

PROJECT MANUAL

*Replace Steam, Water and Sewer
Lines, Building 3*

Maryville Treatment Center

Maryville, Missouri

Designed By: IMEG Corp
1600 Baltimore Ave, Suite 300
Kansas City, MO 64108

Date Issued: February 7, 2024

Project No.: C1921-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION
Facilities Management, Design & Construction

SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS

PROJECT NUMBER: (C1921-01)

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:

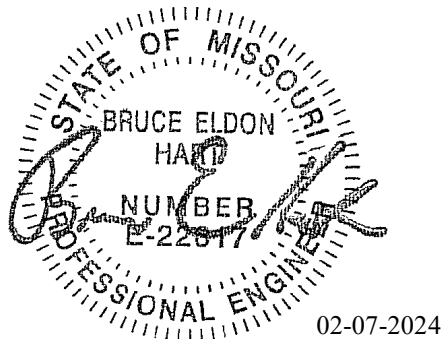


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PART 1 - GENERAL

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	Sheet G001	02/07/24	G001.dwg
2.	Site Layout Plan	Sheet C100	02/07/24	C100.dwg
3.	Main Bldg Tunnel - Abatement	Sheet ENV100	02/07/24	ENV100.dwg
4.	Main Bldg – Enlarged Abatement Plans	Sheet ENV200	02/07/24	ENV200.dwg
5.	HVAC Coversheet - Symbols and Legends	Sheet M000	02/07/24	M000.dwg
6.	HVAC Coversheet - Abbreviations and General Notes	Sheet M001	02/07/24	M001.dwg
7.	Boiler Bldg – Lower Level - Mechanical Demolition	Sheet M100	02/07/24	M100.dwg
8.	Boiler Bldg – Upper Level - Mechanical Demolition	Sheet M101	02/07/24	M101.dwg
9.	Main Bldg – Tunnel Level - Mechanical Demolition	Sheet M109	02/07/24	M109.dwg
10.	Boiler Bldg – Lower Level - Mechanical	Sheet M200	02/07/24	M200.dwg
11.	Boiler Bldg – Upper Level - Mechanical	Sheet M201	02/07/24	M201.dwg
12.	Main Bldg – Tunnel Level - Mechanical	Sheet M209	02/07/24	M209.dwg
13.	Main Bldg – Basement Level - Mechanical	Sheet M210	02/07/24	M210.dwg

14.	Main Bldg – Level 01 – Mechanical	Sheet M211	02/07/24	M211.dwg
15.	Main Bldg – Level 02 - Mechanical	Sheet M212	02/07/24	M212.dwg
16.	Main Bldg – Level 03 - Mechanical	Sheet M213	02/07/24	M213.dwg
17.	Main Bldg – Basement Level Temp Controls	Sheet M220	02/07/24	M220.dwg
18.	Main Bldg – Level 01 - Temperature Controls	Sheet M221	02/07/24	M221.dwg
19.	Main Bldg – Level 02 - Temperature Controls	Sheet M222	02/07/24	M222.dwg
20.	Main Bldg – Level 03 - Temperature Controls	Sheet M223	02/07/24	M223.dwg
21.	Mechanical Details	Sheet M400	02/07/24	M400.dwg
22.	Mechanical Details	Sheet M401	02/07/24	M401.dwg
23.	Mechanical Diagrams	Sheet M500	02/07/24	M500.dwg
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25.	Mechanical Control Diagrams	Sheet M520	02/07/24	M520.dwg
26.	Mechanical Control Diagrams	Sheet M521	02/07/24	M521.dwg
27.	Mechanical Control Diagrams	Sheet M522	02/07/24	M522.dwg
28.	Mechanical Schedules	Sheet M600	02/07/24	M600.dwg
29.	Mechanical Schedules	Sheet M601	02/07/24	M601.dwg
30.	Plumbing Coversheet	Sheet P000	02/07/24	P000.dwg
31.	Boiler Bldg – Lower Level - Plumbing Demolition	Sheet P100	02/07/24	P100.dwg
32.	Boiler Bldg – Upper Level - Plumbing Demolition	Sheet P101	02/07/24	P101.dwg
33.	Main Bldg – Tunnel Level - Plumbing Demolition	Sheet P109	02/07/24	P109.dwg
34.	Boiler Bldg – Lower Level - Plumbing	Sheet P200	02/07/24	P200.dwg
35.	Boiler Bldg – Upper Level - Plumbing	Sheet P201	02/07/24	P201.dwg
36.	Main Bldg – Tunnel Level - Plumbing	Sheet P209	02/07/24	P209.dwg
37.	Main Bldg – Basement Level - Plumbing	Sheet P210	02/07/24	P210.dwg
38.	Main Bldg – Level 01 – Plumbing	Sheet P211	02/07/24	P211.dwg
39.	Main Bldg – Level 02 – Plumbing	Sheet P212	02/07/24	P212.dwg
40.	Main Bldg – Level 03 – Plumbing	Sheet P213	02/07/24	P213.dwg

