Start and stop times adjustable from master schedule.

d. Schedule expiration.

    d. Temporary overrides of systems with user adjustable time-out.

e. Provide minimum three tiers of priorities for scheduling.

    1) Priority 1: Event, temporary, or override.

    2) Priority 2: Calendar.

    3) Priority 3: Default.

f. Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.

g. Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.

10. Custom Application Programming:

    a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.

    b. Programming Features:

        1) English oriented programming language, allowing for free form programming.

2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.

3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.

4) Allows the development of independently, executing, program modules designed to enable and disable other modules.

5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:

1. User access secured via user passwords and usernames.

2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.

3. User Log On/Log Off attempts are recorded.

4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:

1. Weekly Schedules Based on Separate, Daily Schedules:

a. Include start, stop, optimal stop, and night economizer.

b. 10 events maximum per schedule.

c. Start/stop times adjustable for each group object.

2. Exception Schedules:
    a. Based on any day of the year.
    b. Defined up to one year in advance.
    c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
3. Holiday or Special Schedules:
    a. Capability to define up to 99 schedules.
    b. Repeated annually.
    c. Length of each period is operator defined.

D. System Coordination: Provide a standard application for equipment coordination. The application shall provide the operator with a method of grouping together equipment based on function and location. Groups shall be capable of being used for scheduling and other applications.

E. Alarms:
1. Binary object is set to alarm based on the operator specified state.
2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically or manually disabled.
4. Alarm Reporting:
    a. Operator determines action to be taken for alarm event.
    b. Alarms to be routed to appropriate workstation.
5. Reporting Action Options:
    a. Start Programs.
    b. Print.
    c. Logged.
    d. Custom messaging.
    e. Graphical displays.
    f. Dial out to workstation receivers via system protocol.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation on the control drawings.

H. PID Control Characteristics:
1. Provide proportional-integral algorithms.
2. Direct or reverse action.
3. Anti-windup.
4. Calculated, time-varying, analog value, positions an output or stages a series of outputs.

5. User selectable controlled variable, set point, and PI gains.

I. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.

2. Order of equipment startup is user selectable.

J. Anti-Short Cycling:

1. All binary output objects protected from short cycling.

2. Allows minimum on-time and off-time to be selected.

3. Allows the number of times each piece of equipment may be cycled within any one-hour period.

K. On-Off Control with Differential:

1. Algorithm allows binary output to be cycled based on a controlled variable and set point.

2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

L. Trending: Building controllers shall allow collection and delivery of (time, value) pairs.

M. Totalization:

1. Run-Time Totalization:

a. Totalize run-times for all binary input objects.

b. Provides operator with capability to assign high run-time alarm.

c. Generates unique, user-specified messages when the limit is reached.

d. Resolution: Adjustable down to one minute.

2. Pulse Totalization:

a. Totalize consumption for user-selected analog and binary pulse input-type objects.

b. Configurable for a daily, weekly, or monthly basis.

c. Provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons, KBTU, tons, etc.).

d. Resolution: Adjustable down to one minute.

e. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

f. The information available from the Pulse Totalization shall include, but not be limited to, the following:

1) Peak Demand, with date and time stamp

2) 24-hour Demand Log

3) Accumulated KWH for day

4) Sunday through Saturday KWH usage

5) Sunday through Saturday Demand kW

6) Demand kW annual history for past 12 periods

7) KWH annual history for past 12 periods

3. Event Totalization:

a. Count user-selected events, such as the number of times a pump or fan system is cycled on and off.

b. Provide storage accumulations of up to 9,999,999 events before reset.

c. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Verify that conditioned power supply is available to the control units and to the operator workstation. Verify that field end devices and wiring are installed prior to installation proceeding.

E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.

F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Coordination:

1. The BAS Contractor shall execute their work in such a manner as to cause the minimum interference to the operation of the building.

2. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

3. Coordinate with the Owner to display additional virtual points on individual schematic graphic screens that are not directly associated with that system. Examples may include outdoor air temperature or global alarm conditions.

B. Web Services Enabled Network:

4. Provide an IP network data drop for connection of BAS into Owner's IP network. Coordinate final location of IP network data drop with the Owners' IT staff.

5. If the Owner has no preference or not indicated on the drawings, locate data drop within the main BAS control panel.

6. Coordinate with the Owner's IT department to implement proper security measures, including secure access to the network data drop and firewalls at all virtual access points to the internet to protect access to the BAS.

C. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.

2. Install all equipment in readily accessible locations.

3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

7. Control wiring routed in wall cavities shall be installed in conduit.

8. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

9. Install software in control units and in operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Controllers:

1. Install controllers in a locked control panel. Provide common keying for all controller covers.

2. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.

3. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.

4. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

D. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.

3. Properly ground all controllers.

4. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.

2. Provide interlock wiring between devices as indicated on the control drawings.

3. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.

4. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

5. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

5. Conceal all low voltage wiring in finished rooms.

6. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.

7. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:

a. Wiring shall be plenum rated.

b. Do not lay wiring on ceiling tiles.

6. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.

7. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.

8. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).

9. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.

10. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

11. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.

12. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

13. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.

14. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

15. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.

16. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

17. Include one pull string in each raceway 1 inch and larger.

18. Use coded conductors throughout with conductors of different colors.

19. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

20. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).

21. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

22. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

23. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.

24. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.

25. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.

26. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.

27. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

28. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

E. Communication Wiring:

1. Adhere to the items listed in the “Wiring” article in Part 3 of this specification in addition to the requirements listed below.

2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer’s installation recommendations for all communication wiring.

3. Do not exceed 328 feet in Ethernet wiring length between switches or repeaters.

4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

5. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer’s wiring practice.

6. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care

shall be taken to route the cable as far from interference generating devices as possible.

7. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.

8. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

9. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.

10. Ground (earth ground) all shields at one point only, to eliminate ground loops.

11. All runs of communications wiring shall be unspliced length when that length is commercially available.

12. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.

13. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.

14. Label all communications wiring to indicate origination and destination data.

15. Ground coaxial cable in accordance with NEC regulations.

16. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135

    a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 17 pF per foot at 76,800 Baud.

    b. The maximum length of an MS/TP segment shall be 3000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

    c. The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.

    d. An MS/TP EIA-485 network shall have no T connections.

F. Identification of Hardware and Wiring:

1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.

4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.

5. Identify room sensors related to terminal box or valves with nameplates.

6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.

7. Identifiers shall match record documents.

3.3 STARTUP AND DEMONSTRATION

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.

B. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.

C. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.

B. BAS graphics shall be updated with final equipment names, equipment numbers, room names and room numbers to match the final construction documents and any Owner changes made prior to occupancy.

D. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.

E. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

F. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.

1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

2. Demand limiting. The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

3. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

4. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

G. Test and verify control interfaces to other building systems integrated into the network.

H. Verify all alarms and interlocks.

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.

I. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.

J. Demonstrate complete and operating system to Owner.

1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.

3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.

4. Demonstrate compliance with sequences of operation through all modes of operation.

5. Demonstrate complete operation of operator interface.

K. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.

2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of eight hours on the operation and maintenance of the equipment provided under this section.

B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.

C. Day-to-day Operator Training:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Proficiently operate the BAS.
3. Understand BAS architecture and configuration.
4. Understand BAS components.
5. Understand system operation, including BAS control and optimizing routines (algorithms).
6. Operate the workstation and peripherals.
7. Log on and off the system.
8. Access graphics, point reports, and logs.
9. Adjust and change system set points, time schedules, and holiday schedules.
10. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
11. Understand BAS drawings and Operation and Maintenance manual.
12. Understand the job layout and location of control components.
13. Access data from BAS controllers and ASCs.
14. Operate portable operator's terminals.
15. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

D. Review data included in the operation and maintenance manuals.

E. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

F. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 230923

SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.

B. Hydronic piping materials.

C. Hydronic piping fittings.

D. Hydronic piping joining materials.

1.2 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.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Reference Division 23 Section, "Basic Piping Materials and Methods" for additional submittal requirements.

C. Reports as specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

PART 2 - PRODUCTS AND MATERIALS

2.1 HYDRONIC PIPING MATERIALS

A. Carbon Steel Pipe:

1. NPS 2 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.

2. NPS 2-1/2 inch through 10 inch: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain or beveled ends.

3. NPS 12 inch and Larger: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule STD, black steel, plain or beveled ends.

B. Copper Tubing:

1. Drawn Temper Tubing: ASTM B88, Type L.

2.2 HYDRONIC PIPING FITTINGS:

A. General: Fittings shall be of wall thickness, pressure rating, and material matching adjoining pipe.

B. Reference Division 23 Section "Basic Piping Materials and Methods" for basic piping materials and fittings.

C. Threaded:

1. All threads shall conform to ASME B1.20.1.

2. Malleable-Iron: ASME B16.3, standard pattern.

D. Flanged:

1. Wrought Cast-Iron, Forged Steel, and Stainless Steel: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connection, and facing:

a. Material Group: 1.1.

b. End Connections: Butt welding.

c. Facings: Raised face.

2. Gaskets: ASME B16.21, non-metallic, asbestos free, 1/8 inch thick, full-face for cast-iron flanges and raised-face steel flanges, suitable for chemical and thermal conditions of piping system contents.

3. Flange bolts and nuts: ASME B18.2.1, hex head carbon steel according to ASTM A307, Grade B.

E. Welded:

1. Carbon and Galvanized Steel: ASME B16.9, seamless weld conforming to ASTM A234.

F. Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.

2.3 HYDRONIC PIPING JOINING MATERIALS:

A. Reference Division 23 Section "Basic Piping Materials and Methods" for basic joining materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

D. Do not install PVC or non-plenum rated CPVC piping in return air plenums.

3.2 PIPE APPLICATION SCHEDULE

A. Mechanically Joined Hydronic Piping:

1. Contractor shall not use mechanically joined hydronic piping systems for hydronic piping in lieu of welded, threaded or flanged piping methods.

    a. Exception: Grooved couplings may be used at equipment connections where specified for vibration isolation control only.

B. Heating Hot Water Piping, Above Grade:

1. Acceptable Pipe Materials:

    a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.

    b. Type L copper with soldered, brazed, or flanged fittings.

2. Fitting Pressure Class: Minimum rating of 150 psig.

C. Chilled Water Piping, Above Grade:

1. Acceptable Pipe Materials:

    a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.

    b. Type L copper with soldered, brazed, or flanged fittings.

2. Fitting Pressure Class: Minimum rating of 150 psig.

3.3 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 using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.4 PIPING INSTALLATION

A. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 time the pipe diameter may be used only where space does not permit the long radius elbows.

B. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

C. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

D. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.

1. Tee-drilling is prohibited as a means for connecting branch taps into any main.
2. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.

E. Anchor piping to ensure proper direction of expansion and contraction.

3.5 PIPE HANGERS AND SUPPORTS APPLICATION

C. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

A. Provide vibration isolation on piping as specified in Division 23 Section "Vibration Isolation for HVAC."

B. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)
8	19	16	7/8 (3/4 for copper)
10	20	18	7/8 (3/4 for copper)
12	23	19	7/8 (3/4 for copper)
14	25	1	
16	27	1	
18	28	1 1/4	
20	30	1-1/4	
24	32	1-1/4	
30	33	1-1/4	

C. Use copper tube maximum hanger span requirements for PVC and CPVC supports and hangers, unless manufacturer's recommendations specify closer hanger spacing.

D. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.

E. Install a support within one foot of each change of direction.

F. Space supports not more than five feet apart at valves, strainers, or piping accessories in piping larger than 2 inches.

3.6 PIPE JOINT CONSTRUCTION

A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.

B. Where more than one pipe material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.

C. Install non-conductive dielectric connections whenever joining dissimilar metals.

D. Pipe-to-Valve and Pipe-to-Equipment Connection: Install flanges or unions between piping and valves and equipment for servicing. Do not use direct welded, brazed, or soldered connections unless specifically called for in the manufacturer's installation instructions.

3.7 FIELD QUALITY CONTROL

A. Preparation for Testing:

1. Prepare hydronic piping in accordance with ASME B31.9.
2. Leave joints, including welds, uninsulated and exposed for examination during the test.
3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Pressure Testing:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.

3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

4. Subject piping system to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leaks. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

6. Provide test reports summarizing the test procedures and results of the tests.

C. Flushing:

1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.

2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.

3. Isolate new pipe from existing pipe during flushing.

4. Provide temporary valves, connections, and bypasses where required.

5. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.

6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.

7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.

8. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

D. Fluid Testing: After filling the system as described under Paragraph “Startup”, perform the following fluid test procedures:

1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.

2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.

3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage

and repeat the circulation and testing procedures specified above. Coordinate with the water treatment supplier.

4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.

5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

3.8 ADJUSTING AND CLEANING

A. After installation of entire system, fill, clean, and treat systems. Refer to Section 232500 HVAC Water Treatment for additional requirements.

B. Cleaning Agent Concentration:

1. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

C. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.

2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.

3. Refill with clean water and circulate for 6 hours at design temperatures, then drain.

4. Refill with clean water and repeat until system cleaner is removed.

D. Chilled Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.

2. Refill with clean water, circulate for 24 hours, then drain.

3. Refill with clean water and repeat until system cleaner is removed.

E. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

F. Remove and clean or replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

J. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

K. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.9 STARTUP

A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages. Refer to Division 23 Section "HVAC Water Treatment" for chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to fully open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper direction of correct improper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valves.
8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 232113

SECTION 232114 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Bladder expansion tanks.

B. Air vents.

C. Air separators.

D. Strainers.

E. Suction diffusers.

F. Flexible connectors.

G. Triple Duty Valves.

H. Balancing valves.

1.2 SUBMITTALS

A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.

B. Product Data: Include rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, component sizes, rough-in requirements, service sizes, and finishes.

1. Balancing Valves and Diverting Fittings: Include flow and pressure drop curves based on manufacturer's testing.

C. Certificates:

1. Inspection certificates for pressure vessels for compliance with ASTM and ANSI manufacturing standards.

2. Welders' certificates complying with the requirements specified in Article, "Quality Assurance."

D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list for inclusion in Operating and Maintenance manual.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

C. Fabricate and stamp air separators, air and dirt separators, expansion tanks, and buffer tanks to comply with ASME BPVC-VIII-1.

D. Comply with ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

E. Comply with AWWA Standards for governing filter media; American Water Works Association, Current Edition.

F. Hydronic specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.4 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.

PART 2 - PRODUCTS

2.1 BLADDER EXPANSION TANKS

A. Manufacturers:

1. American Wheatley.
2. Amtrol, Inc.
3. Armstrong Fluid Technology.
4. Bell & Gossett; Xylem.
5. Caleffi.
6. Grundfos.
7. John Wood Co.
8. Patterson Pump Co.
9. Taco, Inc.
10. Wessels.

B. Construction: Closed, welded carbon steel, tested and stamped in accordance with ASME BPVC-VIII-1; with flexible EPDM bladder sealed into tank, cleaned and prime coated; with tappings for installation of accessories.

1. Pressure rating: As scheduled on the drawings.
2. Maximum operating temperature: 240 degrees F.

C. Accessories: Pressure gauge, air charging fitting, and drain fitting.

2.2 AIR VENTS

A. Manufacturers:

1. American Wheatley.
2. Amtrol, Inc.
3. Armstrong International.
4. Bell & Gossett; Xylem.
5. John Wood Company.
6. Nexus Valves.
7. Spirax Sarco.
8. Taco, Inc.

B. Manual Type: Bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections.

C. Automatic Type: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.

2.3 AIR SEPARATORS

A. In-line Type:

1. Manufacturers:
   a. American Wheatley.
   b. Amtrol, Inc.
   c. Armstrong Fluid Technology.
   d. Bell & Gossett; Xylem.
   e. Caleffi.
   f. Grundfos
   g. John Wood Company.
   h. Patterson Pump Co.
   i. Spirotherm.
   j. Taco, Inc.
   k. Thrush.
   l. Wessels.
2. Construction: Closed, welded black steel; tested and stamped according to ASME BPVC-VIII-1; with perforated stainless steel air collector tube designed to direct released air into expansion tank or automatic air vent as indicated on the drawings; inline inlet and outlet connections; threaded connections up to and including 2 inch

NPS; flanged connections for 2-1/2 inch NPS and above; with tappings for installation of accessories.

a. Pressure rating: As scheduled on the drawings.

b. Maximum operating temperature: 375 degrees F.

3. Accessories: Threaded blowdown connection, sized for full system flow capacity.

2.4 STRAINERS

A. Manufacturers:

1. American Wheatley.
2. Armstrong International.
3. Hoffman Specialty; Xylem.
4. Keckley.
5. Metraflex Co.
6. Mueller Steam Specialties.
7. Spirax Sarco.
8. Nexus Valve.
9. Watts Water Technologies.

B. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.

C. Size 2 inch and Smaller:

1. Body: Bronze, ASTM B62 or forged brass ASTM B283.
2. Ends: Threaded.
3. Cover: Screwed.
4. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.

D. Size 2-1/2 inch and Larger:

1. Body: Cast iron, ASTM A126 Class B.
2. Ends: Flanged or grooved.
3. Cover: Bolted.
4. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.

2.5 SUCTION DIFFUSERS

A. Manufacturers:

1. American Wheatley.
2. Armstrong Fluid Technology.
3. Bell & Gossett; Xylem.

4. Grundfos
5. Keckley.
6. PACO; Grundfos Pumps Corp.
7. Patterson Pump Co.
8. Taco, Inc.
9. Victaulic.

B. Construction: Angle pattern, cast-iron body, threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger.

1. Pressure Rating: As scheduled on the drawings, minimum working pressure as defined by the ANSI fitting class of the system.
2. Maximum operating temperature: 300 degrees F.

C. Accessories:

1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head. Provide stainless steel strainer in condenser water system.
3. Provide disposable screen (5/32 inch mesh) to fit over cylinder strainer for cleaning during startup procedures.
4. Adjustable foot support, designed to carry weight of suction piping.
5. Blowdown tapping in bottom; gauge tapping inside.
6. Permanent magnet located in flow stream, removable for cleaning.

2.6 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.

B. Metal-Type:

1. Manufacturers:
   a. American Wheatley.
   b. Duraflex.
   c. Flex-Hose, Inc.
   d. Flexicraft Industries.
   e. Flex Pipe USA
   f. Hyspan Precision Products.
   g. Mason Industries, Inc.
   h. Metraflex Co.
   i. Twin City Hose.
   j. Unaflex, Inc.

2. Construction:

   a. Braided Hose: Flanged or threaded to match equipment connection, corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

   b. Bellows: Flanged, stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket.

3. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.

4. Maximum operating temperature: 250 degrees F.

5. Lateral Movement: Capable of accepting 3/4 inch misalignment.

C. Rubber-Type:

1. Manufacturers:

   a. American Wheatley.

   b. Duraflex.

   c. Flex-Hose, Inc.

   d. Flexicraft Industries.

   e. Flex Pipe USA.

   f. General Rubber Corp.

   g. Griswold Controls.

   h. Hydronic Components Inc.

   i. IMI Hydronic Engineering.

   j. Mason Industries, Inc.

   k. Mercer Rubber Co.

   l. Metraflex Co.

   m. Nexus Valves

   n. Nutech Hydronic Specialty Products

   o. Proco Products, Inc.

   p. Twin City Hose.

   q. Unaflex, Inc.

2. Construction:

   a. Braided Hose: Threaded, CPE or EPDM inner tube, stainless steel braid, stainless steel ferrules, brass or steel end connections.

   b. Bellows Type: Flanged, fiber-reinforced EPDM rubber body with steel flanges. Do not use control rods.

      1) Basis of Design: Mason Industries Type SFDEJ twin sphere connection or equal.

3. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.

4. Maximum operating temperature: 250 degrees F.

5. Lateral Movement: Capable of accepting 3/4 inch misalignment.

2.7 TRIPLE DUTY VALVES

A. Manufacturers:

1. American Wheatley.
2. Armstrong Fluid Technology.
3. Bell & Gossett; Xylem.
4. Grundfos
5. Keckley.
6. PACO; Grundfos Pumps Corp.
7. Taco, Inc.
8. Watts Water Technologies.

B. Construction: Straight or angle pattern, flanged, cast-iron body with bolt-on bonnet, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

1. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
2. Maximum operating temperature: 300 degrees F.

2.8 BALANCING VALVES

A. Manufacturers:

1. American Wheatley.
2. Armstrong Fluid Technology.
3. Bell & Gossett; Xylem.
4. Caleffi.
5. Griswold Controls.
6. Hays Fluid Controls.
7. Hydronic Components Inc.
8. IMI Hydronic Engineering.
9. Nexus Valve.
10. Nibco Inc.
11. Nutech Hydronic Specialty Products
12. Oventrop.
13. Pro Hydronic Specialties.
14. Taco, Inc.
15. Victaulic Company of America.

B. Construction: Provide balancing valve with fixed orifice flow balancing, flow measurement, and shut-off capabilities, memory stops, and minimum of two differential pressure metering ports.

1. Quarter Turn: Provide ball or butterfly quarter turn style for measurement use in variable flow applications.

2. Full Turn: Provide plug or globe, full or multiple turn style for balancing use in constant flow applications.

3. Size 2 inch and Smaller: Bronze, forged brass or DZR forged brass body, threaded connections.

4. Size 2-1/2 inches and Larger: Cast iron, carbon steel, or ductile iron body, with flanged or grooved connections.

5. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.

6. Maximum operating temperature: 250 degrees F.

C. Accessories: Valve shall include integral pointer and calibrated scale to register degree of valve opening, with position indication readout for repeatable regulation and control.

PART 3 - EXECUTION

3.1 HYDRONIC SPECIALTY APPLICATIONS

A. Reference Division 23 Section “General Duty Valves for HVAC Piping” for general duty valve applications.

B. Air Vents:

1. Manual Type: High points in the system outside of mechanical rooms, at heat transfer coils, and elsewhere as required for system air venting.

2. Automatic Type: Air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers, and elsewhere as required for system air venting within a mechanical room.

C. Strainers: Inlet of each pressure reducing valve, pump, and elsewhere as indicated. Do not install strainers on the inlet of pumps serving open loop condenser water systems. Provide strainers in open loop condenser water system where shown on the drawings.

