

PROJECT MANUAL

Chilled Water Renovations
Missouri State Capitol Building
Jefferson City, Missouri

Designed By: Henderson Engineers
8345 Lenexa Drive, Suite 300
Lenexa, KS 66214

Date Issued: November 14, 2024

Project No.: O2353-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION
Facilities Management, Design and Construction

SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS

PROJECT NUMBER: O2353-01 "CHILLED WATER RENOVATIONS – MISSOURI CAPITOL 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:

MECHANICAL/ELECTRICAL

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

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

Drawings Sheets: E-000, E-001, E-101, E-103, E-300, E-301, E-400, E-401, E-402, M-000, M-100, M-101, M-102, M-103, M-300, M-301, M-302, M-303, M-304, M-305, M-400, M-500, M-600, M-601, M-700, M-701, M-702, M-703.

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: _____

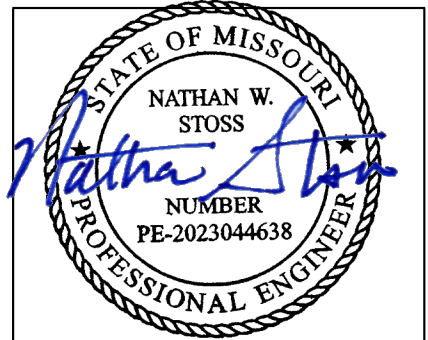
Kelley P. Cramm, P.E. (Div. 23)



11/14/2024

By: _____

Nathan W. Stoss, P.E. (Div. 26)



11/14/24

TABLE OF CONTENTS

SECTION	TITLE	NUMBER OF PAGES
DIVISION 00 – PROCUREMENT AND CONTRACTING INFORMATION		
000000	INTRODUCTORY INFORMATION	
000101	Project Manual Cover	1
000107	Professional Seals and Certifications	1
000110	Table of Contents	2
000115	List of Drawings	2
001116	INVITATION FOR BID (IFB)	1
002113	INSTRUCTIONS TO BIDDERS	7
<u>NOTICE TO BIDDERS</u>		
The following procurement forms can be found on our website at: https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans and shall be submitted with your bid to FMDCBids@oa.mo.gov		
004000	PROCUREMENT FORMS & SUPPLEMENTS	
004113	Bid Form	*
004336	Proposed Subcontractors Form	*
004337	MBE/WBE/SDVE Compliance Evaluation Form	*
004338	MBE/WBE/SDVE Eligibility Determination Form for Joint Ventures	*
004339	MBE/WBE/SDVE Good Faith Effort (GFE) Determination Forms	*
004340	SDVE Business Form	*
004541	Affidavit of Work Authorization	*
004545	Anti-Discrimination Against Israel Act Certification form	*
005000	CONTRACTING FORMS AND SUPPLEMENTS	
005213	Construction Contract	3
006000	PROJECT FORMS	
006113	Performance and Payment Bond	2
006325	Product Substitution Request	2
006519.16	Final Receipt of Payment and Release Form	1
006519.18	MBE/WBE/SDVE Progress Report	2
006519.21	Affidavit of Compliance with Prevailing Wage Law	1
007000	CONDITIONS OF THE CONTRACT	
007213	General Conditions	20
007300	Supplementary Conditions	1
007346	Wage Rate	4
DIVISION 1 - GENERAL REQUIREMENTS		
011000	Summary of Work	2
012100	Allowances	2
012600	Contract Modification Procedures	2
013100	Coordination	4
013115	Project Management Communications	4
013200	Schedules	5
013300	Submittals	7
013513.10	Site Security and Health Requirements (OA)0	3
015000	Construction Facilities and Temporary Controls	8
017400	Cleaning	3
017900	Demonstration and Training	6

DIVISION 23 - MECHANICAL

230010	General Mechanical Requirements	7
230015	Electrical Coordination for Mechanical Equipment	3
230500	Common Work Results for HVAC	7
230510	Basic Piping Materials and Methods	9
230513	Common Motor Requirements for HVAC Equipment	6
230514	Variable Frequency Drives	8
230519	Meters and Gauges for HVAC Piping	5
230523	General Duty Valves for HVAC Piping	13
230529	Hangers and Supports for HVAC Piping and Equipment	15
230550	Vibration Isolation for HVAC	9
230553	Identification for HVAC Piping and Equipment	7
230593	Testing, Adjusting, & Balancing for HVAC	8
230700	HVAC Insulation	15
230913	Instrumentation and Control Devices for HVAC	21
230923	Direct Digital Control for HVAC	27
232113	Hydronic Piping	8
232114	Hydronic Specialties	10
232123	Hydronic Pumps	8
233113	Metal Ducts	8
233300	Air Duct Accessories	3

DIVISION 26 - ELECTRICAL

260010	General Electrical Requirements	11
260500	Common Work Results for Electrical	8
260502	Equipment Wiring Systems	3
260519	Low Voltage Electrical Power Conductors and Cables	10
260526	Grounding and Bonding for Electrical Systems	7
260529	Hangers and Supports for Electrical Systems	8
260533	Raceway and Boxes for Electrical Systems	13
262816	Enclosed Switches and Circuit Breakers	7
262913	Enclosed Controllers	7

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:

	<u>TITLE</u>	<u>SHEET #</u>	<u>DATE</u>	<u>CAD #</u>
1.	Cover Sheet	G-000	11/14/24	G-000
2.	Electrical Legend	E-000	11/14/24	E-000
3.	Electrical General Notes	E-001	11/14/24	E-001
4.	Equipment Connection Basement Plan – Overall	E-101	11/14/24	E-101
5.	Equipment Connection Level 2 Plan – Overall	E-103	11/14/24	E-103
6.	Electrical Enlarged Plans	E-300	11/14/24	E-300
7.	Electrical Enlarged Plans	E-301	11/14/24	E-301
8.	Electrical Schedules	E-400	11/14/24	E-400
9.	Electrical Schedules	E-401	11/14/24	E-401
10.	Electrical Schedules	E-402	11/14/24	E-402
11.	Mechanical General Notes and Legend	M-000	11/14/24	M-000
12.	Mechanical Basement Plan – Overall	M-100	11/14/24	M-100
13.	Mechanical Level 1 Plan - Overall	M-101	11/14/24	M-101

14.	Mechanical Level 2 Plan - Overall	M-102	11/14/24	M-102
15.	Mechanical Level 3 Plan - Overall	M-103	11/14/24	M-103
16.	Mechanical Enlarged Views - Demo	M-300	11/14/24	M-300
17.	Mechanical Enlarged Views - Demo	M-301	11/14/24	M-301
18.	Mechanical Enlarged Views - Demo	M-302	11/14/24	M-303
19.	Mechanical Enlarged Views - New	M-303	11/14/24	M-303
20.	Mechanical Enlarged Views - New	M-304	11/14/24	M-304
21.	Mechanical Enlarged Views	M-305	11/14/24	M-305
22.	Mechanical Details	M-400	11/14/24	M-400
23.	Mechanical Schedules	M-500	11/14/24	M-500
24.	Mechanical Flow Diagram	M-600	11/14/24	M-600
25.	Mechanical Flow Diagram	M-601	11/14/24	M-601
26.	Mechanical Controls	M-700	11/14/24	M-700
27.	Mechanical Controls	M-701	11/14/24	M-701
28.	Mechanical Controls	M-702	11/14/24	M-702
29.	Mechanical Controls	M-703	11/14/24	M-703

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. Chilled Water Renovations
Missouri State Capitol Building
Jefferson City, Missouri
Project No.: O2353-01

3.0 BIDS WILL BE RECEIVED:

- A. Until: 1:30 PM, March 27, 2025
- B. **Only electronic bids sent to FMDCBids@oa.mo.gov shall be accepted:** (See Instructions to Bidders for further detail)

4.0 DESCRIPTION:

- A. Scope: The project includes installation of chilled water pumps, along with modifications of piping, ductwork modifications, controls, and sequences of operations.
- B. MBE/WBE/SDVE Goals: MBE 0%, WBE 0%, 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.**

5.0 PRE-BID MEETING:

- A. Place/Time: 10:00 AM, March 14, 2025, at Harry S. Truman Building, Room 400, 301 W. High Street, Jefferson City, 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 \$100.00 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: Frank Cunningham, (573) 395-6216, email: frank.cunningham@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.

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 one (1) party may be limited in accordance with available supply.
- B. For the convenience of contractors, subcontractors and suppliers, bidding documents are available on the Owner's website at <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 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 successful Bidder (contractor) to fulfill every detail of the requirements of the contract, nor accepted as a basis for any claims for extra compensation or time extension.
- B. Under no circumstances will Bidders give their plans and specifications to other Bidders. It is highly encouraged, but not required, that all Bidders be on the official planholders list to receive project updates including but not limited to any addenda that are issued during the bidding process.

4.0 - INTERPRETATIONS

- A. No Bidder shall be entitled to rely on oral or written representations from any person as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction.
- B. Bidders shall make all requests for interpretations in writing and submit all requests to the Project Designer and Project Manager identified in Section 007300 – Supplementary Conditions with all necessary supporting documentation no less than five (5) working days before opening of bids. Responses to requests for interpretation will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.
- C. Bidders shall make all requests for an "Acceptable Substitution" on the Section 006325 Substitution Request Form. The request shall be emailed to the Project Designer and Project Manager identified in Section 007300 – Supplementary Conditions no less than five (5) working days before opening of bids. Responses to requests for substitutions will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.
- D. An "Acceptable Substitution" requested after the award of bid will only be approved if proven to the satisfaction of the Owner and the Designer 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 and all requests of this nature must be submitted in accordance with Article 3.1 of the General Conditions.

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 on the bid documents or the bid will be rejected for being non-responsive.
- B. Depending on the specific project requirements, **the following is a GENERIC list** of all possible bid forms that may be due with bid submittals. Bidders must verify each specific project’s requirements in Section 004113 to ensure they have provided all the required documentation with their submission.

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

- C. The Bidder shall submit its bid on the forms provided by the Owner in the same file format (PDF) with each space fully and properly completed, typewritten or legibly printed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner will reject bids that are not on the Owner’s forms or that do not contain all requested information. All forms can be found on the Owner’s website at <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans> and shall be submitted with your bid to FMDCBids@oa.mo.gov.
- D. All bids shall be submitted without additional terms and conditions, modifications, or reservations. The completed forms should not include interlineations, alterations, or erasures. Bids not in compliance with the requirements of this paragraph will be rejected as non-responsive.
- E. 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 in the bid documents in Section 004113. Failure of the Bidder to submit the duly authorized bid bond or 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 bid closing or if the Bidder, within ten (10) working days after notification of award, refuses or is unable to 1) execute the tendered contract, 2) provide an acceptable performance and payment bond, or 3) provide evidence of required insurance coverage.
- F. The bid bond 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.

6.0 - SIGNING OF BIDS

- A. 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. If the Bidder is an entity organized in a state other than Missouri, the Bidder must provide a Certificate of Authority to do business in the State of Missouri.
- B. If the successful Bidder is doing business in the State of Missouri under a fictitious name, the Bidder 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.
- C. A bid from an individual shall be signed as noted on the Bid Form.
- D. 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.

- E. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.
- F. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual and the corporate license number shall be provided. In addition, for corporate proposals, the President or Vice-President listed per the current filing with the Missouri Secretary of State should sign as the Bidder. If the signatory is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signatory has the legal authority to bind the corporation.

7.0 - RECEIVING BID SUBMITTALS

- A. It is the Bidder's sole responsibility to ensure receipt of the bid submittals by Owner on or before the date and time specified in the Invitation for Bid or as modified via written addenda. Bids received after the date and time specified will not be considered by the Owner.
- B. All bids shall be received via email at FMDCBids@oa.mo.gov and bids received by the Owner through any other means, including hard copies, will not be considered, and will be discarded by the Owner unopened.