41.	Main Bldg – Enlarged Plumbing Plans	Sheet P311	02/07/24	P311.dwg
42.	Main Bldg – Enlarged Plumbing Plans	Sheet P312	02/07/24	P312.dwg
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44.	Electrical Coversheet	Sheet E001	02/07/24	E001.dwg
45.	Boiler Bldg – Lower Level - Electrical Demolition	Sheet E100	02/07/24	E100.dwg
46.	Boiler Bldg – Lower Level - Electrical	Sheet E200	02/07/24	E200.dwg
47.	Boiler Bldg – Upper Level - Electrical	Sheet E201	02/07/24	E201.dwg
48.	Main Bldg – Tunnel Level - Electrical	Sheet E209	02/07/24	E209.dwg
49.	Main Bldg – Basement Level - Electrical	Sheet E210	02/07/24	E210.dwg
50.	Main Bldg – Level 01 – Electrical	Sheet E211	02/07/24	E211.dwg
51.	Main Bldg – Level 02 – Electrical	Sheet E212	02/07/24	E212.dwg
52.	Main Bldg – Level 03 – Electrical	Sheet E213	02/07/24	E213.dwg
53.	Electrical Details	Sheet E400	02/07/24	E400.dwg
54.	Riser Diagram	Sheet E500	02/07/24	E500.dwg
55.	Panel Schedules	Sheet E600	02/07/24	E600.dwg
56.	Panel Schedules	Sheet E601	02/07/24	E601.dwg
57.	Panel Schedules	Sheet E602	02/07/24	E602.dwg

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. Replace Steam, Water and Sewer Lines, Building 3
Maryville Treatment Center
Maryville, Missouri
Project No.: C1921-01

3.0 BIDS WILL BE RECEIVED:

- A. Until: 1:30 PM, April 2, 2024
- B. **Only electronic bids on MissouriBUYS shall be accepted: <https://missouribuys.mo.gov>. Bidder must be registered to bid.**

4.0 DESCRIPTION:

- A. Scope: The project includes hazardous material abatement in tunnels and plumbing chases; replacement of domestic water and/or sanitary waste & vent piping mains in main plumbing chases and tunnels; replacement of the old steam heating system throughout the buildings with a new 2-pipe hydronic system; replacement of main plumbing equipment; and electrical upgrades as required to accommodate the new mechanical & plumbing equipment
- B. MBE/WBE/SDVE Goals: MBE 10%, WBE 10%, and SDVE 3%. **NOTE: Only MBE/WBE firms certified by the State of Missouri Office of Equal Opportunity as of the date of bid opening, or SDVE(s) meeting the requirements of Section 34.074, RSMo and 1 CSR 30-5.010, can be used to satisfy the MBE/WBE/SDVE participation goals for this project.**
- C. ****NOTE:** Bidders are provided new Good Faith Effort (GFE) forms on MissouriBUYS.

5.0 PRE-BID MEETING:

- A. Place/Time: 10:30 AM, March, 19, 2024, at Maryville Treatment Center, 30227 US HWY 136, Maryville, MO, 64468
- 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: IMEG Corp, Matthew Lee, 816-842-8437, email: Matthew.j.lee@imegcorp.com
- B. Project Manager: Christopher Lloyd, 573-526-0160, email: Christopher.Lloyd@oa.mo.gov

8.0 GENERAL INFORMATION:

- A. The State reserves the right to reject any and all bids and to waive all informalities in bids. No bid may be withdrawn for a period of 20 working days subsequent to the specified bid opening time. The contractor shall pay not less than the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed, as determined by the Missouri Department of Labor and Industrial Relations and as set out in the detailed plans and specifications.
- B. Bid results will be available at <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans> after it is verified that at least one bid is awardable and affordable.