D. Suction Diffusers: Install on the pump suction inlet. Do not include strainer in suction diffusers installed on pumps serving open condenser water systems, such as cooling towers. Provide strainers in open loop condenser water system where shown on the drawings.

E. Flexible Connectors:

1. Metal Type: Inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment.

2. Rubber Type: Inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment.

3. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.

F. Triple Duty Valves: Contractor has option to provide triple duty valve in the pump discharge line if lieu of balance and check valves. Shutoff valve is still required even if triple duty valve is used.

G. Balancing Valves:

1. Constant Volume Pumping Systems: Where shown on the drawings and elsewhere as required to facilitate system balancing.

2. Variable Volume Pumping Systems: Where shown on the drawings, sized for the smaller of the pipe size or to have a minimum pressure drop of 1 psig at the design flow rate.

3.2 STRAINER SCHEDULE

A. Acceptable strainer types based on fluid and pipe size:

1. Hydronic in Pipes Smaller than 4 inch: Y-Type.

2. Hydronic in Pipes Larger than 4 inch: Y-Type, T-Type, Basket.

B. Acceptable strainer types based on orientation:

1. Horizontal: Y-Type, T-Type, Basket.

2. Vertical: Y-Type, T-Type.

C. Screen Mesh Rating Based on Application:

1. General Piping:

a. Pipe size 4 inch and smaller: 0.062 inches (12 mesh).

b. Pipe size larger than 4 inch: 0.125 inch (6 mesh).

2. Upstream of automatic flow control valves: 0.0331 inch (20 mesh).

3. Upstream of brazed plate heat exchangers: 0.0331 inch (20 mesh).

4. Upstream of plate and frame heat exchangers: 0.0787 inch (10 mesh).

3.3 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

C. Expansion Tanks:

1. Bladder Tanks:

a. Install diaphragm/bladder-type expansion tanks on floor or support from structure as indicated on the drawings. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.

b. Support tank as detailed on the Drawings. In the absence of details, provide support from the floor or structure above, sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming

a full tank of water. Do not overload building components and structural members.

c. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles.

D. Air Vents:

1. Where large air quantities can accumulate, provide enlarged air collection standpipes.

2. Install manual air vents in piping mains with a tee fitting, 1/2 inch ball valve, threaded nipple, and cap.

3. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

E. Air Separators:

1. Install with shutoff valves on the inlet and outlet piping.

2. Install automatic air vent at air outlet and run piping to floor drain.

3. Install in-line air separators with drain valve on units 2 inch and larger.

4. Install air and air/dirt separators on floor or support from structure as indicated on the drawings.

5. Support tank as detailed on the Drawings. In the absence of details, provide support from the floor or structure above, sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming a full tank of water. Do not overload building components and structural members.

F. Strainers:

1. Provide valved drain and hose connection on strainer blowdown connection for strainers 2 inch and larger.

G. Suction Diffusers:

1. Adjust foot support to carry weight of suction diffuser. Install nipple and ball valve in blowdown connection.

H. Triple Duty Valves:

1. Install triple duty valves with stem in upward position. Allow clearance above stem for check mechanism removal.

3.4 STARTUP

A. Reference Division 23 Section Hydronic Piping for general startup requirements.

B. Start up and commissioning of water filtration unit shall be performed by a factory authorized representative.

C. Start up and commissioning of glycol makeup unit shall be performed by a factory authorized representative.

D. Remove temporary strainer after cleaning system.

3.5 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment and/or glycol makeup equipment.

B. Training for Owner's personnel shall include but not be limited to:

1. Overview of the system and /or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

C. Review manufacturer's safety data sheets for handling of chemicals.

D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."

E. Schedule at least two hours of training with Owner, through Architect, with at least seven days' advance notice.

F. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

END OF SECTION 232114

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vertical in-line closed-coupled inline pumps.

1.2 SUBMITTALS

A. See Section 01 33 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. Millwright's Certificate: Certify that base mounted pumps have been aligned.

D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Pump Seals: 1 for each type and size of pump.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

B. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

C. Product Options: Drawings indicate size, profiles and connections requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

D. Regulatory Requirements: Fabricate and test pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.5 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS

2.1 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. 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.

C. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.

D. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.

E. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve. Refer to Section “Common Motor Requirements for HVAC Equipment” for additional requirements.

1. Motors scheduled as ECM type shall be synchronous permanent magnet type with integral VFD.

2. Efficiency: Motors shall have a minimum efficiency meeting the requirements of the Energy Policy Act of 1992 as defined in NEMA MG-1 when tested in accordance with IEEE Standard 112, Test Method B.

a. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer's standard.

F. Apply factory finish paint to assembled, tested units prior to shipping.

2.2 VERTICAL INLINE CLOSE COUPLED PUMPS

A. Type: Pumps shall be variable speed, wet rotor circulator type. Pumps shall be centrifugal, close-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, for 125 psi maximum working pressure and 225 deg F continuous water temperature.

B. Casing: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gauge tappings at inlet and outlet connections.

C. Impeller: PES type or statically and dynamically balanced, closed, overhung, single suction, cast bronze, conforming to ASTM B 584, and keyed to shaft.

D. Shaft: Ground and polished steel shaft, with bronze sleeve and integral thrust bearing. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings for close coupled centrifugal type.

E. Motor: Direct mounted to pump casing; with lifting and supporting lugs in top of motor enclosure for motors greater than 3hp..

F. Seal: If required, provide a carbon seal rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

G. For the secondary heating water pumps scheduled, provide dual head type pumps with single inlet and outlet, and multi-pump functionality through wireless controls or building management system operation.

H. Manufacturers:

1. Armstrong Pumps, Inc.
2. Bell & Gossett, ITT.
3. Grundfos Pumps Corp.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 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 eccentric reducers installed flat on top. Support piping adjacent to pump such that no weight is carried on pump casings. For Vertical In-line or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

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. A separate strainer is not required if a suction diffuser with strainer is provided.

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. Install flexible connectors on the suction and discharge side of each pump mounted on housekeeping pad. Install flexible connectors between the pump casing and the discharge valves, and upstream of the pump suction diffuser.

H. Provide vibration isolation for pumps as specified in Section “Vibration Isolation for HVAC”.

I. Install a combination pressure gauge with tubing connected to the suction and discharge of each pump at the integral pressure gauge tappings provided as well as a tap upstream of the suction diffuser and strainer.

J. Install temperature and pressure gauge connector plugs in suction and discharge piping around pump. Temperature and pressure gauge connector plugs are specified in Section "Meters and Gauges."

K. Check, align, and certify alignment of base-mounted pumps prior to start-up. Comply with pump and coupling manufacturer’s written instruction.

L. Install floor mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to the drawings and Section “Vibration Isolation for HVAC” to determine where concrete inertia bases are required.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

2. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

M. Lubricate pumps before start-up.

3.3 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.

2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.

3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

5. Clean strainers.

6. Check piping connections for tightness.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.

2. Open the valve in the cooling water supply to the bearings, where applicable.

3. Open the cooling water supply valve if the stuffing boxes are water-cooled.

4. Open the sealing liquid supply valve if the pump is so fitted.

5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

6. Open the recirculating line valve if the pump should not be operated against dead shutoff.

7. Start the motor.

8. Open the discharge valve slowly.

9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

10. Check the general mechanical operation of the pump and motor.

11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge valve open, the steps are the same, except that the discharge valve is opened some time before the motor is started.

D. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

E. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.4 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 232123

SECTION 232500 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Chemicals and test equipment.

B. Chemical feeding equipment.

1.2 REFERENCE STANDARDS

A. ASHRAE Guideline 12, Managing the Risk of Legionellosis Associated with Building Water Systems.

B. ASHRAE Standard 188, Legionellosis: Risk Management for Building Water Systems.

C. FM (AG) – FM Approval Guide.

D. ITS (DIR) – Directory of Listed products.

E. UL (DIR) – Online Certifications Directory.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Submit product cutsheets, materials, accessories, chemicals, and equipment, including electrical characteristics and connection requirements, rated capacities, water-pressure drops, shipping, installed, and operating weights for the water treatment system.

C. Shop Drawings: Indicate system schematic, equipment locations, controls schematics, and electrical characteristics. Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

F. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment to confirm compliance with performance requirements.

G. Certificate: Submit certificate of compliance from Authority Having Jurisdiction indicating approval of chemicals and their proposed disposal.

H. Project Record Documents: Record actual locations of equipment and piping.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Sufficient chemicals for treatment and testing during required maintenance period.

J. Warranty and maintenance agreement.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 WARRANTY

A. Warranty: Submit written warranty, signed by Manufacturer and countersigned by Installer and Contractor, agreeing to adjust or replace system or portions thereof, as required to achieve required performances, during 1-year period following final start-up for continued operation of condenser water system.

B. Agreement to Maintain: Prior to time of final acceptance, manufacturer of water treatment system shall submit 4 copies of "Agreement for Continued Service and Maintenance" for water treatment system for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year with option for renewal of Agreement by Owner.

1.6 SPARE PARTS

A. Chemicals, Water Treatment: Furnish 6 month supply of chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality.

1. Ascertain from water piping system Installer, what materials are used for pump seals. Provide only chemicals that are compatible with these materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: The following manufacturers of water treatment systems are acceptable. Manufacturers shall provide chemical feed equipment that meet the requirements specified herein.

1. Walter Louis, a State of Missouri approved water treatment contractor.

a. Contact: Walt Gising (217) 223-2017

2.2 CHEMICALS AND TEST EQUIPMENT

A. General: Furnish chemicals of type and quantity as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

B. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

2. For closed systems, provide nonoxidizing biocide treatment if needed to meet biological parameters from water test performed after system is cleaned..

C. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust Ph.

2. Corrosion inhibitors.

3. Conductivity enhancers.

2.3 CHEMICAL FEEDING EQUIPMENT

A. Bypass (Pot) Feeder: Cast iron or steel, for introducing chemicals into system; with funnel shutoff valve on top, air-release valve on top, drain valve on bottom, and recirculating shutoff valves on sides.

1. Capacity: 1.8 gal. for working pressure of 125 psig.

PART 3 - EXECUTION

3.1 PERFORMANCE REQUIREMENTS

A. Provide a water treatment system sized and equipped to treat raw make-up water available at project site.

B. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

C. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

D. Coordinate the use of oxidizing agents supplemented with non-oxidizers sequentially to ensure organisms do not become immune to treatment per ASHRAE Guideline 12-2000.

E. Except as otherwise indicated, provide water treatment system manufacturer's standard materials and components as indicated by published product information, and as recommended by manufacturer for application indicated.

F. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

G. Perform work in accordance with local health department regulations.

3.2 PREPARATION

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified.

B. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

C. Place terminal control valves in open position during cleaning.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install treatment equipment level and plumb.

C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Install piping adjacent to equipment to allow service and maintenance.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

3.5 FIELD QUALITY CONTROL

A. Test chemical feed piping as follows:

1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
6. Prepare test reports, including required corrective action.