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

- A. Bidder may withdraw a bid at any time prior to the 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. Bidder may modify a bid until the scheduled closing time by sending a revised bid to FMDCBids@oa.mo.gov with a note in the subject line and body of the email that it is a revised bid. All revised bids must be submitted to FMDCBids@oa.mo.gov, revised bids sent any other way will not be considered.

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 limited to, contracts for the furnishing and installation of furniture, equipment, machinery, appliances and other apparatuses.
- C. The Owner will award a contract to the lowest, responsive, and 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 award shall be considered binding upon the Owner until the written contract has been properly executed and the following documentation has been provided: 1) performance and payment bond consistent with Article 6.1 of the General Conditions; 2) proof of the required insurance coverage; 3) an executed Section 004541 - Affidavit of Work Authorization form; and 4) documentation evidence enrollment and participation in a federal work authorization program.
- F. Failure to execute and return the contract and associated documents within the prescribed period 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.
- G. 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.

- H. 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. 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.
- I. The successful Bidder must be registered in MissouriBUYS powered by MOVERS at <https://missouribuys.mo.gov/supplier-registration#> as an approved vendor prior to being issued a contract.

10.0 - CONTRACT SECURITY

- A. The successful Bidder shall furnish a performance/payment bond as set forth in General Conditions Article 6.1 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, manufacturer, or suppliers 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. 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 or if more than one subcontractor is listed for any category without designating the portion of work to be performed by each, 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 Bidder’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. 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 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 required to complete and submit the applicable portion of Section 004545 - Anti-Discrimination Against Israel Act Certification with its 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.

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 nonresponsive, and its bid shall be rejected.
- 2. The Bidder should submit with its bid all 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 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 Prime Bidder that qualifies as an SDVE shall receive a three-percentage 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 will become 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.

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.) 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 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 Equal Opportunity or by the Federal U.S. Small Business Administration directory.
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 Office of Equal Opportunity online SDVE directory at <https://o eo.mo.gov/sdve-certification-program/> or the Federal U.S. Small Business Administration directory <https://veterans.certify.sba.gov/#search>.
3. Additional information, clarifications, or other information regarding the MBE/WBE/SDVE listings in the directories may be obtained by contacting 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 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 granted a waiver and will be considered 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;

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 in the 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 nonresponsive 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 the 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 in writing.
- 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 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: Chilled Water Renovations
Missouri State Capitol Building
Jefferson City, Missouri

Project Number: O2353-01

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 **160 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 \$1,000** 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)

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.

DAVIS-BACON ACT: If this Project is financed in whole or in part from Federal funds (as indicated in the Instructions to Bidders or other bid or contract documents for this Project), then this contract shall be subject to all applicable federal labor statutes, rules and regulations, including provisions of the Davis-Bacon Act, 40 U.S.C. §3141 et seq., and the “Federal Labor Standards Provisions,” as further set forth in Section 007333 – Supplementary General Conditions for Federally Funded/Assisted Construction Projects, which is incorporated into the contract by reference. Where the Missouri Prevailing Wage Law and the Davis-Bacon Act require payment of different wages for work performed under this contract, the Contractor and all Subcontractors shall pay the greater of the wages required under either law, on a classification-by-classification basis.

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

The Contractor has been granted a waiver of the 0% MBE and 0% 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), if applicable
- 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), if applicable
 - 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.

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

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	DATE INSTALLED
LOCATION		

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



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

MBE/WBE/SDVE PROGRESS REPORT

Remit with ALL Progress and Final Payments

(Please check appropriate box) CONSULTANT CONSTRUCTION

PAY APP NO.	PROJECT NUMBER
CHECK IF FINAL <input checked="" type="checkbox"/> FINAL	DATE

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
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	

Revised 06/2023

INSTRUCTIONS FOR MBE/WBE/SDVE PROGRESS REPORT

CONTRACTOR OR CONSULTANT TO FILL OUT AND REMIT WITH EACH PAY APPLICATION:

The MBE/WBE/SDVE Progress Report for the project is issued with the contract comprising values reported in the consultant's Proposal or on the successful contractor's Section 004337 Compliance Evaluation Forms.

At Initial Pay Application fill in the following:

1. Pay App No. Start with 1.
2. Fill in the Project Number and Date.
3. Enter Project Title, Project Location, and Firm.
4. Fill in the "Original Contract Sum" and "Total Contract Sum To Date" (Reference applicable Line Items on Form A of Application for Payment).
5. Indicate the Total Participation Dollar Amount from the Original Contract.
6. Select MBE, WBE, or SDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier.
7. Enter the "Total Amount of Subcontract", "\$ Amount (Paid-To-Date)", and Company Name.

For all subsequent Pay Applications fill in the following:

1. Pay App No.
2. If Final Pay App, check box.
3. Fill in the Project Number and Date.
4. Enter Project Title, Project Location, and Firm
5. At each Pay App fill in the "Original Contract Sum" and "Total Contract Sum To Date" (reference applicable Line Items on Form A of Application for Payment).
6. Indicate the Total Participation Dollar Amount from the Original Contract.
7. Select MBE, WBE, or SDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier
8. Enter the "Total Amount of Subcontract", "\$ Amount (Paid-To-Date)", and Company Name.



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

FILE: Closeout Documents

GENERAL CONDITIONS

INDEX

ARTICLE:

1. General Provisions

- 1.1. Definitions
- 1.2. Drawings and Specifications
- 1.3. Compliance with Laws, Permits, Regulations and Inspections
- 1.4. Nondiscrimination in Employment
- 1.5. Anti-Kickback
- 1.6. Patents and Royalties
- 1.7. Preference for American and Missouri Products and Services
- 1.8. Communications
- 1.9. Separate Contracts and Cooperation
- 1.10. Assignment of Contract
- 1.11. Indemnification
- 1.12. Disputes and Disagreements

2. Owner/Designer Responsibilities

3. Contractor Responsibilities

- 3.1. Acceptable Substitutions
- 3.2. Submittals
- 3.3. As-Built Drawings
- 3.4. Guaranty and Warranties
- 3.5. Operation and Maintenance Manuals
- 3.6. Other Contractor Responsibilities
- 3.7. Subcontracts

4. Changes in the Work

- 4.1. Changes in the Work
- 4.2. Changes in Completion Time

5. Construction and Completion

- 5.1. Construction Commencement
- 5.2. Project Construction
- 5.3. Project Completion
- 5.4. Payments

6. Bond and Insurance

6.1. Bond

6.2. Insurance

7. Termination or Suspension of Contract

7.1. For Site Conditions

7.2. For Cause

7.3. For Convenience

SECTION 007213 - GENERAL CONDITIONS

- 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. Acting by and through the Office of Administration, Division of Facilities Management, Design and Construction.
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"**: All supervision, labor, materials, tools, supplies, equipment, and any incidental operations and/or activities required by or reasonably inferable from the Contract Documents necessary to construct the Project and to produce the results intended by the Contract Documents 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 ensure 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 under this clause to any labor union with which they have bargaining or other agreements.

B. 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 plate 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 ensure 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 subject to the following limits: (a) the percentage mark-up for the Contractor shall be limited to the Contractor's fee; (b) fifteen percent (15%) maximum for Work directly performed by employees of a subcontractor, or sub-subcontractor; (c) five percent (5%) maximum for the Work performed or passed through to the Owner by the Contractor; (d) five percent (5%) maximum subcontractor's mark-up for

Work performed by a sub-subcontractor and passed through to the Owner by the subcontractor and Contractor; and (e) in no case shall the total overhead and profit paid by the Owner on any Contract Changes exceed twenty-five percent (25%) 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 Contractor's payment and performance bonding, builder's risk insurance, and general liability insurance to their cost of work. The above listed bonding and insurance cost shall not exceed two percent (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(s) 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 the same as those for additive Contract Changes provided above.
- 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 without 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.

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 contract 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, KS 66214
Telephone: (913) 742-5742
Email: Matt.Swaback@hendersonengineers.com

Construction Representative:

Robert Rehagen
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, MO 65101
Telephone: 573-616-6307
Email: robert.rehagen@oa.mo.gov

Project Manager:

Frank Cunningham
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
Telephone: 573-395-6216
Email: frank.cunningham@oa.mo.gov

Contract Specialist:

Paul Girouard
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
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. 31

Section 026
COLE 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 8, 2024**

Last Date Objections May Be Filed: **April 8, 2024**

Prepared by Missouri Department of Labor and Industrial Relations

Building Construction Rates for
COLE County

Section 026

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$62.47
Boilermaker	\$30.53*
Bricklayer-Stone Mason	\$54.17
Carpenter	\$50.84
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$43.74
Plasterer	
Communication Technician	\$57.89
Electrician (Inside Wireman)	\$58.31
Electrician Outside Lineman	\$30.53*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$30.53*
Glazier	\$56.48
Ironworker	\$68.93
Laborer	\$43.22
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$30.53*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$67.64
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$42.11
Plumber	\$70.54
Pipe Fitter	
Roofer	\$54.75
Sheet Metal Worker	\$57.54
Sprinkler Fitter	\$52.79
Truck Driver	\$30.53*
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
COLE County

Section 026

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$55.19
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$80.11
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$48.42
General Laborer	
Skilled Laborer	
Operating Engineer	\$63.82
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$48.68
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 chilled water renovations.
 - 1. Project Location: Missouri Capitol Building, 201 West Capitol Avenue, Jefferson City, MO 65101.
 - 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 November 14, 2024 were prepared for the Project by Henderson Engineers, 8345 Lenexa Drive, Suite 300, Lenexa KS 66214.
- C. The Work consists of chilled water renovations:
 - 1. The Work includes:
 - a. Installation of chilled water pumps, piping modifications, piping insulation, control valves at pump stations 1, 2, 3, 4, 5, 6, 7, and main Capitol pump station. Installation of variable frequency drives at pump station 1, 2, 3, 5, 6, and main Capitol pump station. Installation of electrical power to serve pumps.
 - b. Removal of 2-way control valve and installation of 3-way control valve, piping modifications, piping insulation at air handling units 317 and 318.
 - c. Revision of control sequences for air handling units 508, 509 and 510.
 - d. Addition of recirculating pump and replacement of control valve for air handling unit B15A preheat coil.
 - e. Replacement and relocation of lobby radiant heater temperature sensors with wireless sensors.
 - f. Modification of air handling unit 116A outside air ductwork.
- D. The Work will be constructed under a single prime contract.

1.3 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..

1.4 OCCUPANCY REQUIREMENTS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

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. Facility Interruption 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 FACILITY INTERRUPTION ALLOWANCE

- A. Included within the completion period for this project are a specified number of “facility interruption” days (see Schedule of Allowances).
- B. The Contractor’s progress schedule shall clearly indicate the interruption day allowance as an “activity” or “activities”. In the event facility interruption precludes 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 facility interruption (a “facility interruption” 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 “facility interruption” 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 “facility interruption” 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 “facility interruption” day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the “facility interruption” 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 “facility interruption” day allowance.
- E. Once this allowance is depleted, a no cost Change Order time extension will be executed for “facility interruption” days, as defined above, encountered during the remainder of the Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES

- A. Facility Interruption Allowance: Included within the completion period for this Project five “facility interruption” days.

END OF SECTION 012100

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 012100 "Allowances" for procedural requirements for handling and processing Allowances.
 - 2. Division 1, Section 012200 "Unit Prices" for administrative requirements for using Unit Prices.
 - 3. Division 1, Section 013115 "Project Management Communications" for administrative requirements for communications.
 - 4. Division 0, Section 007213, Article 3.1 "Acceptable Substitutions" for administrative procedures for handling Requests for Substitutions made after Contract award.
 - 5. 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 Contractor 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. Coordination Drawings.
 - 2. Administrative and supervisory personnel.
 - 3. Project meetings.
- B. Each Contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific Contractor.
- C. Related Sections include the following:
 - 1. Division 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.
- B. Coordination: Each Contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other Contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.