Very Important MissouriBUYS Instructions to Help Submit a Bid Correctly

- A. The bidder shall submit his or her bid and all supporting documentation on MissouriBUYS eProcurement System. No hard copy bids shall be accepted. Go to <https://missouribuys.mo.gov> and register. The bidder must register and complete a profile fully with all required documents submitted prior to submitting a bid.
- B. Once registered, log in.
1. Under "Solicitation" select "View Current Solicitations."
 2. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8", then click "Filter Solicitation" button.
 3. Select "Active Solicitations" tab.
 4. To see the Solicitation Summary, click on the Project Number and the summary will open. Click each heading to open detailed information.
- C. Here are simplified instructions for uploading the bid to MissouriBUYS:
1. Find the solicitation by completing Steps 1 through 4 above.
 2. Select the three dots under "Actions." Select "Add New Response."
 3. When the Quote box opens, give the response a title and select "OK."
 4. The detailed solicitation will open. Select "Check All" for the Original Solicitation Documents, open each document, and select "Accept." If this step is not completed, a bid cannot be uploaded. Scroll to the bottom of the page and select "Add Attachments." If you do not see this command, not all documents have been opened and accepted.
 5. The Supplier Attachments box will open. Select "Add Attachment" again.
 6. The Upload Documents box will open. Read the instructions for uploading. Disregard the "Confidential" check box.
 7. Browse and attach up to 5 files at a time. Scroll to bottom of box and select "Upload." The Supplier Attachments box will open. Repeat Steps 5 through 7 if more than 5 files are to be uploaded.
 8. When the Supplier Attachments box opens again and uploading is complete, select "Done." A message should appear that the upload is successful. If it does not, go to the Bidder Response tab and select "Submit."
 9. The detailed solicitation will open. At the bottom select "Close."
- D. Any time a bidder wants to modify the bid, he or she will have to submit a new one. FMDC will open the last response the bidder submits. The bidder may revise and submit the bid up to the close of the solicitation (bid date and time). Be sure to allow for uploading time so that the bid is successfully uploaded prior to the 1:30 PM deadline; we can only accept the bid if it is uploaded before the deadline.
- E. If you want to verify that you are uploading documents correctly, please contact Paul Girouard: 573-751-4797, paul.girouard@oa.mo.gov ; April Howser: 573-751-0053, April.Howser@oa.mo.gov ; or Mandy Roberson: 573-522-0074, Mandy.Roberson@oa.mo.gov.
- F. If you are experiencing login issues, please contact Web Procure Support (Proactis) at 866-889-8533 anytime from 7:00 AM to 7:00 PM Central Time, Monday through Friday. If you try using a userid or password several times that is incorrect, the system will lock you out. Web Procure Support is the only option to unlock you! If you forget your userid or password, Web Procure Support will provide a temporary userid or password. Also, if it has been a while since your last successful login and you receive an "inactive" message, contact Web Procure (Proactis). If you are having a registration issue, you may contact Cathy Holliday at 573-751-3491 or by email: cathy.holliday@oa.mo.gov.

IMPORTANT REMINDER REGARDING REQUIREMENT FOR OEO CERTIFICATION

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

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

SECTION 002113 – INSTRUCTIONS TO BIDDERS

1.0 - SPECIAL NOTICE TO BIDDERS

- A. If awarded a contract, the Bidder's employees, and the employees of all subcontractors, who perform the work on the project must adhere to requirements in Section 013513 – Site Security and Health Requirements as applicable per Agency.
- B. The Bidder's prices shall include all city, state, and federal sales, excise, and similar taxes that may lawfully be assessed in connection with the performance of work, and the purchased of materials to be incorporated in the work. THIS PROJECT IS NOT TAX EXEMPT.

2.0 - BID DOCUMENTS

- A. The number of sets obtainable by any one (1) party may be limited in accordance with available supply.
- B. For the convenience of contractors, sub-contractors and suppliers, copies of construction documents are on file at the office of the Director, Division of Facilities Management, Design and Construction and on the Division's web site - <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans>.

3.0 - BIDDERS' OBLIGATIONS

- A. Bidders must carefully examine the entire site of the work and shall make all reasonable and necessary investigations to inform themselves thoroughly as to the facilities available as well as to all the difficulties involved in the completion of all work in accordance with the specifications and the plans. Bidders are also required to examine all maps, plans and data mentioned in the specifications. No plea of ignorance concerning observable existing conditions or difficulties that may be encountered in the execution of the work under this contract will be accepted as an excuse for any failure or omission on the part of the contractor to fulfill in every detail all of the requirements of the contract, nor accepted as a basis for any claims for extra compensation.
- B. Under no circumstances will contractors give their plans and specifications to another contractor. Any bid received from a contractor whose name does not appear on the list of plan holders may be subject to rejection.