B. Fluid Testing:

1. Coordinate with the testing requirements specified in Division 23 Section "Hydronic Piping"

3.6 ADJUSTING

A. Sample boiler water at one-week intervals after boiler startup for a period of five weeks and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

B. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

3.7 CLOSEOUT ACTIVITIES

A. Training: Train Owner’s personnel on operation and maintenance of chemical treatment system.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

C. Provide overview of the system and /or equipment as it relates to the facility as a whole.

D. Review operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

E. Review manufacturer's safety data sheets for handling of chemicals.

F. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."

G. Provide minimum of two hours of training with Owner with at least seven days advance notice.

H. Have operation and maintenance data prepared and available for review during training.

I. Conduct training using actual equipment after treated system has been put into full operation.

J. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

K. Submit certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

3.8 MAINTENANCE

A. Provide a separate maintenance contract for specified maintenance service.

B. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

C. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of Owner.

D. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

E. Provide laboratory and technical assistance services during this maintenance period.

F. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

G. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

END OF SECTION 232500

SECTION 235100 – BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Plastic gas vents.

1.2 DEFINITIONS

A. Breeching: The conduit conveying flue gas from the appliance to the chimney.

B. Chimney: A structure containing one or more vertical or nearly vertical passageways for conveying flue gases to the outside atmosphere.

C. Stack: A primarily vertical, round, vent.

D. Vent: A flue-gas conveying system intended for use with certain gas-, liquid-, or solid fuel-fired appliances that do not produce flue gas outlet temperatures higher than a value specified in the listing vent standards.

E. Category I Appliance: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

F. Category II Appliances: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

G. Category III Appliances: An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

H. Category IV Appliances: An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

1.3 SUBMITTALS

A. Product Data: Submit product data including materials, dimensions, weights, required clearances, and accessories.

1.4 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:

1. NFPA 211 "Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances."
2. NFPA 54 “National Fuel Gas Code” for natural gas and propane burning appliances.
3. NFPA 31 “Standard for the Installation of Oil-Burning Equipment” for fuel oil appliances.

4. NFPA 37 “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines” for generator engines.

5. UL: Comply with applicable portions of UL safety standards; provide products which have been UL listed and labeled.

6. SMACNA: Comply with SMACNA’s “HVAC Duct Construction Standards” for fabricated breeching and smoke pipe and with SMACNA’s “Guide for Steel Stack Design and Construction” for steel stacks.

7. AWS: All welders and procedures shall be certified in accordance with AWS D1.1, “Structural Welding Code-Steel,” for hangers and supports and in accordance with AWS Standard D9.1, “Sheet Metal Welding Code” for duct joining and seam welding.

8. ASHRAE: Comply with the ASHRAE Systems and Equipment Handbook for Chimney, Gas Vent, and Fireplace Systems material requirements and design criteria.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Handle breeching and stack components carefully to prevent damage, denting and scoring. Do not install damaged components; replace with new.

PART 2 - PRODUCTS AND MATERIALS

2.1 PLASTIC GAS VENTS

A. General: UL 1738 listed, with positive or negative flue pressures complying with NFPA 211 and suitable for condensing gas appliances.

B. Polypropylene:

1. Materials: Minimum 2.2 mm thick polypropylene, rated for 230 degrees F continuously.

2. Fittings: Same material and thickness as the piping.

3. Joining Materials: EPDM or Viton gaskets with stainless steel locking clamp.

4. Manufacturers:

a. Centrotherm Innoflue Single Wall.

b. Nova-Flex Group Z-DENS.

c. DuraVent PolyPro

d. Approved equal.

C. Accessories, UL labeled: Provide tees, adjustable and variable lengths, elbows, increasers, draft hood connectors, terminations, dampers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners, fabricated from similar materials and designs as vent pipe straight sections, all listed for same assembly. Provide discharge assembly termination compatible with manufacturer system to protect against and/or drain rainfall.

D. Appliance Adapter: Provide appliance adapter to connect special gas vent to flue outlet of appliance and secure with hose clamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION SCHEDULE

A. Category IV Appliances:

1. Plastic gas vents, material type selected to exceed maximum flue gas temperatures of the equipment.

B. Combination combustion air and flue gas vent: Double wall special gas vent.

3.3 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Maintain minimum clearances from combustibles specified in third party listing.

C. Align connections accurately with internal surfaces smooth.

D. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

E. 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.

F. Install guy wires and/or braces where maximum unsupported lengths of stacks are exceeded.

G. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.

H. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack, minimum 1/4 inch per foot or per manufacturer's recommendations, whichever is more stringent. Provide flat bottom transitions where required to maintain continuous slope. Provide condensate drain connection at low points with 3/4" plenum rated drain tubing with pigtail trap sized for system pressure. Pipe drain line to nearest open site drain and terminate with air gap. Provide pH neutralizer in drain line in accessible location.

I. All connections to common breechings shall be 45 degree lateral tees.

J. Install firestopping to preserve fire resistance rating of partitions and other elements.

K. Coordinate installation of dampers and draft control devices. Locate dampers as close to draft hood collar as possible.

L. Install slip joints permitting removal of appliance without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.

3.4 INSTALLATION OF PLASTIC GAS VENTS

A. Coordinate vent material compatibility with the appliance manufacturer's installation instructions prior to installation.

B. Where plastic gas vents are installed in a return air plenum, wrap the vent with fire rated plenum insulation.

3.5 FIELD QUALITY CONTROL

A. Temporary Closure: At ends of breechings and chimneys that are not completed or connected to equipment, provide temporary closure that will prevent entrance of dust and debris until installations are completed.

B. Touch-up or refinish sections or accessories that are scratched or marred during shipping and handling or require touch-up after welding.

3.6 ADJUSTING AND CLEANING

A. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.

END OF SECTION 235100

SECTION 235216 – CONDENSING BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured units.

B. Boiler construction.

C. Boiler trim.

D. Fuel burning system.

E. Factory installed controls.

1.2 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.

B. AHRI 1500 - Performance Rating of Commercial Space Heating Boilers; 2015.

C. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2012.

D. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.

E. ASHRAE Std 103 - Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2007, Including All Amendments.

F. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2015.

G. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.

H. NFPA 54 - National Fuel Gas Code; 2015.

I. SCAQMD 1146.1 - South Coast Air Quality Management District Rule No.1146.1; current edition.

1.3 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.

C. Water Sample: Conduct a water sample test prior to boiler installation to coordinate the chemical treatment requirements with the water treatment supplier.

1.4 SUBMITTALS

A. General: Submit the following in accordance with the Conditions of the Contract and Division 1 Specification Sections.

B. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories; and installation and startup instructions. For boilers with factory-mounted starters, provide short circuit current rating.

C. Shop drawings detailing fabrication and installation of equipment assemblies. Indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.

2. AGA design certificates, for information.

D. Manufacturer's field reports, indicating work supervised and performed and related observations, for information.

1. Indicate compliance with specified performance and efficiency.

2. Provide results of the following combustion tests:

a. Boiler firing rate.

b. Over fire draft.

c. Gas flow rate.

d. Heat input.

e. Burner manifold gas pressure.

f. Percent carbon monoxide.

g. Percent oxides of nitrogen.

h. Percent oxygen.

i. Percent excess air.

j. Flue gas temperature at outlet.

k. Ambient temperature.

l. Net stack temperature.

m. Percent stack loss.

n. Percent combustion efficiency.

o. Heat output.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

G. Software: Copy of software provided under this section.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Comply with NFPA 70 "National Electrical Code" for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. AGA Compliance: Design certified by AGA, tests and ratings according to AGA requirements.

E. ASME Compliance: Fabricate and stamp boilers according to ASME Boiler and Pressure Vessel Code, Section IV, "Heating Boilers." Provide control and safety devices in compliance with locally adopted edition of ASME CSD-1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.7 WARRANTY

A. Refer to Division 01 for additional warranty requirements.

B. Provide a ten year warranty to include coverage for heat exchanger.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Constant Primary/Variable Secondary Flow System Condensing Boilers.

1. Lochinvar.

2. Raypak

3. RBI.

2.2 MANUFACTURED UNITS

A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Metal membrane wall, fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

C. Performance Characteristics: Refer to the schedule on the drawings for capacity, efficiency and electrical characteristics.

2.3 BOILER CONSTRUCTION

A. Conform to the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1.

C. Required Directory Listings:

1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.

2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.

D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.

E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

F. Insulate casing with insulation material, protected and covered by heavy-gage metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated or painted finish.

2.4 BOILER TRIM

A. ASME rated pressure relief valve.

B. Flow switch.

C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.

D. Temperature and pressure gage.

E. Pressure Switches:

1. High gas pressure.

2. Low gas pressure.

3. Air pressure.

F. Manual reset high limit.

G. Boiler Pump (where required by boiler design):

1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.

2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.

2.5 FUEL BURNING SYSTEM

A. Provide forced draft automatic burner or pulse combustion, integral to boiler, designed to burn natural gas and maintain fuel-air ratios automatically.

1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.

2. Forced Draft Design: Mixes combustion air and gas to achieve minimum 90 percent combustion efficiency.

3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.

4. Combustion Air Filter: Protects fuel burning system from debris.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with local authorities having jurisdiction requirements for nitrous oxide emissions for natural gas fired systems, as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe

2.6 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:

1. Automatic reset type to control fuel burning system on-off and modulating firing rate to maintain temperature.

2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.

3. Low fire start timed delay relay.

4. Flue gas temperature and supply water temperature compensation to prevent boiler over-firing.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls

E. Controller: Provide a master firing control processor. Processor shall be capable of all boiler operation and efficient staging. The master firing control shall be equipped with open protocol communication according to the drawings and specifications. The processor shall be compatible with the existing or specified control system.

F. Boiler pump time delay.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect boilers according to ASME Boiler and Pressure Vessel Code, Section IV for low-pressure boilers and Section I for high-pressure boilers.

B. Provide factory tests to check construction, controls, and operation of unit.

C. Manufacturer to conduct boiler inspection prior to shipment; submit copy of inspection report to Architect.

2.8 ACCESSORIES

A. BACnet MSTP communications kit

B. Condensate neutralization kit.

C. High and low gas pressure switches w/ manual reset

D. Firing controls: M13-CSD-1/FM/GE Gap

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate layout and installation of boilers with related work.

B. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.

C. Coordinate size and location of concrete housekeeping pads.

3.2 INSTALLATION

A. Install boilers level and plumb, according to manufacturer's written instructions, rough-in drawings, and referenced standards.

B. Install according to NFPA 54.

C. Support boilers on concrete pad constructed in accordance with Division 23 section “Common Work Results for HVAC”. Cast anchor bolt inserts into pad.

D. Provide spring vibration isolation mounts where recommended by manufacturer for pulse combustion boilers.

E. Assemble units and parts shipped loose or disassembled.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.3 CONNECTIONS

A. Install piping adjacent to boiler to allow service and maintenance.

B. Connect air intake and exhaust piping to boiler, size as recommended by manufacturer. Provide intake piping material per manufacturer’s recommendations unless otherwise noted on the drawings. Refer to Division 23 Section “Breechings, Chimneys, and Stacks” for flue exhaust piping. Pitch toward boiler minimum of 2 percent or as indicated. Provide termination as indicated.

C. Connect gas piping to boiler according to requirements of Division 22 Section "Natural Gas Systems." Provide union with sufficient clearance for burner removal and service.