4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components including mechanical and electrical.
- C. Prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other Contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
 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.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
- B. Key Personnel Names: Within fifteen (15) work days of starting construction operations, submit a list of key personnel assignments including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 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. Review of mockups
 - i. Possible conflicts
 - j. Compatibility problems
 - k. Time schedules
 - l. Weather limitations
 - m. Manufacturer's written recommendations
 - n. Warranty requirements
 - o. Compatibility of materials

- p. Acceptability of substrates
 - q. Temporary facilities and controls
 - r. Space and access limitations
 - s. Regulations of authorities having jurisdiction
 - t. Testing and inspecting requirements
 - u. Installation procedures
 - v. Coordination with other Work
 - w. Required performance results
 - x. Protection of adjacent Work
 - y. Protection of construction and personnel
3. 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. Revise paragraph below if Project requires holding progress meetings at different intervals. Insert special intervals such as "every third Tuesday" to suit special circumstances.
 7. Project name
 8. Name and address of Contractor
 9. Name and address of Designer
 10. RFI number including RFIs that were dropped and not submitted
 11. RFI description
 12. Date the RFI was submitted
 13. Date Designer's response was received
 14. 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 location¹ 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 system² 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 – SCHEDULE – 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.
- B. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
 - 1. Requirement for Phased completion
 - 2. Work by separate Contractors

3. Work by the Owner
 4. Pre-purchased materials
 5. Coordination with existing construction
 6. Limitations of continued occupancies
 7. Un-interruptible services
 8. Partial Occupancy prior to Substantial Completion
 9. Site restrictions
 10. Provisions for future construction
 11. Seasonal variations
 12. Environmental control
- C. Work Stages: Use crosshatched bars to indicate important stages of construction for each major portion of the Work. Such stages include, but are not necessarily limited to, the following:
1. Subcontract awards
 2. Submittals
 3. Purchases
 4. Mockups
 5. Fabrication
 6. Sample testing
 7. Deliveries
 8. Installation
 9. Testing
 10. Adjusting
 11. Curing
 12. Startup and placement into final use and operation
- D. Area Separations: Provide a separate time bar to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a “major area” is a story of construction, a separate building, or a similar significant construction element.
1. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Permanent space enclosure
 - c. Completion of mechanical installation
 - d. Completion of the electrical portion of the Work
 - e. Substantial Completion

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. The Contractor shall comply with the General Conditions, Article 3.2.
- B. The Contractor shall submit full-size, fully fabricated samples, cured and finished as specified, and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
 1. The Contractor shall mount or display samples in the manner to facilitate review of qualities indicated. Prepare samples to match the Designer's sample including the following:
 - a. Specification Section number and reference
 - b. Generic description of the Sample
 - c. Sample source

- d. Product name or name of the Manufacturer
 - e. Compliance with recognized standards
 - f. Availability and delivery time
2. The Contractor shall submit samples for review of size, kind, color, pattern, and texture. Submit samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show approximate limits of the variations.
 - b. Refer to other Specification Sections for requirements for samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 - c. Refer to other Sections for samples to be returned to the Contractor for incorporation in the Work. Such samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of sample submittals.
 - d. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
3. Field samples are full-size examples erected onsite to illustrate finishes, coatings, or finish materials and to establish the Project standard.
- a. The Contractor shall comply with submittal requirements to the fullest extent possible. The Contractor shall process transmittal forms to provide a record of activity.

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
230010	General Mechanical Requirements - Welders	Certification
230010	General Mechanical Requirements	Operation / Maintenance Manual
230010	General Mechanical Requirements	As-Builts
230500	Common Work Results for HVAC	Product Data
230510	Basic Piping Material and Methods	Product Data
230513	Common Motor Requirements for HVAC Equipment	Product Data
230514	Variable Frequency Drives	Product Data
230519	Meters and Gauges for HVAC Piping	Product Data
230523	General Duty Valves for HVAC Piping	Product Data
230529	Hangers and Supports for HVAC Piping and Equipment	Product Data
230550	Vibration Isolation for HVAC	Product Data

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 & Control Devices for HVAC	Product Data
230913	Instrumentation & Control Devices for HVAC	Shop Drawings
230913	Instrumentation & Control Devices for HVAC	Operation / Maintenance Manual
230913	Instrumentation & Control Devices for HVAC	Warranty
230923	Direct Digital Control	Product Data
230923	Direct Digital Control	Shop Drawings
230923	Direct Digital Control	Operation / Maintenance Manual
230923	Direct Digital Control	As-Builts
230923	Direct Digital Control	Warranty
232113	Hydronic Piping	Test Report
232114	Hydronic Specialties	Product Data
232114	Hydronic Specialties	Operation / Maintenance Manual
232114	Hydronic Specialties	Certification
232123	Hydronic Pumps	Product Data
232123	Hydronic Pumps	Operation / Maintenance Manual
232123	Hydronic Pumps	Certification
232123	Hydronic Pumps	Warranty
233113	Metal Ducts	Product Data
233300	Air Duct Accessories	Product Data
260010	General Electrical Requirements	Operation / Maintenance Manual
260010	General Electrical Requirements	As-Builts
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
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
262816	Enclosed Switches and Circuit Breakers	Product Data
262816	Enclosed Switches and Circuit Breakers	Shop Drawings
262816	Enclosed Switches and Circuit Breakers	Test Report
262816	Enclosed Switches and Circuit Breakers	Operation / Maintenance Manual
262816	Enclosed Switches and Circuit Breakers	Warranty

262913	Enclosed Controllers	Product Data
262913	Enclosed Controllers	Test Report
262913	Enclosed Controllers	Operation / Maintenance Manual

END OF SECTION 013300

SECTION 013513.10 – SITE SECURITY AND HEALTH REQUIREMENTS (OA)

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/FMDC 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.

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. Water service and distribution
 - 2. Temporary electric power and light
 - 3. Temporary heat
 - 4. Ventilation
 - 5. Telephone service
 - 6. Sanitary facilities, including drinking water
 - 7. Storm and sanitary sewer
- C. Support facilities include, but are not limited to, the following:
 - 1. Field offices and storage sheds
 - 2. Temporary roads and paving
 - 3. Dewatering facilities and drains
 - 4. Temporary enclosures
 - 5. Hoists and temporary elevator use
 - 6. Temporary project identification signs and bulletin boards
 - 7. Waste disposal services
 - 8. Rodent and pest control
 - 9. 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. Barricades, warning signs, and lights
 - 3. Sidewalk bridge or enclosure fence for the site
 - 4. 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”.
 - 1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 “National Electric Code”.
- 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. Lumber and Plywood: Comply with requirements in Division 6 Section "Rough Carpentry".
 - 1. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sized and thicknesses indicated.
 - 2. For fences and vision barriers, provide minimum 3/9" (9.5mm) thick exterior plywood.
 - 3. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" (16mm) thick exterior plywood.
- C. Paint: Comply with requirements of Division 9 Section "Painting".
 - 1. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.
- D. Water: Provide potable water approved by local health authorities.
- E. Open-Mesh Fencing: Provide 0.120" (3mm) thick, galvanized 2" (50mm) chainlink fabric fencing 6' (2m) high with galvanized steel pipe posts, 1½" (38mm) ID for line posts and 2½" (64mm) ID for corner posts.

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. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated re-circulation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- H. 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: When overhead floor or roof deck has been installed, 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 and Cooling: The normal heating and/or cooling system of the building shall be maintained in operation during the construction. Should the Contractor find it necessary to interrupt the normal HVAC service to spaces, which have not been vacated for construction, such interruptions shall be pre-scheduled with the Construction Representative.
- F. Temporary Toilets: Install self-contained toilet units. Use of pit-type privies will not be permitted. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
 - 1. Shield toilets to ensure privacy.
 - 2. Provide separate facilities for male and female personnel.
 - 3. Provide toilet tissue materials for each facility.
- G. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a health and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
 - 1. Provide paper towels or similar disposable materials for each facility.
 - 2. Provide covered waste containers for used material.
 - 3. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
- H. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

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. Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at the Project site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip office as follows:
 1. Furnish with a desk and chairs, a 4-drawer file cabinet, plan table, plan rack, and a 6-shelf bookcase.
 2. Equip with a water cooler and private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.
- C. 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.
- D. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.
- 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. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.
 1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.
 2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.
- G. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.
- H. 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: At the earliest feasible date in each area of the Project complete installation of the permanent fire-protection facility including connected services and place into operation and use. Instruct key personnel on use of facilities.
- D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting including flashing red or amber lights.
- E. Enclosure Fence: Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.
1. Provide open-mesh, chainlink fencing with posts set in a compacted mixture of gravel and earth.
 2. Provide plywood fence, 8’ (2.5m) high, framed with (4) 2”x4” (50mm x 100mm) rails, and preservative-treated wood posts spaced not more than 8’ (2.5m) apart.
- F. 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.
- G. 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 impeding 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 <once><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. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects, and other pests. Comply with regulations of local authorities.
- D. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.
- E. 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. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.

3. At completion of training, submit complete training manual(s) for Owner's use 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.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations 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. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 3. Owner will furnish Contractor with names and positions of participants.
- 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. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. 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 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
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
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
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' 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 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.

1.6 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements.

1.7 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

1.9 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.10 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

1.11 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.

1.12 PAINTING

- A. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- B. 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.

1.13 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

1.14 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

1.15 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

1.16 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 Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.
 - 4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become their property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
 - 5. Mechanical 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 Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 - 6. General 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. Refer to Division 01 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned mechanical 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 mechanical 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. 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.
- 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 Owner prior to cutting. Do not cut or disturb structural members without prior approval from the Owner and 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 Owner.

3.5 CLEANING

- A. Refer to Division 01 and General Conditions for Cleaning requirements.

3.6 SUBSTANTIAL COMPLETION REVIEW

- A. Refer to Division 01 and General Conditions for Substantial Completion requirements.

END OF SECTION 230010

SECTION 230015 – ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- 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 General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General 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.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t

DIV23m = Mechanical Contractor

DIV26 = Electrical Contractor

DIV28 = Electronic Safety and Security

DIV23t = Temperature Controls Sub-Contractor

END OF SECTION 230015

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical equipment nameplate data.
- B. Concrete for bases and housekeeping pads.
- C. Non-shrink grout for equipment installations.
- D. Sleeves for mechanical penetrations.
- E. Miscellaneous metals for support of mechanical materials and equipment.
- F. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
- G. Joint sealers for sealing around mechanical materials and equipment.
- H. Sealing penetrations through noise critical spaces.
- I. Firestopping

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. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. 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.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
 - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

- a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

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 compliance's, 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
Base Mounted Pumps up to 30 HP. All Vertical Inline Pumps/Inline Circulators located on slab, (See Note 1)	5-1/2”
Base Mounted Pumps 30 HP to 75 HP (See Note 1)	7-1/4”

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 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.7 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

2.8 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 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.4 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.

3.5 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 skinning 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.

3.6 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. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

- I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- K. As-built drawings for each piping system in electronic and PDF format.
- L. 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. 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. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 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.
- D. 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. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

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. Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
3. 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.
4. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
5. 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.
6. 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.
7. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
8. 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. Capacitors.

1.2 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. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.3 QUALITY ASSURANCE

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

1.4 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.

1.5 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. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide 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.