1. Install pressure relief lines from the gas train devices to discharge outside of the building. Relief lines shall be black steel pipe with malleable iron fittings one pipe size larger than the relief outlet of the device. Provide turn down with 40 mesh insect screen at discharge. Provide individual relief lines for each gas train device.

2. Install pressure regulators required in the main gas piping a minimum of 10 feet from the burner connections.

D. Connect hot water piping to supply and return boiler tappings, according to requirements of Division 23 section "Hydronic Piping." Provide shutoff valve and union or flange at each connection.

E. Connect condensate piping to boiler connection and/or flue stack according to manufacturer's requirements. Install Schedule 40 CPVC pipe and fittings from boiler to nearest floor drain or as indicated with PH neutralizer. Provide clear plastic tubing between boiler module connection and manifold connection.

F. Pipe relief valves to nearest floor drain.

3.4 CLEANING AND TOUCH-UP PAINTING

A. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

B. Just prior to substantial completion clean unit's exposed surfaces.

C. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

3.5 STARTUP

A. Arrange with National Board of Boiler and Pressure Vessel Inspectors and/or local authority having jurisdiction for inspection of boiler piping and for certification of completed boiler units.

B. Provide services of a factory-authorized service representative to provide startup service.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment installer.

D. Start boilers according to manufacturer's instructions.

E. Adjust burner for maximum burning efficiency.

F. Operate and adjust controls and safeties.

G. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

3.6 DEMONSTRATION

A. Provide services of a factory-authorized service representative to demonstrate the operation of the boiler, burner and controls.

B. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.

3.7 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section. The contractor shall account for all shifts.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals.

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 235216

SECTION 237313 – CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Drain pan construction.

B. Fan section.

C. Coil section.

1.2 DEFINITIONS

A. Low Pressure: Greater than 1 inch w.c. and less than or equal to 4 inches w.c. internal positive or negative pressure.

B. Medium Pressure: Greater than 4 inches w.c. and less than 10 inches w.c. internal positive or negative pressure.

C. High Pressure: Greater than or equal to 10 inches w.c. internal positive or negative pressure.

1.3 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ACGIH - Ultraviolet Radiation, TLV Physical Agents.

D. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment.

E. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

F. AHRI 430 (I-P) - Performance Rating of Central Station Air-Handling Units.

G. AHRI 610 (I-P) - Performance Rating Of Central System Humidifiers for Residential Applications.

H. AHRI 1060 I-P - Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.

I. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; http://www.amca.org/certified/search/company.aspx.

J. AMCA 99 - Standards Handbook.

K. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

L. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

M. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

N. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.

O. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.

P. AMCA 611 - Certified Ratings Program for Airflow Measurement Stations.

Q. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

R. ASHRAE Std 62.1 - Laboratory Method of Testing to Determine the Sound Power in a Duct

S. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, Including All Addenda.

T. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating.

U. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

V. CGA 3.2 - Industrial and Commercial Gas-Fired Package Furnaces; Current Edition, Including All Amendments.

W. NEMA MG 1 - Motors and Generators.

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

Y. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

Z. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

AA. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

BB. UL 153 - Portable Electric Luminaries; Current Edition, Including All Revisions.

CC. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

DD. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc; Current Edition, Including All Revisions.

EE. UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.

FF. UL 1598 - Luminaires; Current Edition, Including All Revisions.

GG. UL 1812 - Ducted Heat Recovery Ventilators; Current Edition, Including All Revisions.

HH. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation with size, location and installation of service utilities.

B. Coordinate the work with other trades for installation of roof mounted air handling units on roof curbs.

C. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

D. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. Product Data:

1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
4. Sound Power Level Data: Certified fan outlet, inlet, and casing radiation at rated capacity. For variable speed fans, provide sound ratings at 100, 80 and 60 percent of maximum rpm.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
6. Certified coil performance ratings with system operating conditions indicated.
7. Motor ratings and electrical characteristics plus motor and fan accessories.
8. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
9. Total pressure drop for the unit with itemized pressure drop per module. At a minimum, provide line items for the following:
    a. External static pressure loss.
    b. Unit inlet and outlet opening losses.
    c. Internal filter, coil, and casing losses.
    d. Pressure drop per module.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

D. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

C. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters' Laboratories.

D. Nationally Recognized Tested Laboratory and NEMA Compliance (NRTL): Electric coils, along with the complete central-station air-handling unit shall be listed and labeled by a NRTL. The term “NRTL” shall be as defined in OSHA Regulation 1910.7.

E. AHRI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of AHRI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Follow manufacturer's written instructions for rigging. Inspect for damage. Replace damaged units or components.

B. Store in clean dry place off the ground and protect from weather, physical damage, and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Replace any sections that experience internal water damage due to lack of protection.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURED UNITS

A. General Description: Replacement components for an existing air handling unit consisting of fans, motor and drive assembly, coils, and drip pans.

B. Types: Central-station air-handling units included in this project are of the following types:

1. Dual duct.

C. Motor: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

D. Electrical Components: Refer to Division 26 Sections.

2.2 CASING CONSTRUCTION

A. Drain Pan Construction:

1. Double-Wall Drain Pans: Formed sections of galvanized sheet steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at the maximum cataloged face velocity across the cooling coil. Fill space between double-wall construction with foam insulation and seal moisture tight. Comply with ASHRAE Std 62.1 for indoor air quality and sufficiently size to collect all condensate.
2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
5. Drain connections: Both ends of the pan.
6. Pan top surface coating: Elastomeric compound.
7. Units with stacked coils shall have an intermediate drain pan or a drain trough to collect condensate from top coil.

2.3 FAN ARRAY SECTION

A. Manufacturers:

1. Chicago Blower Corp.
2. Greenheck Fan Corp.
3. PennBarry.
4. Trane Co.
5. Twin City Fan Company.

B. Performance — Fans shall conform to AMCA test standards, 205 (fan efficiency grade), 210 (air performance) and 300 (sound performance) and shall bear the AMCA certified ratings seal for both sound and air, and fan efficiency grade (FEG).

C. Construction — Fans shall be housed and incorporate a non-overloading type backward inclined airfoil blade wheel or centrifugal plenum wheel, heavy-gauge galvanized G90 steel frame, and front panel. The front panel shall have a removable inlet cone designed for smooth airflow transition into the wheel. The motor base shall be designed to ensure proper alignment of the fan wheel, motor and inlet cone. The design shall also ensure the structural integrity of the base to minimize vibration.

1. The fan array shall consist of multiple fan and motor “cubes” or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.

2. The fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing such that the array dimensions fill a minimum of 90% of the cross-sectional area of the AHU air way tunnel.

D. Wheel — Wheels shall be constructed of non-overloading extruded airfoil shaped blades. Airfoil blades shall be continuously welded. The entire wheel shall be constructed of aluminum to reduce weight and vibration. Blades shall be extruded aluminum. Wheel hubs shall be machined aluminum. Aluminum fan wheels shall not require a finish coating. Wheels shall be attached to the motor shaft using taper lock bushings. The wheel and fan inlet shall be matched and have precise running tolerances for maximum performance and operating efficiency.

E. Finish and Coating — Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.

F. Motors — Motors shall meet or exceed EISA 2007 (The Energy Independence and Security ACT of 2007) efficiencies. Motors shall be NEMA rated, 720, 900 1200, 1800 or 3600 RPM in 60 Hz, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor. Motors shall include permanently sealed (L10-400,000 hr) bearings and shaft grounding rings to protect the motor bearings from electrical discharge machining due to stray shaft currents.

G. Fan Balancing — All fans prior to shipment shall be run tested at the specified operating speed. Each fan shall be dynamically balanced as a complete unit in accordance with ANSI/AMCA 204-96 “Balance Quality and Vibration Levels for Fans” to a minimum Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken electronically in the axial, vertical and horizontal directions. Records of each fan balance shall be maintained, and a written copy shall be available upon request.

H. Fan Isolation:

1. Blank off Panels — Each Multiple Fan section to be provided with fan blank-off panels to enable manual isolation of fan for servicing. Quantity of panels shall equal the number of rows of fans.

I. Fan Array Motor Controls

1. All fan motors shall be factory-wired to individual manual motor protection (MMP) device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch (one per motor) for power isolation. Field wiring of MMPs to fan motors shall not be permitted.

2. MMPs shall be contained in a single control panel (MMP panel) and shall be mounted on the exterior wall panel of the fan array section.

3. MMP panel shall have a single point of connection for input power wiring and shall feed power to individual MMP’s through a common bus bar. Independent wiring of input power to individual MMP’s shall not be permitted.

4. All ECM motors shall be operated together from a single control point so that all fan motors operate together. Independent control of fan motors shall not be permitted.

5. Options:

a. Power panel, factory wired, ship loose, field mounted; NEMA-3R enclosure, UL-508A listed, overload protection – integral fused,

disconnect – integral, setpoint control – static pressure, communication protocol – BACnet MSTP, wiring – array to controls, Control panel, factory wired, ship loose, field mounted; Hand/Off/Auto – factory wired.

6. Fan Options:

   a. System redundancy – N-1.

2.4 COIL SECTION

A. Manufacturers:

1. Aaon, Inc.
2. Aerofin
3. Carrier Corp.
4. Daikin Applied.
5. Dunham-Bush, Inc.
6. Heatcraft
7. Johnson Controls, Inc.
8. Marlo
9. Trane (The) Co.
10. USA Coil & Air

B. Testing Requirements: The following factory tests are required:

1. Coil Performance Tests: Cooling and heating coils, except sprayed surface coils, shall be factory tested for rating in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

C. Coil Pressure Ratings:

1. Water Coils: Design for 200 psi working pressure at 325 F, and pressure test at 300 psi under water.

D. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

E. Air Coils:

1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

F. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
   a. Thickness: Minimum 0.006 inches.
   b. Spacing: Maximum 12 fins per inch.
3. Casing: Die formed channel frame of galvanized steel.
4. Water Coil Turbulators: Bronze, spring-type.

G. Water Heating Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.

2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type.

H. Water Cooling Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.

2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Bolt sections together with gaskets.

D. Isolate fan section with flexible duct connections.

E. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

F. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section "Vibration Isolation for HVAC". Adjust snubbers to prevent tension in flexible connectors when fan is operating.

G. Provide fixed sheaves required for final air balance.

H. Make connections to coils with unions or flanges.

I. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

2. Route unit condensate drain piping to location shown on the plan or, if not shown, to the nearest equipment or floor drain. Provide trap at connection to drain pan with depth as noted on the drawings and install cleanouts at changes in direction.

Size condensate drain piping in accordance with local code and as shown on the drawings.

J. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 26.
2. Temperature control wiring and interlock wiring is specified in Division 23 section "Direct-Digital Control for HVAC."

K. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

L. Hydronic Coils:

1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
3. Locate water supply at bottom of supply header and return water connection at top.
4. Provide manual air vents at high points complete with stop valve.
5. Ensure water coils are drainable and provide drain connection at low points.

M. Insulate Coil Headers Located Outside Air Flow as Specified for Piping: Refer to Section "HVAC Insulation" for additional requirements.

3.3 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.4 FIELD QUALITY CONTROL

A. Final Acceptance Requirements:

1. Use dial indicator gages to demonstrate fan and motor are aligned.
2. Verify conformance to specifications using vibration analysis.
3. Maximum Vibration Levels:
   a. 0.075 inch per second at 1 time run speed and at fan/blade frequency.
   b. 0.04 inch per second at other multiples of run speed.

3.5 SYSTEM STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

5. Set outside-air and return-air mixing dampers to minimum outside-air setting.

6. Comb coil fins for parallel orientation.

7. Install clean filters. Do not operate air handling unit without pre-filters installed.

8. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

9. Disable automatic temperature control operators.

B. Provide manufacturer's field representative to observe and approve systems startup.

C. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

D. Adjust for proper operation within manufacturer's published tolerances.

E. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

1. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Shut unit down and reconnect automatic temperature control operators.

4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.6 CLOSEOUT ACTIVITIES

A. At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel on the operation and maintenance of the equipment provided under this section.

B. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.

2. Conduct walking tour of project.

3. Briefly describe function, operation, and maintenance of each component.

C. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.

3. Instructor: Manufacturer's training personnel.

4. Location: At project site.

D. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

E. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 237313

SECTION 260010 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and to all following sections within Division 26.

1.2 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."

2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."

3. Provide: "To furnish and install complete, and ready for the intended use."

4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.

6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the “Engineer”.

7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified

B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

C. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

E. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.4 REFERENCE STANDARDS

A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC International Building Code

ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufactures' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.

G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make do provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

I. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.

2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.

4. Include work provided by others routed through the equipment rooms.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.

a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in the Engineer's Agreement with the Client, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual Sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

1.8 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.

   d. Same warranty will be furnished for proposed substitution as for specified Work.

   e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

   f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

   a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.

4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. The following must be received before electronic drawing files will be sent:

1. Engineer’s release agreement form
2. Payment

1.10 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer’s review, and for the Owner’s use, four (4) copies of Operation and Maintenance

Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to

adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. Also warrant the following additional items:

1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
2. All raceway seals are effective.
3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

   a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.

   b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

1.17 FIELD CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.

2. Schedule work in the existing building with the Owner.

3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, equipment, raceways, equipment supports or materials.

4. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.

5. Finish material will be installed under other divisions.

6. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

PART 2 - PRODUCTS AND MATERIALS

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

C. Notify Contract Administrator immediately of any dangerous conditions that exist on the job site, as they are discovered, before demolition, during selective demolition or before remodel work begins.

3.3 EXISTING UTILITIES

A. Prepare and submit a schedule of anticipated utility outages indicating dates and duration. Schedule

B. Schedule and coordinate with the utility companies, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the bid.

C. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or utility companies without additional cost.

D. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.

E. Make repairs and restoration of utilities before workers leave the project at the end of the workday in which the interruption takes place.

F. Include in bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the site prior to submitting a bid, to determine the nature and extent of work involved.

B. Schedule work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.

3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.

4. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.

G. Finish materials are specified in other divisions.

H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.

I. Penetrate roofs, channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all penetrations and channeling not specifically noted on the Drawings.

J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch. Where circuit designations are not specifically indicated on the Drawings, provide a unique identifier for each updated circuit within the directory.

K. Coordinate work with Architectural phasing drawings to properly stage transitions of work to provide power to existing, new and temporary loads. Monitor loads on distribution system to ensure shifting of loads does not overload electrical equipment.

3.5 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including

connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.6 TEMPORARY ELECTRICAL SERVICE AND WIRING

A. In existing facilities, with Owner's approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner's Representative.

B. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.

C. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

D. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

E. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.

F. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.7 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

    a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.

b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

3.8 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Maintain all code required clearances and clearances required by manufacturers.

3.9 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.10 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

D. Patch around openings to match adjacent construction, including fire ratings, if applicable.

E. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.11 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer’s instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.12 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.

C. Damaged finishes shall be touched-up and restored to their original condition

3.13 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

B. Check motors for alignment with drive and proper rotation, and adjust as required.

C. Check and test protective devices for specified and required application, and adjust as required.

D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.

E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.

H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.

J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.

K. Refer to individual sections for additional and specific requirements.

3.14 START-UP OF SYSTEMS

A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.

B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.

C. Adjust taps on each transformer for rated secondary voltages.

D. Balance all single-phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.

E. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

F. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

G. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.15 TEST REPORTS

A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.

B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:

1. Perform tests as described in the individual sections.

C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:

1. Building service entrance voltage and amperes at each phase.
2. Electrical service grounding conditions and grounding resistance.
3. Proper phasing throughout the entire system.
4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
5. Phase voltages and amperes at each three-phase motor.

6. Test all wiring devices for electrical continuity and proper polarity of connections.

D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

3.16 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.
2. Submit complete Record Drawings.
3. Perform all required training of Owner's personnel.
4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
5. Perform start-up tests of all systems.
6. Remove all temporary facilities from the site.
7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days' notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 260010

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:

1. Sleeves and seals for electrical penetrations.
2. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these Specifications:

1. AHJ: Authority(ies) having Jurisdiction
2. ATS: Acceptance Testing Specifications
3. EPDM: Ethylene-propylene-diene monomer rubber
4. MC: Metal Clad
5. N/A: Not Available or Not Applicable
6. NBR: Acrylonitrile-butadiene rubber
7. NRTL: Nationally Recognized Testing Laboratory
8. PCF: Pounds per Cubic Foot

B. The following definitions apply to this and other Sections of these Specifications:

1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

E. Coordinate with general contractor to provide at least one path to outside with 8'-0" tall door in main electrical rooms and generator rooms that contain switchgear, motor control centers, generators and other electrical equipment taller than 6'-6".

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

2.2 SLEEVES

A. Steel sleeves for raceways and cables:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables:

1. Manufacturers
   a. Josam Mfg. Co.
   b. Smith (Jay R) Mfg. Co.
   c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
   d. Watts Industries, Inc.
   e. Zurn Industries, Inc.; Hydromechanics Div.
2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with setscrews.
3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138- inch thickness as indicated and of length to suit application.

4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.3 SEALANTS

A. JOINT SEALERS

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.

3. Elastomeric Joint Sealers: Provide the following types:

a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

1) Dow Corning, Dowsil 790

2) Dow Corning, Dowsil 795

3) GE, Silglaze II SCS 2350

4) GE, Silpruf SCS 2000

5) Owens Corning, Energy Complete

6) Pecora, 864 NST

7) Tremco, Spectrem 1

8) Tremco, Spectrem 2

b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

1) Dow Corning, Dowsil 786

2) GE, Momentum SCS 1700

3) Pecora, 898 Silicone NST

c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:

1) BASF, MasterSeal NP 100

2) Pecora, DyanTrol I-XL

3) Tremco, Dymonic FC

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

C. Comply with NECA 1.

D. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

G. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 SLEEVES AND SLEEVE SEALS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.

C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.

D. Construction in Existing Facilities:

1. Saw cut or core drill existing walls, roofs and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls, roofs or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator. Provide roofing penetration seals and covers to match existing roofing materials. Coordinate roofing repair of adjacent roofing material with Owner's roofing contractor to provide a waterproof installation.

E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

G. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.

2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

H. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

I. Sleeve Length:

1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.

J. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed[or as required to meet seismic criteria]; in which case, size sleeves as recommended by the seal manufacturer[or per seismic criteria, or both].

K. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

L. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint

M. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.

c. Install galvanized sheet metal for rectangular sleeves

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

N. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

O. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

P. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

Q. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

R. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

T. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.3 JOINT SEALERS

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.

2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess

sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.4 ACOUSTICAL PENETRATIONS

A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.

B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 260500

SECTION 260502 – EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.

B. Coordinate with work described in Division 23 Section “Common Work Results for HVAC”.

C. Coordinate with work described in Division 23 Section “Direct-Digital Control for HVAC”.

D. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

E. Determine connection locations and rough-in requirements based on shop drawings.

F. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

G. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product data for the following products for:

1. Special connectors

2. Special conductors or cable assemblies.

C. Shop drawings for:

3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

4. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

5. Marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CORDS AND CAPS

A. Attachment Plugs: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

C. Cord: See Paragraph “Flexible Cords” in Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

1.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 ELECTRICAL DEVICES

A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.3 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturers’ instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.4 EQUIPMENT

A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.

C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

3.5 SIGNAGE AND WAYFINDING

A. Provide junction boxes, disconnect switches and grounding per manufacturer's installation drawings.

B. Coordinate rough-in requirements with signage installation instructions.

C. Coordinate box locations and conduit routing with parapets and roof elevations.

D. Provide labelling on all junction boxes and disconnects in accordance with Division 26 section "Identification for Electrical Systems"

END OF SECTION 260502

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conductors, cables, and cords rated 600V and less.

B. Connectors and terminations rated 600V and less.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these specifications:

1. MC: Metal Clad
2. NBR: Acrylonitrile-butadiene rubber
3. NETA ATS: Acceptance Testing Specification.

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.
    a. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
    a. Conductors, cables, and cords rated 600V and less.
    b. Metal Clad (MC) cable and fittings.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

F. Qualification Data: For testing agency.

G. Field quality-control test reports in accordance with NETA ATS:

1. Submit all system and component test results.

H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

I. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.

J. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When

installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.

C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section "Seismic Controls for Electrical Systems" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUCTORS AND CABLES - GENERAL

A. Manufacturers, unless noted otherwise:

1. AFC Cable Systems, Inc.
2. Alan Wire
3. Cerrowire
4. Colonial Wire & Cable
5. Encore Wire Corporation
6. General Cable
7. Northern Cables Inc.
8. Okonite Company
9. Southwire Company

B. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.

1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger

2. Stranded for all flexible cords, cables, and control wiring.

3. As noted otherwise below.

C. Aluminum conductors are not allowed.

D. Conductor Insulation: Type THHN/THWN-2, complying with ICEA S-95-658/NEMA WC70.

E. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).

F. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.

G. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.2 SINGLE CONDUCTORS

A. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

Phase	208Y/120V	480Y/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray**
Equipment Ground	Green	Green

**Except as provided in NFPA 70.

B. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.

2.3 FLEXIBLE CORDS

A. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SEO, SO, or STO for indoor dry and damp locations.

2.4 CONTROL WIRING

A. Refer to Division 23 Section “Direct-Digital Control for HVAC”

B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.5 CONNECTORS

A. Manufacturers:

1. AMP; Tyco

2. FCI-Burndy

3. Gould
4. Ideal Industries, Inc.
5. Ilsco
6. NSi Industries, Inc.
7. O-Z/Gedney
8. Panduit
9. Thomas and Betts
10. 3-M Electrical Products Division

B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings for copper conductors: Bare copper, 1-hole pad and inspection port.

C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings: Bare copper, 1-hole pad and inspection port.

D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.

E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: ring-tongue type.

F. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

G. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

B. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.

C. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

D. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

3.2 INSTALLATION

A. General

1. Unless otherwise indicated on the Drawings on in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.

2. Install in accordance with manufacturer’s instructions.

3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.

5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.

6. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.

7. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.

8. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:

a. Normal or Non-Essential circuits.

1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.

2) The minimum wire size for all conductors in this raceway: No. 10 AWG.