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. Shaft Bearing Protection:
 - a. Provide shaft grounding system as listed below. Install system in accordance with manufacturer's recommendations.
 - 1) AEGIS SGR Bearing Protection Ring,
 - 2) Inpro/Seal Current Diverter Ring (CDR).
 - 3) Helwig Carbon Products BPK.
 - b. Provide magnetic core as listed below. Install system in accordance with manufacturer's recommendations.
 - 1) VLT MCC 105.
 - 2) CoolBLUE Inductive Absorbers.
 - 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. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

- Q. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.
- R. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.6 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
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
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

END OF SECTION 230513

SECTION 230514 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable speed drives shall be furnished for those units so indicated on the drawings. All variable speed drives provided under this section shall be by the same manufacturer.
- B. Type of variable speed drive specified in this Section include the following:
 - 1. Pulse Width Modulated

1.2 CODES AND STANDARDS:

- A. The VFD shall meet the following standards.
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. Standard 519-2022 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
 - 2. Nationally recognized testing lab such as UL or ETL
 - a. UL 508C (Variable frequency drive)
 - b. UL 508A (Bypass)
 - 3. NEMA – ICS 7.0, AC Adjustable Speed Drives

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product Data: Submit manufacturer's technical product data for variable speed drive including dimensions, capacities, component performance data, ratings, features, motor electrical characteristics, over current protection rating, gages and finishes of material, and installation instructions.
 - 2. Shop Drawings: Submit assembly-type shop drawings including unit dimensions, required clearances, control description, construction details, and field connection details.
 - 3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to variable speed drives. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
 - 4. Maintenance Data: Submit maintenance instructions, including instructions for adjustments, troubleshooting, operation, testing and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1 and Division 23 Section “General Mechanical Requirements.”
 - 5. Harmonic Analysis Report: Provide project-specific calculations and manufacturer’s statement of compliance with IEEE 519.

1.4 QUALITY ASSURANCE

- A. Testing: The variable speed drive, all components and subassemblies shall be factory tested. The variable speed drive shall be tested and cycled under motor load.
- B. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.
 - 1. Component Testing: All power semiconductors and integrated circuits shall be 100% tested.
 - 2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0°C and 65°C and receive electrical power-on and power-off cycle tests.
 - 3. Burn In: All VFD's shall be tested/run in the equivalent of a NEMA 1 enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

1.5 WARRANTY

- A. Provide warranty including on site parts and labor for minimum 36 months from date of shipment.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL:

- A. Provide factory assembled and factory tested variable speed drives as indicated, of sizes and capabilities as scheduled, and as specified herein.

2.2 MANUFACTURERS:

- A. Subject to compliance with requirements, manufacturers offering variable speed drives which may be incorporated in the work are limited to the following:
 - 1. ABB.
 - 2. Danfoss.
 - 3. Toshiba

2.3 VARIABLE FREQUENCY DRIVES

- A. The VFD shall provide the following design features as standard:
 - 1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus. Drive shall be provided with dual DC bus chokes or AC line reactors, as required, for a total input impedance of 5% or better.
 - 2. Output Section: The inverter shall use power transistors to provide three phase output power to the motor.

3. Input Displacement Power Factor: The input displacement power factor shall be 0.97 or higher at all operating speeds and loads.
4. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.
5. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.
6. Current Limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110%.
7. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.
8. Critical Frequency Avoidance (Frequency Jump Points): The VFD shall provide selectable frequency jump points to be used to avoid critical resonance frequencies of the mechanical system.
9. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated at 4-20 mA or 0-10Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.
10. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting specific parameters including motor design type (TEFC, ODP, or other) and speed range. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.
11. Open Collector Outputs: The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.
12. Output Signals: The VFD shall include analog output signals for output load, output speed, instantaneous kw and motor voltage. The signals shall be 4-20 ma or 0-10 Vdc @ 1 mA.
13. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed deceleration rate.
14. V/Hz Profiles: The VFD shall provide selectable V/Hz profiles.
15. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.

- B. The VFD supplier shall provide the same design/technology to cover the HP range for all VFD's.
- C. Output Ratings: The VFD shall operate within the following ratings:
 - 1. Frequency range: 1-120 Hz
 - 2. Overload rating: 110% for one minute
- D. Motor Performance: The VFD shall provide 3% speed regulation.
- E. Input Power: The VFD shall operate within (+5%/-10%) of the nominal rated voltage.
- F. Set-up Adjustments: Standard setup adjustments shall include:
 - 1. Minimum speed: 0 to 100%
 - 2. Maximum speed: 0 to 100%
 - 3. Linear accel: 0.5 to 600 seconds
 - 4. Linear decel: 0.5 to 600 seconds
 - 5. Maximum output voltage: Adjustable
 - 6. V/Hz: Adjustable with selectable profiles
 - 7. Current limit: 50 to 110%
- G. Environmental Ratings: The VFD shall operate within the following parameters without the requirement for derating:
 - 1. Operating temperature: 0°C to 40°C
 - 2. Altitude: Up to 1000m (3300 ft.)
 - 3. Humidity: 95% non-condensing
- H. Enclosure: Refer to VFD schedule or drawings for enclosure type. At minimum, the enclosure shall be suitable for environment installed. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation.
- I. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:
 - 1. AC Input Overcurrent Protection: The VFD's power circuit shall be isolated internally with respect to ground and provided with a 100,000 AIC interrupting rated input circuit breaker. As an alternate to the circuit breaker, fuses may be used to accomplish the 100,000 A interrupting rating.
 - 2. Logic Common: The power unit's logic common shall be at ground potential.
 - 3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.
 - 4. Power Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power. Opening of the VFD's input and/or output line switches while operating shall not result in damage to the power circuit components.

5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at nominal rated voltage plus 10%(i.e., 480V rated drive + 10% = 528V short circuit voltage). The VFD shall be capable of providing 110% motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.
6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with UL 1449 with the test circuit adjusted for a 2100 amp peak 8x20 us short circuit discharge current pulse.
7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.
8. DV/DT Filters: Dv/dt filters shall be provided per the VFD schedule, or if recommended by the VFD manufacturer to ensure that the VFD is applied correctly and to maintain the manufacturer's full warranty.

J. Maintainability

1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.
2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.
3. VFD shall be capable of starting and operating without a motor connected for ease of service.
4. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall be to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

K. Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the building management system to monitor feedback such as process variable feedback, output speed /

frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The building management system shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The building management system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The VFD shall allow the building management system to control the drive’s digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive’s digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive’s digital and analog inputs shall be capable of being monitored by the building management system.
4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. Required Optional Features

1. Operator Panel: A door-mounted Softouch Operator Panel shall be included with the following features:
 - a. Shall digitally display motor speed, load, amps, and output volts. (and controller setpoint and system pressure when setpoint controller is included).
 - b. Shall have indication for drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.
 - c. Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operator’s panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.
 - d. Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operator’s panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.

- e. Shall name all parameters in English, not codes or numbers.
 - f. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.
 - g. Shall store from three to six drive faults in a history batch file in the order they occur to simplify trouble-shooting. This file will automatically be updated should new faults occur.
2. Input Overcurrent Protection Device: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position.
 3. Elapsed Time Meter: Meter shall provide indication of how long the drive has been running.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which variable speed drive is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION

- A. General: Install systems and materials in accordance with manufacturer's instruction.
- B. Maintain minimum clearance of 12 inches on each side and 36 inches in front of the variable speed drive.
- C. Install variable speed drive in the vertical position.
- D. Provide separate conduits for input and output power cables.
- E. Provide separate conduits for control cables and the output cables to the motor.
- F. Install power and control cabling in separate conduits.
- G. Provide dedicated conduits for power cables to the motors.
- H. Load Side Disconnects: Provide a disconnect switch on the load side of the VFD near the motor for ease of service and safety. Disconnect switch shall be lockable in the open position when the VFD is not within sight of the motor. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.
 1. When a separate disconnect is provided at the motor, provide auxiliary contact in the disconnect switch that will shut down the variable speed drive when the disconnect switch is turned off.

3.3 START UP

- A. All units shall be started up at the jobsite by a factory trained and authorized representative.

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 [two][four][eight] 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 "Operating and Maintenance Data."
- C. Certification: Contractor shall submit to the Engineer a certification letter written by the Contractor 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. Copies of the startup report shall be attached to the certification letter.
- D. Schedule: Schedule training with Owner with at least 14 days' advance notice.

END OF SECTION 230514

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 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. Samples: Submit two of each type of instrument specified.
- E. Project Record Documents: Record actual locations of components and instrumentation.
- F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Pressure Gauges: One of each type and size.

1.3 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; .
 - 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 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.

2.5 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 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.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

- H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULE

- A. Pressure Gage Tappings, Location:
 - 1. Major coils – inlets and outlets.
- B. 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. Hydronic zone supply and return.
 - c. After major coils. Reference details on plans.
 - 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.

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. Globe valves.
- D. Ball valves.
- E. Butterfly valves.
- F. Check valves.
- G. Gate valves.
- H. Chainwheels.

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.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

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 .

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 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, and Globe.
 - 2. Isolation (Hydronic): Butterfly, Gate, Ball, and Globe.
 - 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: 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: 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) Stainless steel components.
 - 2) Lift check.

- 3) Swing check.
 - 4) Wafer plate-type check.
 - 5) Gate.
 - 6) Globe.
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) Stainless steel components.
 - 2) Butterfly: Ductile iron body.
 - 3) Lift check.
 - 4) Swing check.
 - 5) Wafer plate-type check.
 - 6) Gate.
 - 7) Globe.
- 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) Stainless steel components.
 - 2) Lift check.
 - 3) Swing check.
 - 4) Wafer plate-type check.
 - 5) Gate.
 - 6) Globe.
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.
- b) Stainless steel components.
- 2) Butterfly: Ductile iron body.
- 3) Lift check.
- 4) Swing check.
- 5) Wafer plate-type check.
- 6) Gate.
- 7) Globe.

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.
- 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 GLOBE VALVES

- A. Class 125, 200 psig CWP:
1. Comply with MSS SP-80, Type 2, nonmetallic disc to metal seat.
 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 3. Ends: Threaded or solder joint.
 4. Stem and Disc: Bronze stem, PTFE disc.
 5. Packing: Asbestos free, brass gland.
 6. Operator: Malleable iron handwheel.

2.5 IRON GLOBE VALVES

- A. Class 125, 200 psig CWP and Class 250, 500 psig CWP:
1. Comply with MSS SP-85, Type 1.
 2. Body: Gray iron; ASTM A126, with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Packing and Gasket: Asbestos free, two-piece backing gland assembly.
 6. Operator: Handwheel or chainwheel.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 IRON, WAFER PLATE-TYPE CHECK VALVES

- A. Class 125 Dual-Plate (Twin Disc):
 - 1. Comply with API STD 594.
 - 2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 - 3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
 - 4. Design: Wafer, non-slam, spring-loaded plates, designed to open and close at approximately 0.5 psi differential.
 - 5. Body: ASTM A126, cast iron.
 - 6. Ends: Flanged.
 - 7. Trim: Stainless steel.
 - 8. Disc: Replaceable bronze.
 - 9. Seat: EPDM, or NBR.

2.11 BRONZE GATE VALVES

- A. Class 125:
 - 1. Comply with MSS SP-80, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body: Bronze, ASTM B62 with integral seat and screwed bonnet.
 - 4. Trim: Bronze.
 - 5. Ends: Threaded or solder joint.
 - 6. Stem: Bronze, RS type. NRS type where exceptions apply.
 - 7. Disc: Solid wedge; bronze.
 - 8. Packing: Asbestos free, brass.

9. Operator: Malleable iron handwheel.

2.12 IRON GATE VALVES

- A. Class 125:
 1. Comply with MSS SP-70, Type I.
 2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
 3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
 4. Body: Cast iron, ASTM A126 Class B with bolted bonnet.
 5. Ends: Flanged.
 6. Trim: Bronze.
 7. Stem: OS&Y, RS type, NRS type where exceptions apply.
 8. Disc: Solid wedge.
 9. Packing and Gasket: Asbestos free, 2-piece packing gland assembly.
 10. Operator: Malleable iron handwheel.

2.13 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 3. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

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. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- G. Install valves in a position to allow full stem movement.
- H. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- I. 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.
- J. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install horizontal style with stem plumb and vertical.
 - 2. Swing Check: Install horizontal maintaining hinge pin level.
 - 3. Orient plate-type into horizontal or vertical position, between flanges.
- K. Provide chainwheels on operators for valves 2-1/2 NPS and larger where located 72 inches or more above finished floor in mechanical rooms, terminating 60 NPS above finished floor.

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 Globe Valves, Class 125:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER RS
Apollo	--	120T	120S

Crane	--	5TF	--
Nibco	--	T-211-Y	S-211-Y
Stockham	B-13T	--	B-14T

B. Iron Globe Valves:

<u>MANUFACTURER</u>	<u>CLASS 125 STRAIGHT BODY</u>	<u>CLASS 125 ANGLE BODY</u>	<u>CLASS 250 STRAIGHT BODY</u>
Apollo	711F	--	721F
Bray	DG	--	--
Crane	351	353	21E
Hammond	IR116	IB463	IR313
Jenkins	2342J	2344J	162J
Milwaukee	F2981A	--	F2983-M
Nibco	F-718-B	F-818-B	F-768-B
Powell	241	--	--
Stockham	G-512	G-515	F-532

C. 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.

<u>MANUFACTURER</u>	<u>THREADED ENDS</u>	<u>SOLDER ENDS</u>
Apollo	77C-140	77C-240
Hammond	8301A	8311A
Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

D. Iron Butterfly Valves, 200 psig CWP:

<u>MANUFACTURER</u>	<u>SERIES</u>
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

E. Iron Butterfly Valves, 250 psig CWP:

<u>MANUFACTURER</u>	<u>SERIES</u>
Bray	31H
Keystone	Paraseal
Nibco	LD-3000

F. Bronze Swing Check Valves:

<u>MANUFACTURER</u>	<u>CLASS 125 THREADED</u>	<u>CLASS 125 SOLDER</u>	<u>CLASS 150 THREADED</u>	<u>CLASS 200 THREADED</u>
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

G. 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

H. Iron Wafer Plate-Type Check Valves:

MANUFACTURER	CLASS 125	CLASS 250
Apollo	910WB	--
Center Line	800	--
Crane	DuoChek StyleG	DuoChek Style G
Metraflex	CVOSSXXX	CVOSSXXX
Nibco	W-920-W	W-960-W
Stockham	WG970	--

I. Bronze Gate Valves, Class 125:

MANUFACTURER	THREADED	THREADED	SOLDER	SOLDER
	NRS	RS	NRS	RS
Apollo	102T	101T	102S	101S
Crane	438	428	--	--
Hammond	IB645	IB640	IB647	IB635
Jenkins	992AJ	990AJ	993AJ	991AJ
Milwaukee	105	148	115	149
Nibco	T113	T111	S113	S111
Powell	507	500	--	--
Stockham	B-103	B-100	B-104	B-108

J. Iron Gate Valves, Class 125:

MANUFACTURER	OS&Y RS	NRS
Apollo	611F	610F
Crane	465-1/2	461
Hammond	IR1140	IR1138
Jenkins	651A	326
Milwaukee	F2885A	F-2882A
Nibco	F617-O	F619
Powell	1793	1787
Stockham	G-623	G-612

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.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.4 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 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test fluid. Include the weight of the pipe, valves, insulation and piping accessories.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.2 SUPPORT AND ATTACHMENT COMPONENTS

- B. 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.
 - a. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
- C. 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. Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.
 - c. Outdoor Locations: Galvanized steel or Type 304 stainless steel.
 - d. Natatorium or other treated pool environments: Type 316 stainless steel.
 - e. 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.
- D. Hanger Rods:
- 1. Material:
 - a. Indoor Dry Locations: Zinc-plated steel.
 - b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
 - c. Natatorium or other treated pool environments: Type 316 stainless 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. Piping Technology and Products, Inc.
 12. Power-Strut.
 13. 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” 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: Same as hanger and Supports.
 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)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	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.

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. Piping Technology and Products, Inc.
9. Power-Strut.
10. 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 PIPE ANCHORS

- A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.
- B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.6 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 rod dimensions.
 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. 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 lock-nuts for anchoring in place.
- F. Vibration Isolation Anchors: Reference Section “Vibration Isolation for HVAC” for vibration isolation anchors.

2.7 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” 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. Comply with Division 09 Section "Painting."
 - 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.

- 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.
- 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.
 - a. Axial movement due to thermal expansion or contraction is greater than one inch.
 - b. Between anchor locations shown on the drawings.

END OF SECTION 230529

SECTION 230550 – VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. 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. Shop Drawings:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.
 2. Piping isolators shown and identified on piping layout drawings.
 3. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:
 - a. Concrete reinforcing steel details and templates for all foundations and supports.
 - b. Required hanger bolts.
 - c. All other appurtenances necessary for proper installation of equipment.
- C. Vibration Isolation System Schedule: Include the following for each isolation element:
 1. Manufacturer, isolator type, model number, size.
 2. Height when uncompressed and static deflection.
 3. Spring constant.
 4. Spring outside diameter, free operating, and solid heights.
 5. Design of supplementary bases.
 6. Details of attachment to load-bearing structure or supplementary framing.
- D. 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 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. 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.
- L. 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 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. 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.
- G. 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.
- H. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.
- I. Flexible Connectors:
1. Pipe: Refer to Section “Hydronic Piping Specialties.”

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 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.

3.4 EQUIPMENT ISOLATION

- A. 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.
 - d. Suspended: Type SPNH isolation with 2 inch static deflection.
- B. Base-mounted Pumps:
 1. Slab-on-Grade:
 - a. Less than 50 hp: Housekeeping pad.
- C. 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.

3.5 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. Pumps with motors greater than 5 hp.
 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 the following:
 1. Pumps except suspended in-line pumps supported by the piping.
 2. Mechanical equipment supported or suspended by spring isolators.
 3. 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.
 - a.

3.6 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. Adhesive-backed duct markers.
- D. Pipe markers.
- E. 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.
- C. Product Data: Submit manufacturer's technical product data for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.3 SPARE PARTS

- A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.
- B. Furnish not less than 3 additional numbered valve tags for each piping system.
- C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

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. Ductwork: Adhesive-backed duct markers.
- E. Instrumentation: Tags.
- F. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.
- G. Piping: Pipe Markers.

- H. Pumps: Nameplates or engraved plastic laminate signs.
- I. Relays: Tags.
- J. Valves: Tags. Ceiling tacks are acceptable where located above a lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

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.
 - 3. Combination cooling and heating equipment: Yellow/Green.
 - 4. Energy reclamation equipment: Brown.
 - 5. Hazardous equipment: Colors and designs recommended by ASME.
 - 6. Equipment and components that do not meet any of the above criteria: Blue.
- F. Plastic: Conform to ASTM D709.

2.4 TAGS

- A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- B. 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.
- C. 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.

- D. 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.
- E. Letter Height:
 - 1. System Abbreviation: Minimum 1/4 inch.
 - 2. Valve Number: Minimum 1/2 inch.

2.5 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual label.
- C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.
- D. Color: Yellow background with black lettering or blue background with white lettering.

2.6 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.
 - 3. Toxic and Corrosive Fluids: Orange with black letters.
 - 4. Compressed Air: Blue with white letters.

- G. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

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 DUCTWORK IDENTIFICATION

- A. Install identification on the most obviously visible portion of the duct from the point of access.
- B. Location: Install ductwork identification where ductwork 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 control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
 2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
 4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
 5. Within 5 feet of equipment outlets and other points of origin or termination.
 6. Install marker on the most obviously visible portion of the duct from point of access.

3.6 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.
 5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.
- 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 hydronic systems.
- C. Testing, adjustment, and balancing of hydronic systems.
- D. 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. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
- C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. 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 hand written, 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. Hydronic Systems
 - c. Temperature Control Systems
 - d. Special Systems
 - e. Sound and Vibration 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.
- G. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

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. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- 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.

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. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.
- C. 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.
- D. 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.
- E. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.
- F. 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.
- G. 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. Hydronic systems are flushed, filled, and vented.

6. Hydronic systems are tested for leaks.
 7. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
 8. Pumps are rotating correctly.
 9. Proper strainer baskets are clean and in place.
 10. Service and balance valves are open.
 11. 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. Prepare schematic diagrams of system "as-built" piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

- A. 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 piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
 - I. Patch and seal insulation, vapor barrier, and housings, using materials identical to those removed.
 - J. Seal 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 HYDRONIC 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. Open automatic control valves to full design position to simulate a design day. Close coil bypass valves.
 - 2. Examine HVAC system and equipment installations to verify that existing balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed. Verify that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 - 3. Remove, clean, and reinsert all strainers.
 - 4. Examine hydronic systems and determine if water has been treated and cleaned.
 - 5. Check pump rotation.
 - 6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
 - 7. Check air vents at high points of systems and determine if all are operating freely (automatic type) or to bleed air completely (manual type).
 - 8. Set temperature controls so all coils are calling for full flow.
 - 9. Check operation of automatic bypass valves.
 - 10. Measure and record the operating speed, hydronic flow and pressure drop of each pump and hydronic coil.
 - 11. Measure and record the hydronic flow and pressure drop of each piece of HVAC equipment.
 - 12. Measure motor voltage and amperage. Compare the values to motor nameplate information.
- C. Mechanical Contractor:
 - 1. Install additional instrumentation and test ports as requested by the testing, adjusting, and balancing contractor to obtain the necessary measurements of the existing system.

3.7 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Open valves to full 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 controls 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. External Ductwork Insulation.
- C. 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 Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.
- D. Hot Duct: Ductwork that carries airflow with a minimum operating temperature greater than 75 degrees F temperature.
- E. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.
- F. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.
- G. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.
- H. Exposed: Insulation that is visible from the occupied space.
- I. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.
- J. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.
- K. 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.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

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. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. 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. Field-Applied Jacket:
 - 1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.
- C. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- D. 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)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	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.
- E. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- F. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
- G. High Density Insulation Billets:
1. Calcium Silicate: ASTM C533 and C795.
 2. Flexible elastomeric: ASTM C534, Type 1.
 3. Polystyrene: ASTM C578, Type XIII.
 4. Phenolic: ASTM C1126, Type III, Grade 1.

2.2 EXTERNAL DUCTWORK 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 or 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.
 - d. Density:
 - 1) 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 stapling tab.
 - b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.
 - c. Color: White.
- B. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.
- C. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds 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. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.
 - 3. 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 Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.
 - 4. 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.
 - 5. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.3 EQUIPMENT INSULATION MATERIALS

- A. 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.
- B. 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.
- C. 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.
- D. 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. Condensate piping between steam trap and union.
 5. Steam relief vent piping.
 6. Chiller emergency refrigerant vent piping.

7. 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.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Mineral fiber.
- 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.

3.6 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft ² ·°F)	Mean Rating Temp., °F.	<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:

- a. 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.
- b. 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
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),

- 3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
 - d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
 - e. 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:
 1. All-service jacket.
- C. Piping within return air plenums:
 1. All-service jacket.

3.8 DUCTWORK INSULATION SYSTEM INSTALLATION

- A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces.
- D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert

to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.

- F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.
- I. Cold Ducts:
 - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
 - 2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
 - 3. Seal joints with vapor barrier mastic.
 - 4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
 - 5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
 - a. Install thermal break such as rigid board insulation between the support and duct.
 - b. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.
 - c. If a support device similar to Unistrut is used, foam fill or stuff tube.
- J. Hot and Neutral Ducts:
 - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
 - 2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
 - 3. Secure joints with staples, tape, or wires.
 - 4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

3.9 DUCTWORK SYSTEM INSULATION SCHEDULE

- A. Omit insulation on the following:
 - 1. Lined ductwork that is interior to the building unless otherwise indicated on the drawings.
- B. Prohibited insulation:
 - 1. Polyisocyanurate installed within a return air plenum.
- C. Outdoor Air:
 - 1. Service:
 - a. Interior untreated outdoor air intake ducts.
 - b. Pre-conditioned outdoor air ducts.
 - 2. Acceptable Insulation:
 - a. Flexible mineral fiber.

3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

- A. Flexible Mineral Fiber:
 - 1. Interior Ductwork:
 - a. 1.5 pounds per cubic foot density:
 - 1) 2 inch thick, minimum R-6.0.
 - 2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.