3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

9. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.

10. Branch circuit conductors shall be copper.

B. Flexible Cords

1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.

C. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.

2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

D. Connections:

1. Apply a zinc based, anti-oxidizing compound to connections.

2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

4. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.

5. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.

a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus

b. Compression – splices, terminals

c. Mechanical – where temporary removal is required

6. Do not use terminals on wiring devices to feed through to the next device.

3.3 IDENTIFICATION

A. General: Provide all identification per Division 26 "Identification for Electrical Systems".

B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:

1. Factory provided colored insulation
2. Color-Coding Conductor Tape.
3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.

E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section “Identification for Electrical Systems”. Note conductor identification on record Drawings.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.

1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

3.4 FIELD QUALITY CONTROL

A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over.

B. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. This Section includes:

1. Grounding Conductors
2. Connector Products
3. Miscellaneous Grounding Materials and Products

1.2 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. Ground ring: Bare underground grounding conductor encircling the building or structure.
2. NETA ATS: Acceptance Testing Specification.
3. PSF: Pounds per Square Foot
4. EMT: Electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. FMC: Flexible metal conduit.
7. GRS: Galvanized Rigid Steel Conduit
8. IMC: Intermediate metal conduit.
9. LFMC: Liquidtight flexible metal conduit.
10. LFNC: Liquidtight flexible nonmetallic conduit.
11. RAC: Rigid Aluminum Conduit
12. RMC: Rigid Metal Conduit
13. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
    a. Electrodes, mechanical and compression connectors, and exothermic connectors .

B. Qualification Data: For Contractor.

C. Quality-Control Test Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

2. Marked for intended use.

3. Comply with UL 467.

E. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

A. Manufacturers:

1. ABB, Inc.

2. Advanced Lightning Technology (ALT)

3. AFL Global

4. Boggs, Inc.

5. Burndy; Hubbell.

6. Cooper Power; Eaton.

7. Copperweld Corp.

8. ECN/Korns; Division of Robroy Industries.

9. Erico; nVent.

10. Galvan Industries, Inc.

11. Greaves Corp.
12. Harger.
13. Hastings Fiber Glass Products, Inc.
14. Heary Brothers Lightning Protection Co.
15. Ideal Industries, Inc.
16. ILSCO.
17. Lightning Master Corp.
18. Lyncole XIT Grounding; Division of VFC.
19. O-Z/Gedney Co.; Emerson.
20. Panduit, Inc
21. RACO; Hubbell, Inc.
22. Robbins Lightning, Inc.
23. Superior Grounding Systems, Inc.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Material:

1. Copper.

C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.

D. Bare Copper Conductors:

1. Solid Conductors: Comply with Conductors: ASTM B 8.
2. Tinned Conductors: Comply with ASTM B 33.

E. Copper Bonding Conductors:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

F. Ground Ring:

2. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

G. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.

2. Conductor Protector: Half-round PVC or wood molding. If wood molding is utilized, use pressure-treated fir, or cypress or cedar.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors.

C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

3. Company symbol and/or logo.
4. Catalog number.
5. Conductors accommodated.
6. Installation die index number or die catalog number is required.
7. Underwriters Laboratories “Listing Mark:”.
8. The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467.

D. Cast connectors: copper base alloy according to ASTM B 30.

E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

9. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
10. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.
11. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise

indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Equipment Grounding Conductors:

1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

2. Install equipment grounding conductors in all feeders and branch circuits.

3. Install equipment grounding conductor with circuit conductors for the following items, in addition to those required by NFPA 70:

a. Feeders and branch circuits.

b. Single-phase motor and appliance branch circuits.

c. Three-phase motor and appliance branch circuits.

d. Flexible raceway runs.

e. Armored and metal-clad cable runs.

4. In branch circuit and feeder raceways, use insulated equipment grounding conductors.

1.2 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:

a. Connecting conductors together.

b. Connecting conductors to building steel.

c. Connecting conductors to ground rods, except at test wells.

C. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:

a. Connecting conductors to ground rods at test wells.

b. Connecting conductors to pipes.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 IDENTIFICATION

A. Provide identification as specified in Division 26 “Low-Voltage Electrical Power Conductors and Cables” and “Identification for Electrical Systems”.

1.3 EXISTING INSTALLATIONS

A. Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Where applicable, verify the neutral and ground are properly bonded at the point of service entrance. Notify the Owner and the Engineer of any existing deficiencies.

END OF SECTION 260526

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.
2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70 and applicable building code.

C. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. General:

1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.

1. Manufacturers:
   a. Allied Tube & Conduit; Atkore International.
   b. Eaton
   c. Erico; nVent.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Atkore International.
   g. Wesanco, Inc.
2. Metallic Coatings:
   a. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
   b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers:

a. Allied Tube & Conduit.

b. Eaton.

c. Enduro Composites.

d. Fabco Plastics Wholesale Limited.

e. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

4. Rated Strength: Selected to suit applicable load criteria.

5. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.

D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Conduit Straps: One-hole or two-hole type.

2. Conduit Clamps: Bolted type unless otherwise indicated.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers:

1) Hilti Inc.

2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

4) Powers Fasteners, Inc;

5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.

C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.

D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:

1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.

   a. Equipment Supports: 1/2 inch diameter minimum.

   b. Busway Supports: 1/2 inch diameter minimum.

   c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.

   d. Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

   a. two-bolt conduit clamps

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Install in accordance with manufacturer’s instructions.

E. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

F. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

1. 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 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

H. Do not use products for applications other than as permitted by NFPA 70 and product listing.

I. Remove temporary supports when no longer required.

J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

K. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Steel:
    a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
    b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
    c. Spring-tension clamps.
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:

1. Accessible to untrained personnel.
2. Located within confined spaces.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.

1.4 SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.

2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit and Tubing

1. Manufacturers:

a. ABB, Inc.

b. AFC Cable Systems, Inc.; a division of Atkore International

c. Allied Tube and Conduit

d. American Conduit

e. Anamet Electrical, Inc.

f. Electri-Flex Co.

g. Nucor Tubular Products.

h. O-Z/Gedney Co.; Emerson.

i. Republic Raceway.

j. Southwire Company, LLC

k. Western Tube and Conduit Corporation.

l. Wheatland Tube Co.

2. RMC:

a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.

1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.

b. RAC: ANSI C80.5, UL6A.

3. IMC: ANSI C80.6, UL 1242.

a. IMC and Fittings: NEMA RN 1, UL-listed.

4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.

a. Fittings: Setscrew or Compression type.

5. FMC: Aluminum or Zinc-coated steel: UL 1. Reduced wall FMC is not allowed.

6. LFMC: Flexible steel raceway with PVC jacket: UL 360.

a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

a. ABB, Inc.

b. AFC Cable Systems, Inc. (Tubing); a division of Atkore International

c. Allied Tube and Conduit

d. American Pipe and Plastics, Inc.

e. Anamet Electrical, Inc.

f. Arnco Corp.

g. Cantex Inc.

h. Champion Fiberglass, Inc.

i. Electri-Flex Co.

j. FRE Composites.

k. Hubbell Inc. (Fittings)

l. IPEX USA, LLC.

m. Phoenix Contact.

n. Prime Conduit.

o. Southwire Corporation.

p. Superflex Ltd.

q. United Fiberglass of America, Inc.

2.2 BOXES, ENCLOSURES AND CABINETS

A. General

1. Manufacturers:

a. ABB, Inc.

b. American Midwest Power

c. Appleton/O-Z Gedney Co.; Emerson.

d. BEL Products, Inc.

e. Cooper Crouse-Hinds; Eaton.

f. Erickson Electrical Equipment Co.

g. FSR, Inc.

h. Hoffman.

i. Hubbell, Inc.

j. Legrand.

k. Molex; Koch Industries.

l. Robroy Industries, Inc.; Enclosure Division.

m. Spring City Electrical Manufacturing Co.

2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

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. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.

a. List and label as complying with UL 514A for non-hazardous locations;

b. List and label as complying with UL 886 for hazardous locations, where required.

3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.

4. 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.

5. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.

6. Minimum Box Size, Unless Otherwise Indicated:

a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

b. Communications Systems Outlets: Comply with Section 27 10 05.

c. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.

d. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

7. Do not use "through-wall" boxes designed for access from both sides of wall.

8. Wall Plates: Comply with Division 26 Section “Wiring Devices”.

C. Cabinets and Enclosures:

1. General:

a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.

b. NEMA 250 Environment ratings:

1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.

c. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.

d. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.

e. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.3 FACTORY FINISHES

A. Interior Finish: All interior components shall be factory finished; manufacturer’s standard grey unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with manufacturer’s instructions

3.2 RACEWAYS

A. General

1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).

    a. 1/2 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.

    b. 3/8 inch flexible conduit may be used for light fixture whips.

3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.

4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.

5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.

6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.

7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

10. Install raceways:

    a. To meet the requirements of the structure and the requirements of all other Work on the Project.

    b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

    c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.

    d. Parallel or perpendicular to building lines or column lines.

    e. Tight to structure.

    f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

11. Raceways Embedded in Slabs:

    a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.

    b. Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.

    c. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

    d. Space raceways laterally to prevent voids in concrete.

    e. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

    f. Change from RNC to coated GRS or IMC before rising above the floor.

12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

    a. Raceways on roof shall be supported from structure not from the roof deck.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:

    a. Attach single raceway directly to structural steel with beam clamps.

    b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.

    c. Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.

    d. Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.

    e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.

    f. Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.

    g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.

h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.

i. Use prefabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.

15. Install electrically- and physically continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.

16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.

17. Align and install raceway terminations true and plumb.

18. Complete raceway installation before starting conductor installation.

19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.

21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.

    b. Where otherwise required by NFPA 70.

23. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above

24. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.

25. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.

26. Install all underground conduits/raceways a minimum of 24" below the bottom of slab/paving/grade, unless noted otherwise, where practicable.

27. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96" AFF.

a. At a minimum, provide 3/4" conduit.

b. Coordinate requirements and locations with system installer and fire alarm specifications.

28. Use RAC in the following areas:

a. Indoors above grade.

B. EMT

1. Use EMT in the following areas:

a. Where indicated.

b. Interior concealed locations for:

1) Branch circuits.

2) Feeders.

3) Low-voltage control, security, and fire alarm circuits

c. Exposed where not subject to physical damage

1) Mechanical rooms

C. FMC and LFMC

1. Use FMC or LFMC:

a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.

b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.

c. Use FMC only in dry locations

2. Do not use FMC or LFMC:

a. For branch circuits, homeruns or feeders.

b. In lengths exceeding 6 feet.

D. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.

2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.

3. RNC is only allowed to be used in the following locations:

a. Where specifically indicated.

1) If an adopted code prevents use of RNC in a location where the contract documents specifically allows its use, contractor shall utilize other types of conduit allowed by the specification.

2) Allowed does not mean required.

3.3 RACEWAY FITTINGS:

A. Compatible with raceways and suitable for use and location.

B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.

C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.

D. Join raceways with fittings designed and approved for that purpose and make joints tight.

E. Use insulating bushings to protect conductors at raceway terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.4 WIREWAYS:

A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Close ends of wireway and unused raceway openings.