3.11 DUCTWORK JACKET SCHEDULE

- A. Omit jacket on internally lined ductwork.
- B. Exposed ductwork within mechanical rooms (above 10 feet):
 - 1. Foil Scrim Kraft (FSK).
 - 2. Polypropylene Scrim Kraft (PSK).
 - 3. All-Service Jacket (ASJ).

3.12 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. 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.
- L. Cold Equipment:
 - 1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
 - 2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.
 - 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- 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.

3.13 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. Cold Equipment:
 - 1. Service:
 - a. Chilled water pumps.
 - 2. Acceptable Insulation:
 - a. Rigid Mineral Fiber:
 - 1) 1-1/2 inch thick for cold surfaces above 35 degrees F.
 - b. Flexible Elastomeric:
 - 1) 1-1/2 inch thick for surfaces above 35 degrees F.

- E. Hot Equipment:
 - 1. Service:
 - a. Hot water pumps.
 - 2. Acceptable Insulation:
 - a. Rigid Mineral Fiber:
 - 1) 2 inch thick for all other applications.

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. Operators.
- D. Input/Output sensors and transmitters.
- E. Output control devices.
- F. Power Supplies.
- G. Thermostats.

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. Mechanical Contractor:
1. Installation of immersion wells.
 2. Installation of automatic control valves.
 3. Installation of pressure tappings and associated shut-off cocks.
 4. 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. Manufacturer's Instructions: Provide for all manufactured components.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
- H. 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. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.1 CONTROL PANELS

A. Construction:

1. Panel shall be UL 508A listed.
2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
3. Provide common keying for all panels.

2.2 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 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 maximum 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.
 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.
- 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 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.
 - 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).

2.3 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 counter-clockwise 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.

2.4 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. Room Temperature Sensors:
 - a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.
 - b. Provide the following features:
 - 1) Non-adjustable, blank front panel.
 - 2) Wireless sensor where indicated on the drawings.
 5. 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.
 6. 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. Humidity Sensors:
 - 1. Elements: Accurate within 3 percent full range with linear output.
 - a. Accuracy shall include temperature effects.
 - 2. Resolution: Plus/minus 1 percent.
 - 3. Drift: Less than 1 percent full scale per year.
 - 4. Sensing Range: 0 to 100 percent relative humidity.
 - 5. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.
- D. Pressure Transmitters:
 - 1. Duct Static Pressure:
 - a. Type: Unidirectional, fixed range.
 - a. Performance Characteristics:
 - 1) Accuracy: Plus/minus one 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 one percent full scale per year.
 - b. Construction:
 - 1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.
 - 2) Insertion length selected as appropriate for duct size.
 - 3) Traverse sensors shall have at least one pickup point every 6 inches.
 - 4) Element: Variable capacitance sensing technology.
 - 5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.
 - 2. Hydronic Pressure:
 - a. Type: Unidirectional, fixed range.
 - a. General Sensor Performance Characteristics:

- 1) Accuracy: Plus/minus 1.0 percent of full scale.
 - 2) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F
 - 3) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.
 - 4) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.
- b. Construction:
- 1) Suitable for the media temperature and pressure.
 - 2) Element: Diaphragm type, stainless steel.
 - 3) Housing: Fire retardant glass-filled polyester, stainless steel, or aluminum.
- E. Equipment Operation Sensors:
1. 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.

2.5 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.
 5. Electromechanical relays shall be UL listed, compact in size, provided with quick connect terminals and be impervious to shock and vibration.
 6. Electronic relays shall be microcomputer-based with PI, time proportioning control capability, have average life greater than 500,000 cycles, have a built-in transformer and have LED status indication.

2.6 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.

2.7 THERMOSTATS

- A. Electric Low Limit Thermostat:

1. Snap acting, single pole, single throw, manual or automatic reset switch as indicated on the drawings that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
 - a. Provide double-throw contacts (one for direct equipment control, one for BAS system notification) where additional alarms are scheduled.
2. Bulb length: Minimum 1 foot for every 1 square foot of coil cross sectional area.
3. Provide one thermostat for every 20 sq ft of coil surface.
4. Setpoint shall be adjustable.

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. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
 - 4. 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.
 - 5. 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.

6. 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.
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. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 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. 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.
12. Mount freeze protection thermostats using flanges and element holders.
 - a. Install thermostat completely across the surface the thermostat serves.
13. Provide separable sockets for liquids and flanges for air bulb elements.
14. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
15. 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. 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.

F. 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.
- G. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- H. 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 OPERATOR VOLTAGE SCHEDULE

<u>SERVICE</u>	<u>VOLTAGE</u>
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.

3.7 CONTROL VALVE SCHEDULES

- A. Allowable Valve Type and Size by Control Application:

VALVE	CONTROL APPLICATION
-------	---------------------

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 MATERIAL	SERVICE APPLICATION	
	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.

D. Allowable End Connection by Size Schedule:

VALVE TYPE	END CONNECTION TYPE	
	THREADED	FLANGED
Globe	≤ 2-1/2 IN	≤ 4 IN
Characterized Ball	≤ 2-1/2 IN	≤ 3 IN
Butterfly	N/A	≥ 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 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.

1.3 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.
- B. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).
- C. BAS: Building Automation System.
- D. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.
- E. 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
- F. DDC: Direct Digital Control.
- G. EMT: Electrical Metallic Tubing
- H. High voltage: 50 volts or higher.
- I. IP: Internet Protocol.

- J. LAN: Local Area Network.
- K. VLAN: Virtual Local Area Network.
- L. Low voltage: Below 50 volts.
- M. NiCS: Niagara Compatibility Statement license.
- N. OSI: Open System Interconnection
- O. PC: Personal Computer.
- P. PICS: Protocol Implementation Conformance Statement.
- Q. 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.

1.4 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 “Instrumentation and Control Devices for HVAC.”
- B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.5 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 C37.90.1 based 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.
 3. 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.
 - 4. 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. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- G. Manufacturer's qualification statement.

- H. Installer's qualification statement.
- 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.
- M. Maintenance Materials:
 - 1. Refer to Division 01 for additional provisions.

1.6 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.

1.7 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 date 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. Provide five year manufacturer's warranty for field programmable micro-processor based units.
- G. 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.

1.8 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 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. Schneider Electric, EcoStruxure Building Operation.
 - a. Contact Information: Brian Schepers, C&C Group, 573-632-4247
- 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.

2.2 SYSTEM DESCRIPTION

- A. General:
1. Expand existing Schneider BAS for new equipment and their sequences of operations.
 2. The BAS modifications 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.
 3. 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.

4. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
5. 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.
6. 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.
7. 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. Utilize the existing network. Expand as needed.

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.

2.3 OPERATOR INTERFACE

A. General:

1. Reuse existing operator interface for new equipment.

2. 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.
3. 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.

1.2 CONTROLLERS

A. 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 hand held 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. 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.
- B. 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 hand held 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.
- C. 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.

2.4 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: $10 \times 10 \text{ E}^6$ 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.

2.5 SYSTEM SOFTWARE

A. General:

1. Upgrade software as needed to for a complete and operable system.

B. System Graphics:

1. Upgrade system graphics for new modifications and additions to existing BAS.
2. 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. 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.

2.6 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 user names.
 - 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 work station. 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.
- A. 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.
- B. 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 work station. 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.
5. Properly ground all controllers.
6. 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.
7. Conceal all low voltage wiring in finished rooms.
8. 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.
9. 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.

- C. 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.
- 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. Refer to Division 1 Section "Operation and Maintenance Data."
- 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.
 3. Cast-Iron: ASME B16.4, standard pattern.
- D. Flanged:
1. Cast-Iron Threaded: ASME B16.1, raised ground face, bolt holes spot faced.
 2. Cast-Bronze Flanges: ASME B16.24, raised ground face, bolt holes spot faced.
 3. 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.
 4. 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.
 5. 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.

- G. Transition Fittings for plastic to metal piping shall be of the plastic material of the adjoining pipe, one-piece, with a threaded brass or copper insert and schedule 80 solvent cement or fusion end.

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.
- 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 125 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 125 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 times 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.

3.5 PIPE HANGERS AND SUPPORTS APPLICATION

- A. Comply with the requirements of Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- B. Provide vibration isolation on piping as specified in Division 23 Section “Vibration Isolation for HVAC.”
- C. 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

- D. Use copper tube maximum hanger span requirements for PVC and CPVC supports and hangers, unless manufacturer's recommendations specify closer hanger spacing.
- E. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.
- F. Install a support within one foot of each change of direction.
- G. 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 “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. 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.
- D. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
- E. Remove and clean or replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- G. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- H. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

- I. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- J. 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 full 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. Air vents.
- B. Strainers.
- C. Suction diffusers.
- D. Flexible connectors.
- E. Triple Duty Valves.
- F. 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. Manufacturer's installation instructions.
- E. 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 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.

2.2 STRAINERS

- A. Y-Strainers

1. Manufacturers:
 - a. American Wheatley.
 - b. Armstrong International.
 - c. Hoffman Specialty; Xylem.
 - d. Keckley.
 - e. Metraflex Co.
 - f. Mueller Steam Specialties.
 - g. Spirax Sarco.
 - h. Nexus Valve.
 - i. Watts Water Technologies.
2. Pressure Rating: Rated for working pressure as defined by the ANSI fitting class of the system.
3. Size 2 inch and Smaller:
 - a. Body:
 - 1) Bronze, ASTM B62.
 - 2) Forged brass ASTM B283.
 - 3) Cast iron ASTM A126 Class B.
 - 4) Type 304 stainless steel ASTM A240.
 - b. Ends: Threaded.
 - c. Cover: Screwed.
 - d. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.
4. Size 2-1/2 inch and Larger:
 - a. Body:
 - 1) Cast iron, ASTM A126 Class B.
 - 2) Carbon steel ASTM A216 Grade WCB.
 - 3) Type 304 stainless steel ASTM A240.
 - b. Ends: Flanged or grooved.
 - c. Cover: Bolted.
 - d. Screen: Type 304 stainless steel with mesh rating based on the Strainer Schedule in Part 3.

2.3 SUCTION DIFFUSERS

- A. Manufacturers:
 1. American Wheatley.
 2. Armstrong Fluid Technology.

3. Bell & Gossett; Xylem.
 4. Keckley.
 5. PACO; Grundfos Pumps Corp.
 6. Patterson Pump Co.
 7. Taco, Inc.
 8. 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 in side.
 6. Permanent magnet located in flow stream, removable for cleaning.

2.4 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.

2.5 TRIPLE DUTY VALVES

A. Manufacturers:

1. American Wheatley.
2. Armstrong Fluid Technology.
3. Bell & Gossett; Xylem.
4. Keckley.
5. PACO; Grundfos Pumps Corp.
6. Taco, Inc.
7. 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.

2.6 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 in 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.
- B. Acceptable strainer types based on orientation:
1. Horizontal: Y-Type.
 2. Vertical: Y-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).

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. 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.
- D. Strainers:
1. Provide valved drain and hose connection on strainer blowdown connection for strainers 2 inch and larger.
- E. Suction Diffusers:
1. Adjust foot support to carry weight of suction diffuser. Install nipple and ball valve in blowdown connection.
- F. 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. 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.
- B. Review manufacturer's safety data sheets for handling of chemicals.
- C. 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."
- D. Schedule at least two hours of training with Owner, through Architect, with at least seven days' advance notice.
- 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.

END OF SECTION 232114

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In-line circulators.
- B. Base-mounted, separately coupled, end suction pumps.

1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- E. Alignment Report: Provide alignment and grout reports for alignment work specified in Part 3. Submit pictures of grouted base with the alignment report.
- F. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Pump Seals: _____ for each type and size of pump.
 - 2. Extra Cartridges for Side-Stream Filters: One set for each filter.

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 - 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. Minimum Quality Standard: .
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. 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.
- E. 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.
- F. 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.

- G. 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. 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.
- H. Apply factory finish paint to assembled, tested units prior to shipping.

2.2 IN-LINE CIRCULATORS

- A. Type: Circulators shall be horizontal inline, centrifugal, separately-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, and rated for 125 psig working pressure and 225 deg F continuous water temperature.
- B. Casing: Provide casing with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gauge tappings at inlet and outlet connections. Construct casing of the following material:
 - 1. Cast iron.
 - 2. Bronze.
 - 3. Stainless Steel.
- C. Impeller: Statically and dynamically balanced, closed, overhung single-suction, and keyed to shaft.
 - 1. Pumps smaller than 1-1/2 inch casing: Rolled temper brass conforming to ASTM B36/B36M.
 - 2. Pumps 1-1/2 inch and larger casing: Cast bronze conforming to ASTM B584.
- D. Pump Shaft and Sleeve: Steel shaft, with copper sleeve. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.
- E. Bearings: Oil-lubricated bronze sleeve.
- F. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- G. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
- H. Seal: Carbon rotating against a stationary ceramic seat, Viton fitted, 275 degrees F maximum continuous operating temperature.
- I. Drive: Flexible coupling.

- J. Motors: Resiliently mounted to the pump casing.
- K. Manufacturers:
 1. Armstrong Pumps, Inc.
 2. Bell & Gossett, ITT.
 3. Grundfos Pumps Corp.
 4. Taco, Inc.

2.3 BASE-MOUNTED, SEPARATELY-COUPLED, END-SUCTION PUMPS

- A. Type: Pumps shall be base-mounted, centrifugal, separately-coupled, end-suction, single-stage, bronze-fitted, radially split case design. Temperature and pressure rating: 175 psi maximum working pressure and 225 degrees F continuous water temperature.
- B. Casing: Cast iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, ANSI B16.1, Class 125 psi flanged suction and discharge.
- C. Impeller: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.
- D. Bearings: Grease lubricated roller or ball bearings in a cast iron housing.
- E. Shaft: Steel shaft, with bronze sleeve. Provide neoprene slinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.
- F. Seals: Mechanical seals consisting of flushed seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
 1. For condenser water pumps serving cooling towers with silica based water treatment system, provide EPDM type seals suitable for the tower water quality generated by the silica based treatment system.
- G. Pump Couplings:
 1. Flexible, capable of absorbing torsional vibration and shaft misalignment; complete with metal coupling guard.
 2. For pumps driven by variable frequency drives, provide coupling type that is rated for this service and has been in use on similar projects for more than five years.
- H. Baseplate: Steel or cast iron.
- I. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM A 36/ A 36M. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.
- J. Motor: Flexible-coupled to pump, with adjustable alignment on mounting frame.

- K. Manufacturers:
 - 1. Armstrong Pumps, Inc.
 - 2. Aurora Pumps.
 - 3. Bell & Gossett, ITT.
 - 4. Grundfos Pumps Corp.
 - 5. Patterson Pump Co.
 - 6. Taco, Inc.

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 tapplings 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. For pumps with flexible couplings requiring alignment and grouting per manufacturer's inspection, operation and maintenance (IOM) plan, measure alignment when pump is set and again after pump has been started. Misalignment shall be no greater than 5 thousandths angular and 3 thousandths parallel. Submit reports of alignment results in accordance with Submittals paragraph.
 - 3. 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 [two][four][eight] 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 233113 – METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Duct sealants.
- C. Duct hangers and supports.

1.2 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
 - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
 - 2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Sealing Materials.
 - 2. Fire-Stopping Materials.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
 - 3. Fittings.

4. Seam and joint construction details.
 5. Location of manual balancing dampers.
- C. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.

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. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.
- C. NFPA Compliance: Comply with the following NFPA Standards:
1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.
- D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.
- E. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.

1.6 PROTECTION AND REPLACEMENT

- A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.
- B. Replace duct liner that is damaged and cannot be repaired satisfactorily, 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 installing new duct liner.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS AND MATERIALS

2.1 DUCT ASSEMBLIES

- A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.
- B. Outside Air Ductwork: 2 inch w.g. pressure class, galvanized steel.

2.2 MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.
- B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.
- C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.
 - 3. For Use with Flexible Ducts: UL labeled.
 - 4. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.
 - 5. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.
 - 6. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
 - 7. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 65 percent solids. Approved products: Design Polymeric DP 1090, Duro Dyne SGD, Fosters 32-14, or approved equal.
 - 8. Water-Based Joint and Seam Sealant: Non-Fibrated, UL 181 listed, rated to minimum SMACNA Pressure Class of ± 10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymeric DP 1010, Ductmate Proseal, Duro Dyne Duroseal EDS-RS, Fosters 32-18, Hardcast Iron-Grip 601, Red Devil D-Seal and United McGill United Duct Seal WB.
 - 9. Water-Based Joint and Seam Sealant: Fiber reinforced, UL 181 listed, rated to minimum SMACNA Pressure Class of ± 10 inches w.g and SMACNA Seal Class

A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymeric DP 1030, Ductmate Fiberseal, Duro Dyne Duroseal EDS-RF, Fosters 32-17, Hardcast CCWI-181, Red Devil F-Seal 181 or United McGill Uni-Mastic.

10. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
11. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of -25 to 180 F. Approved Products: Design Polymeric DP 1040, Ductmate 440, and Hardcast 1104.

D. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
 - a. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 - b. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
 - a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
 - b. For stainless steel ducts, provide stainless steel support materials.
 - c. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

- E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
- F. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).
- B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
 - 1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
 - 2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- D. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.
- E. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.
- F. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
- G. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.

- H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products in accordance with manufacturer's instructions.
- C. Install ducts with the fewest possible joints.
- D. Seal duct joints with the appropriate sealing material.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.
- N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

- O. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
- P. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- Q. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- R. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- S. Seam and Joint Sealing
 - 1. General: Seal duct seams and joints as follows:
 - a. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
 - b. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.
 - 2. Seal externally insulated ducts prior to insulation installation.
- T. Hanging and Supporting
 - 1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.
 - 2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.
 - a. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.
 - 3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
 - 4. Support vertical ducts at a maximum interval of 16 feet and at each floor.
 - 5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.
 - 6. Install concrete insert prior to placing concrete.
 - 7. Install powder actuated concrete fasteners after concrete is placed and completely cured.
 - 8. Provide double nuts and lock washers on threaded rod supports.

9. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- U. Connections
1. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards".

3.2 FIELD QUALITY CONTROL

- A. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.3 ADJUSTING, STARTUP AND CLEANING

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "Testing, Adjusting and Balancing for HVAC" for requirements and procedures for adjusting and balancing air systems.
- B. Vacuum duct systems prior to final acceptance to remove dust and debris.
- C. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

END OF SECTION 233113

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Turning vanes.
- B. Duct opening closure film.

1.2 SUBMITTALS

- A. Product Data: Provide for each type of ductwork accessory the following:
 - 1. Electrical characteristics.
 - 2. Connection requirements.
 - 3. Dimensions.
 - 4. Capacities.
 - 5. Pressure drops,
 - 6. Leakage rates.
 - 7. Materials of construction.
- B. Shop Drawings: Indicate for shop fabricated assemblies the following:
 - 1. Interfacing requirements with ductwork.
 - 2. Method of fastening or support.
 - 3. Methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS) “HVAC Duct Construction Standards Metal and Flexible”.
- C. NFPA Compliance:
 - 1. Comply with applicable provisions of NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems and NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems pertaining to installation of ductwork accessories.
 - 2. Comply with NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for fire-rated grease exhaust ducts.

- D. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 “Standard Test Method for Surface Burning Characteristics of Building Materials” (NFPA 255) method.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect ductwork accessories during shipping and storage from dirt, debris and moisture damage.
- B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 TURNING VANES

- A. Manufacturer:
 - 1. Aero Dyne Co.
 - 2. Anemostat Products Div.; Dynamics Corp. of America.
 - 3. Ductmate Industries.
 - 4. Duro Dyne Corp.
 - 5. Elgen Manufacturing Co., Inc.
 - 6. Hart & Cooley Mfg. Co.
 - 7. Register & Grille Mfg. Co., Inc
 - 8. Sheet Metal Connectors, Inc.
- B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.
 - 1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.
 - 2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
 - 3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

2.2 DUCT OPENING CLOSURE FILM

- A. Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
- B. Thickness: 2 mils.
- C. High tack water-based adhesive.
- D. UV stable.

- E. Elongation Before Break: 325 percent, minimum.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.
- C. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233300

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 prefix 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. The Contractor will show the materials and their relationship to one another, including sizes, shapes, locations, and connections. The Contractor 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.
 - a. A Consultant to, and an authorized representative of, the Owner, 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 “Owner”.
 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 “Owner’s Representative”.
 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.

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
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
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 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 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 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

1.7 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

1.8 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.

1.9 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

1.10 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

1.12 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

1.13 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 foundations and materials.
 - 4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
 - 5. 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.

6. Finish material will be installed under other divisions.
7. Obtain permission from the Contract Administrator for roof penetrations and channeling of floors or walls not specifically noted on the Drawings.
8. 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.
9. Locate, identify, and protect electrical 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, provide temporary services for affected areas.

PART 2 - PRODUCTS AND MATERIALS

(Not Used)

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 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. Work in common areas, shafts or other Owner owned and/or operated spaces must be reviewed and approved by the Contract Administrator and Owner prior to commencement of the work.
 - 1. Contractor shall minimize any disruption and disturbances to other tenants. All work within other tenant spaces must be coordinated with and approved by the Landlord and Owner.

3.4 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.

3.5 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. 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.
- C. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

3.6 SELECTIVE DEMOLITION

- A. Refer to Division 01 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.

3.7 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.

3.8 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.

3.9 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 Owner prior to cutting. Do not cut or disturb structural members without prior approval from the Owner and 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 Owner.

3.10 PAINTING

- A. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports; colors shall be as selected by the Contract Administrator.
- B. 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.
- C. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- D. 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.

3.11 CLEANING

- A. Refer to Division 01 and General Conditions for Cleaning requirements.

3.12 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 electrical devices, fixtures and 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.

3.13 START-UP OF SYSTEMS

- A. Prior to start-up of electrical circuits installed, 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 circuit provided within the project scope of work shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- D. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

- E. 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.

3.14 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. 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. Phase voltages and amperes at each three-phase motor.
 - 2. Test all wiring devices for electrical continuity and proper polarity of connections.
- C. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

3.15 SUBSTANTIAL COMPLETION REVIEW

- A. Refer to Division 01 and General Conditions for Substantial Completion requirements.

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. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 - 2. Sleeves and seals for electrical penetrations.
 - 3. 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.

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. Sleeve seals.
 - b. Joint sealers
 2. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

PART 2 - PRODUCTS AND MATERIALS

2.1 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.

2.2 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. [Available] Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. O-Z/Gedney
 - e. Pipeline Seal and Insulator, Inc.
3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
 - a. EPDM
 - b. NBR
 - c. Neoprene
4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
 - a. Plastic
 - b. Carbon steel
 - c. Stainless steel
 - d. PVC-coated steel
5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements. Include one for each sealing element.
 - a. Carbon steel with corrosion-resistant coating
 - b. Stainless steel

B. 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

C. FIRESTOPPING

- 1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:
 - a. Manufacturers:
 - 1) 3M Corp., Fire Barrier Sealant
 - 2) Hilti, Inc.
 - 3) Tremco, Tremstop Fyre-Sil

- 4) Pecora, AC-20 FTR
- 5) RectorSeal
- 6) Specified Technologies Inc. Firestop
- 7) USG, SHEETROCK Firecode Compound
- 8) Owens Corning Firestopping Insulation

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with NECA 1.
- C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- D. 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.
- E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- F. 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. Utilize existing pathways first before making new penetrations. Coordinate requirements with owner prior to any cutting or drilling.
- 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.
- 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. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- I. 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.
- J. Sleeve Length:
 - 1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.
- 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. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- N. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- O. 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.
- P. 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.
- Q. 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.
- R. 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.
- S. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 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.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

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.
- C. Coordinate with work described in Division 23 Section “Common Work Results for HVAC”.
- D. Coordinate with work described in Division 23 Section “Direct-Digital Control for HVAC”.
- E. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- F. Determine connection locations and rough-in requirements based on shop drawings.
- G. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- H. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 QUALITY ASSURANCE

- A. 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 Authorities Having Jurisdiction.
 - 2. 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.