3.5 BOXES:

A. General

1. Verify locations of device boxes prior to rough in.

2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.

3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.

4. Install boxes to preserve fire ratings of walls, floors, and ceilings.

5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.

6. Support boxes independently of raceway.

7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.

8. Adjust flush-mounted boxes to make front edges flush with finished wall material.

9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.

10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. NEMA Enclosure ratings: Suitable for the environment in which it is installed. At a minimum, provide the following ratings:

1. NEMA 250, type 1

a. Provide at interior and dry locations

C. Outlet Boxes

1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.

2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.

3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes Use sheet-steel boxes for dry locations unless otherwise indicated or required.

4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.

6. Use cast aluminum boxes where aluminum rigid metal conduit is used.

7. Use nonmetallic boxes where exposed rigid PVC conduit is used.

8. Use suitable concrete type boxes where flush-mounted in concrete.

9. Use suitable masonry type boxes where flush-mounted in masonry walls.

10. Use raised covers suitable for the type of wall construction and device configuration where required.

11. Use shallow boxes where required by the type of wall construction.

12. Install extension and plaster rings as required by NFPA 70.

13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.

14. Do not exceed allowable fill per NFPA 70.

15. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.

2. Provide boxes set flush in painted walls or ceilings with primer coated cover.

3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.

4. Boxes for exterior use shall be:

a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.

b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.

c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.

d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

3.6 IDENTIFICATION

A. Refer to Division 26 Section "Identification for Electrical Systems" for identification materials.

1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:

a. Self-Adhesive Vinyl Labels

2. Color for Printed Legend:

a. Power Circuits: Black letters on an orange field.

b. Legend: Indicate system or service and voltage, if applicable

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:

1. Self-adhesive vinyl label

2. Snap around label

3. Self-adhesive vinyl tape applied in bands.

C. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:

1. Fire Alarm System: Red.

2. Fire-Suppression Supervisory and Control System: Red and yellow.

3. Combined Fire Alarm and Security System: Red and blue.

4. Security System: Blue and yellow.

5. Mechanical and Electrical Supervisory System: Green and blue.

6. Telecommunication System: Green and yellow.

7. Control Wiring: Green and red.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

E. Junction Boxes and Pull Boxes:

1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

END OF SECTION 260533

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates.
2. Labels for junction boxes and pull boxes.
3. Labels for wiring devices and lighting control devices.
4. Markers for conductors, and control cables.
5. Tags.
6. Warning labels and signs.
7. Instruction signs.
8. Miscellaneous identification products.
9. Painted Identification.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.

B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

C. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 QUALITY ASSURANCE

A. Electrical Equipment, Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
2. Marked for intended use.

B. Comply with ANSI A13.1 and ANSI C2.

C. Comply with requirements of NFPA 70.

D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Location, text, and method of identification to be used is noted in individual sections. Refer to other sections for additional identification requirements.

2.2 NAMEPLATES

A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.

B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.

1. Punched or drilled for screw mounting.

2. Minimum 1/16 inch (1.6 mm) thick for nameplates with both dimension 4 inches (102 mm) or less and 1/8 inch (3.2 mm) thick for larger sizes.

C. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

D. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

E. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

F. Colors:

1. Normal systems - white letters on a black background.

2. Emergency systems - white letters on a red background.

G. Label Requirements:

1. Service Equipment Label

LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ
LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS
LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS
LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS
LINE 5: DATE CALCULATED

EXAMPLE:

208Y/120V, 60HZ
800A
SCCR = 65,000A
MAX AVAILABLE FAULT CURRENT = 58,815A
CALCULATED: 01/01/2018

2. Panelboard/Switchboard Label:

LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM “ “

EXAMPLES:

H1A 480Y/277V, 3PH, 4W, 200A FED FROM MDB
L1A 208Y/120V, 3PH, 4W, 225A FED FROM H1A VIA XFMR T1

3. Transformer Label:

LINE 1: TRANSFORMER DESIGNATION
LINE 2: FED FROM " "
LINE 3: SUPPLIES " "

EXAMPLE:

T1 FED FROM H1A SUPPLIES L1A

4. Disconnect Switch Label:

LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM " "

EXAMPLES:

WATER HEATER WH1 480V, 3PH, 3W, 100A FED FROM MDB

2.3 LABELS FOR JUNCTION BOXES AND PULL BOXES

A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.4 MARKERS FOR CONDUCTOR AND CONTROL CABLES

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.5 TAGS

A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.

B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.

2. Do not use labels designed to be completed using handwritten text.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.

1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.7 ARC FLASH WARNING LABELS

A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section “Overcurrent Protective Device Study” for additional requirements.

B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.

C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.

E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Available fault current
4. Limited approach boundary
5. Arc flash boundary
6. Restricted approach boundary
7. Hazard risk category
8. Incident energy
9. Working distance
10. Site-specific PPE (personnel protective equipment) requirements.
11. Date calculations were performed.
12. Engineering report number, revision number and issue date.

2.8 INSTRUCTION SIGNS

A. Engraved, Laminated Acrylic or Melamine plastic: Non-conductive phenolic. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

1. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
4. Normal systems: Engraved legend with white letters on black face.
5. Essential Systems: Engraved legend with white letters on red face.

B. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

C. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

D. Colors:

1. General Information and Operating Instructions – Black letters on white background.
2. Normal systems - white letters on a black background.
3. Emergency systems - white letters on a red background.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

2.10 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior concrete and masonry primer.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
2. Exterior Concrete Unit Masonry:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Exterior semi-gloss acrylic enamel.
3. Exterior Ferrous Metal:
   a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior ferrous-metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.
4. Exterior Zinc-Coated Metal (Except Raceways):
   a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior zinc-coated metal primer.
      2) Finish Coats: Exterior semi-gloss alkyd enamel.

5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
    a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
        1) Primer: Interior concrete and masonry primer.
        2) Finish Coats: Interior semi-gloss alkyd enamel.
6. Interior Concrete Unit Masonry:
    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
        1) Block Filler: Concrete unit masonry block filler.
        2) Finish Coats: Interior semi-gloss acrylic enamel.
7. Interior Gypsum Board:
    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
        1) Primer: Interior gypsum board primer.
        2) Finish Coats: Interior semi-gloss acrylic enamel.
8. Interior Ferrous Metal:
    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
        1) Primer: Interior ferrous-metal primer.
        2) Finish Coats: Interior semi-gloss acrylic enamel.
9. Interior Zinc-Coated Metal (Except Raceways):
    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
        1) Primer: Interior zinc-coated metal primer.
        2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify identity of each item before installing identification products.

B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

C. Provide identification product listed for the location in which it is to be installed.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. For surfaces that require finish work, apply identification devices after completing finish work. Do not install identification products until final surface finishes and painting are complete.

C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. 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. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

G. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.

1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.

H. Install identification products centered, level, and parallel with lines of item being identified.

I. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION 260553

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in:
    a. Enclosed switches
    b. Panelboards
    c. Enclosed controllers

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. All items requested under “Product Data”.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248.

1.4 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

B. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Selectivity: Where selectivity is required by the Documents, furnish products as required to achieve selective coordination.

2.2 MANUFACTURERS

A. Manufacturers:

1. ABB Ltd.
2. Eaton Corporation Plc
3. Mersen Electrical Power
4. Littelfuse, Inc.
5. Schneider Electric SE
6. Siemens AG

2.3 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.4 ACCESSORIES

A. Provide the following accessories where indicated or where required to complete installation:

1. Fuseholders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

3. Plug-Fuse Adapters: For using Type S, rejection-base plug fuses in Edison-based fuse holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install in accordance with manufacturer's instructions.

C. Install fuses in fusible devices. Arrange fuses so manufacturer, type and rating information is readable without removing fuse.

D. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

E. Install spare-fuse cabinet(s).

3.3 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Feeders:
    a. 600A or less:
        1) Class RK1, time delay
2. Motor Branch Circuits:
    a. Class RK1 time delay
3. Other Branch Circuits:
    a. Class RK1, time delay

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes enclosed switches and circuit breakers rated 600 V and less, including the following:

1. Fusible switches.
2. Non-fusible switches.
3. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of enclosed switches, circuit breakers and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".

B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
2. Detail enclosure types and details for other than NEMA 250, Type 1.
3. Include general arrangement drawing showing dimensions and weights of each assembled section.

4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.

5. Detail short-circuits current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.

6. Include descriptive documentation of barriers specified for electrical insulation and isolation.

7. Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.

8. Include schematic and wiring diagrams for power, signal, and control wiring.

9. Include nameplate legends.

10. Include list of materials.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed switches and circuit breakers where pipe and ducts are prohibited. Show enclosed switch and circuit breaker layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.

F. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Certificate of compliance.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Qualification Data: For qualified testing agency.

H. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

I. Manufacturer's field service report.

J. Sample Warranty: For warranty.

K. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

L. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 26 Section "General Electrical Requirements," include the following:

1. Routine maintenance requirements for enclosed switches, circuit breakers and all installed components.
2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
3. Time-current curves; include selectable ranges for each type of overcurrent protective device.
4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

M. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

b. Altitude: Not exceeding 6600 feet (2010 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section “General Electrical Requirements”

1.7 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

B. Deliver enclosed switches and circuit breakers in sections or lengths that can be moved past obstructions in delivery path.

C. Coordinate delivery of equipment to allow movement into designated space.

D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

E. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers:
1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2.4 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Wall-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Mount equipment plumb and rigid without distortion of enclosure.

F. Install fuses in fusible devices.

G. Comply with NECA 1.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each section with equipment nameplate.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Diagram and Instructions:

1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of equipment.

a. Operating Instructions: Printed operating instructions for switches and circuit breakers, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

D. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections:

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.

2. Verify that grounding system at the equipment tested at the specified value or less.

3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.

2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories.

B. Video record demonstrations presentation for Owner’s records.

END OF SECTION 262816

SECTION 262913 – ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual:

a. Fractional Horsepower Manual Controllers:

b. Integral Horsepower Manual Controllers:

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.

b. Factory-installed devices.

c. Nameplate legends.

d. Short-circuit current rating of integrated unit.

e. Listed and labeled for integrated short-circuit current (withstand) rating: of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

C. 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.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 26 Section "General Electrical Requirements," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Seismic Controls for Electrical Systems."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.: Cutler-Hammer Business Unit.
2. General Electric Company: GE Consumer & Industrial - Electrical Distribution.
3. Rockwell Automation, Inc.: Allen-Bradley brand.
4. Siemens Energy & Automation, Inc:
5. Square D: a brand of Schneider Electric.

B. Mounting: Controllers may be surface mounted in equipment rooms and unfinished spaces but shall be flush mounted in finished spaces or where noted on the Drawings.

2.2 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Nonreversing.

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.

3. Surface mounting.

4. Red pilot light:

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty type.

a. Push Buttons: Lockable types; maintained as indicated.

b. Pilot Lights: LED types; colors as indicated.

c. Selector Switches: Rotary type.

B. N.C. auxiliary contact(s):

C. Control Relays: Auxiliary and adjustable pneumatic time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

E. Cover gaskets: for Type 1 enclosures:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight

structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Install fuses in each fusible-switch enclosed controller.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

H. Comply with NECA 1.

3.2 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation.

2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913