1.2 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.

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 and mechanical 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. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- D. Qualification Data: For testing agency.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- F. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.
- G. 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. 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.
- D. 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.

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUCTORS AND CABLES - GENERAL

- A. 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.
- B. Aluminum conductors are not allowed.
- C. Conductor Insulation: Type THHN/THWN-2 complying with ICEA S-95-658/NEMA WC70.
- D. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).
- E. 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.
- F. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.
- G. 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.
- H. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.2 SINGLE CONDUCTORS

- A. Manufacturers:
 - 1. Alan Wire
 - 2. Cerrowire
 - 3. Colonial Wire & Cable Co., Inc.

- 4. Encore Wire Corporation
 - 5. General Cable (Prysmian Group)
 - 6. Northern Cables Inc.
 - 7. Okonite Company
 - 8. Southwire Company
- B. 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.

2.3 METAL CLAD CABLE; TYPE MC

- A. General:
 - 1. Shall not be used on this project.

2.4 VARIABLE-FREQUENCY DRIVE CABLE

- A. Manufacturers:
 - 1. Belden
 - 2. Service Wire Co.; ServiceDrive
- B. Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
 - 1. Insulation shall be thermoset types. Thermoplastic insulation types are not permitted.
 - 2. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
 - 3. Provide 100% coverage copper tape shielding.
 - 4. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.5 FLEXIBLE CORDS

- A. Manufacturers:
 - 1. Cerrowire
 - 2. Southwire

- B. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SEO or SO for indoor dry and damp locations; SEOW or SOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
- C. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJEO or SJO for indoor dry locations; SJEOW or SJOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2.6 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.

2.7 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. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.
- G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- H. 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 or 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. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
7. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
8. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
9. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
10. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
11. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
12. 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.
 - b. GFCI-protected circuits.
 - 1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
13. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
14. 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.

15. Branch circuit conductors shall be copper.
 16. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:
 - a. Wet or dry locations, in raceways:
 - 1) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW-2.
 - 2) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.
 - 3) Conductors used between a variable frequency drive (VFD) and associated motor: Type XHHW-2.
- B. Metal Clad Type MCCable:
1. Securing and Supporting:
 - a. Support per NFPA 70 for MC cable
 - b. Secure cable within 12 inches of every box or fitting.
 - c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.
 - d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.
 2. Type MC cable may only be used:
 - a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.
 - b. For vertical drops and horizontal wiring in stud walls.
 3. MC cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
 - a. Unjacketed MC:
 - 1) In locations not permitted by NFPA 70.
 - 2) When specifically not allowed by the local AHJ. .
 - 3) Where subject to physical damage.
 - 4) Corrosive or Hazardous locations.
 - 5) Wet locations.
 - 6) Branch circuits serving HVAC loads.
 - 7) Within mechanical, electrical or telecommunication equipment rooms.
 - b. PVC Jacketed MC:
 - 1) In locations not permitted by NFPA 70.

- 2) When specifically not allowed by the local AHJ.
- 3) Where subject to physical damage.
- 4) Branch circuits serving HVAC loads.
- 5) Within mechanical, electrical or telecommunication equipment rooms.

C. Variable-Frequency Drive Cable:

1. Use for conductors run between variable-frequency drive (VFD) and motor when distance exceeds 200 feet.
2. Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

D. Flexible Cords

1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.

E. 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.

F. 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.
- C. 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.
- D. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.

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 .

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. 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.
- D. 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. Cooper Power; Eaton.
 - 5. Copperweld Corp.
 - 6. ECN/Korns; Division of Robroy Industries.
 - 7. Erico; nVent.
 - 8. Harger.
 - 9. Lightning Master Corp.
 - 10. O-Z/Gedney Co.; Emerson.
 - 11. Panduit, Inc
 - 12. RACO; Hubbell, 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.

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. Cast connectors: copper base alloy according to ASTM B 30.
- D. 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:
 - 1. 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.
 - 2. 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.

3. 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. Application:
1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. 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. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
- D. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:
1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.3 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. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
1. Connecting conductors together.
 2. Connecting conductors to ground rods, except at test wells.
 3. Connecting conductors to building steel.
 4. Connecting conductors to plates.
- C. 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.
- 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.

3.4 IDENTIFICATION

- A. Provide identification as specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" and "Identification for Electrical Systems".

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or

other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
4. Inspect and test in accordance with NETA ATS, except Section 4.
5. Perform inspections and tests listed in NETA ATS, Section 7.13.
6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
7. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
8. Test Values:
 - a. The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.
 - b. Equipment Rated 500 kVA and Less: 10 ohms.
9. Minimum system neutral-to-ground insulation resistance: one megohm.
10. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.
11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements
12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.
13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.6 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.
 - 2. Construction requirements for concrete bases.

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.
 - 6.
- 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.
- C. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 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 and malleable-iron 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 or Battery-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.
- I. Wire Rope Hanging Systems:
1. Manufacturers:
 - a. Gripple.
 2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
 3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
 4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

2.2 FABRICATED METAL CONDUIT OR EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.
 1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.
 2. Equipment supports: Attachment fittings for connection to roof structure.
- C. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.
- D. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

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.
 - 2. Space supports for EMT, IMC, and RMC as required by NFPA 70.
- 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
 - b. single-bolt conduit clamps using spring friction action for retention in support channel
- 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.
- H. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Supported load shall not exceed manufacturer's recommended load rating.

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 Existing Concrete: Expansion anchor fasteners.
 - a. Instead of expansion anchors, powder or battery-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 5. 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.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- 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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.
- C. 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.
- D. Rooftop support assemblies:
1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.
 2. Equipment supports: Coordinate installation of supports with roofing material installation.

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 01 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 Tubing
 - 2. FMC: Flexible Metal Conduit
 - 3. GRS: Galvanized Rigid Steel Conduit
 - 4. IMC: Intermediate Metal Conduit
 - 5. LFMC: Liquidtight Flexible Metal Conduit
 - 6. RAC: Rigid Aluminum Conduit
 - 7. RMC: Rigid Metal 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. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

- 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.
- C. 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. Atkore
 - c. American Conduit
 - d. Anamet Electrical, Inc.
 - e. Electri-Flex Co.
 - f. Hubbell (Fittings).
 - g. Nucor Tubular Products.
 - h. O-Z/Gedney Co.; Emerson.
 - i. Southwire Company, LLC
 - j. Western Tube and Conduit Corporation.
 - k. Wheatland Tube Co.

2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - b. RAC: ANSI C80.5, UL6A.
 3. IMC: ANSI C80.6, UL 1242.
 4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.
 - a. Fittings: Set-screw 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. Metal Wireways
1. Manufacturers:
 - a. BEL Products, Inc.
 - b. Cooper B-Line; Eaton.
 - c. EPI-Electrical Enclosures
 - d. Hoffman.
 - e. Square D.
 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1, 3R, 12, or 4X.
 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
 4. Wireway Covers:
 - a. Screw-cover type
 5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

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 multi-gang 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. Junction and Pull Boxes Larger Than 100 cubic inches:
- 1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.
 - 2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.
 - 3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - 4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

2.3 FACTORY FINISHES

- A. Interior Finish: All interior components shall be factory finished; manufacturer's standard grey unless otherwise noted.
- B. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- C. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

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 or other code compliant connections on all conduit terminations and bond to the enclosure, which connects to the 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. Where masonry, brick, CMU or concrete 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.
12. Where masonry, brick, CMU or concrete walls in public spaces 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.
 - c. Attach groups of raceways to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
 - d. Attach groups of raceways 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 raceways 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 pre-fabricated 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.

B. RMC

1. Use GRS or IMC in the following areas:
 - a. Where indicated.
 - b. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
 - c. Concealed within masonry walls.
 - d. Damp or wet locations.

- e. Interior spaces where exposed to damage. Includes but is not limited to the following areas.
 - 1) Loading dock
 - 2) Corridors used for traffic of mechanized carts, forklifts and pallet handling units.
- 2. Use RAC in the following areas:
 - a. Indoors above grade.
 - b. Interior wet or damp locations.
 - c. For circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- 3. Do not use RAC:
 - a. Below grade.
 - b. Imbedded in concrete or other areas corrosive to RAC.

C. 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
- 2. Do not use EMT:
 - a. Below grade.
 - b. In exterior applications when exposed.

D. 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.

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 3R
 - a. Provide at exterior locations.
 2. NEMA 250, type 1
 - a. Provide at interior and dry locations.
 3. NEMA 250 type 4 stainless steel
 - a. Provide at interior damp or wet locations.
 - b. Provide at interior locations where associated device is labeled as Weather Proof and/or Weather Resistant, unless requirement below already requires box to be rated otherwise.
 4. NEMA 250 type 4X
 - a. Provide at interior locations subject to corrosion.
- 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 CABINETS AND ENCLOSURES:

- A. Unless otherwise indicated on the Drawings, provide
 1. NEMA 1 construction for indoor, dry locations.
 2. NEMA 12 for indoor, damp and dusty locations.
 3. NEMA 4X for indoor wet and corrosive locations.
- B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.
- C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

- D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.
- E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.
- F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.7 IDENTIFICATION

- A. Refer to Division 26 Section “Identification for Electrical Systems” for identification materials.
- B. Raceway Identification:
 - 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. Spray paint at boxes.
 - b. Snap-Around, Color-Coding Bands
 - c. Self-Adhesive Vinyl Tape
 - 2. Color for Printed Legend:
 - a. Power Circuits: Black letters on an orange field.
 - b. Legend: Indicate system or service and voltage, if applicable
- C. 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.
- D. 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.
 - 2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION 260533

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-fusible switches.
- B. Molded-case circuit breakers (MCCBs).

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 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. Detail enclosure types and details for other than NEMA 250, Type 1.
 - 2. Include general arrangement drawing showing dimensions and weights of each assembled section.
 - 3. 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.
 - 4. Detail short-circuit current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.
 - 5. Include schematic and wiring diagrams for power, signal, and control wiring.
- D. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. 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.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. 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.
- C. 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.
- D. Comply with NFPA 70.

1.5 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"

1.6 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 4. 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

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. Mount equipment plumb and rigid without distortion of enclosure.
- E. Comply with NECA 1.

- F. Where installed on either side of a VFD, provide one normally open and one normally closed auxiliary contacts interlocked with the VFD.

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. 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:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.

- 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. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 4. 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. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:
1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 3. 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.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories.

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 magnetic:

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.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.

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 01 Section "Operation and Maintenance Data," 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.

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 seven 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.

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. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 1. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 - 2. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 - 3. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts: "a" and "b" arranged to activate with MCP handle.
 - d. N.C. or N.O. alarm contact: that operates only when MCP has tripped.
 - e. Current-limiting module: to increase controller short-circuit current (withstand) rating to 100 kA.
 - 4. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with

inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

- b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- d. Auxiliary contacts: "a" and "b" arranged to activate with MCCB handle.
- e. N.C. or N.O. alarm contact: that operates only when MCCB has tripped.

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: Standard-duty, type.
 - a. Push Buttons: Unguarded types; momentary as indicated.
 - b. Pilot Lights: LED types; colors as indicated.
 - c. Selector Switches: Rotary type.
 - 2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
 - 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. Reversible N.C./N.O. auxiliary contact(s):
- C. Control Relays: Auxiliary and adjustable solid-state 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. Sun shields: installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- F. Cover gaskets: for Type 1 enclosures:
- G. Terminals for connecting power factor correction capacitors: to the load side of overload relays.
- H. Spare control wiring terminal blocks:, quantity as indicated; unwired.

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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. 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. 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. 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 Owner 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. 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.

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 Owner before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

- E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

END OF SECTION 262913