4.0 - INTERPRETATIONS

- A. No bidder shall be entitled to rely on oral interpretations as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction. Every request for interpretation shall be made in writing and submitted with all supporting documents not less than five (5) working days before opening of bids. Every interpretation made to a bidder will be in the form of an addendum and will be sent as promptly as is practicable to all persons to whom plans and specifications have been issued. All such addenda shall become part of the contract documents.
- B. Approval for an "acceptable substitution" issued in the form of an addendum as per Paragraph 4A above, and as per Article 3.1 of the General Conditions; ACCEPTABLE SUBSTITUTIONS shall constitute approval for use in the project of the product.
- C. An "acceptable substitution" requested after the award of bid shall be approved if proven to the satisfaction of the Owner and the Designer as per Article 3.1, that the product is acceptable in design, strength, durability, usefulness, and convenience for the purpose intended. Approval of the substitution after award is at the sole discretion of the Owner.
- D. A request for "Acceptable Substitutions" shall be made on the Section 006325 Substitution Request Form. The request shall be sent directly to the project Designer. A copy of said request should also be mailed to the Owner, Division of Facilities Management, Design and Construction, Post Office Box 809, Jefferson City, Missouri 65102.

5.0 - BIDS AND BIDDING PROCEDURE

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

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

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

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

- B. All bids shall be submitted without additional terms and conditions, modification or reservation on the bid forms with each space properly filled. Bids not on these forms will be rejected.
- C. All bids shall be accompanied by a bid bond executed by the bidder and a duly authorized surety company, certified check, cashier's check or bank draft made payable to the Division of Facilities Management, Design and Construction, State of Missouri, in the amount indicated on the bid form, Section 004113. Failure of the contractor to submit the full amount required shall be sufficient cause to reject his bid. The bidder agrees that the proceeds of the check, draft or bond shall become the property of the State of Missouri, if for any reason the bidder withdraws his bid after closing, or if on notification of award refuses or is unable to execute tendered contract, provide an acceptable performance and payment bond, provide evidence of required insurance coverage and/or provide required copies of affirmative action plans within ten (10) working days after such tender.
- D. The check or draft submitted by the successful bidder will be returned after the receipt of an acceptable performance and payment bond and execution of the formal contract. Checks or drafts of all other bidders will be returned within a reasonable time after it is determined that the bid represented by same will receive no further consideration by the State of Missouri. Bid bonds will only be returned upon request.

6.0 - SIGNING OF BIDS

- A. A bid from an individual shall be signed as noted on the Bid Form.
- B. A bid from a partnership or joint venture shall require only one signature of a partner, an officer of the joint venture authorized to bind the venture or an attorney-in-fact. If the bid is signed by an officer of a joint venture or an attorney-in-fact, a document evidencing the individual's authority to execute contracts should be included with the bid form.
- C. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.
- D. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual. Corporate license number shall be provided and, if a corporation organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached. In addition, for corporate proposals, the President or Vice-President should sign as the bidder. If the signator is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signator has the legal authority to bind the corporation.

- E. A bid should contain the full and correct legal name of the Bidder. If the Bidder is an entity registered with the Missouri Secretary of State, the Bidder's name on the bid form should appear as shown in the Secretary of State's records.
- F. The Bidder should include its corporate license number on the Bid Form and, if the corporation is organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached to the bid form.

7.0 - RECEIVING BID SUBMITTALS

- A. It is the bidder's sole responsibility to assure receipt by Owner of bid submittals by the date and time specified in the Invitation for Bid. Bids received after the date and time specified shall not be considered by the Owner.
- B. Bids must be submitted through the MissouriBUYS statewide eProcurement system (<https://www.missouribuys.mo.gov/>) in accordance with the instructions for that system. The Owner shall only accept bids submitted through MissouriBUYS. Bids received by the Owner through any other means, including hard copies, shall not be considered and will be discarded by the Owner unopened.
- C. To respond to an Invitation for Bid, the Bidder must first register with MissouriBUYS by going through the MissouriBUYS Home Page (<https://www.missouribuys.mo.gov/>), clicking the "Register" button at the top of the page, and completing the Vendor Registration. Once registered, the Bidder accesses its account by clicking the "Login" button at the top of the MissouriBUYS Home Page. Enter your USERID and PASSWORD, which the Bidder will select. Under Solicitations, select "View Current Solicitations." A new screen will open. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8." Under "Filter by Opp. No." type in the State Project Number. Select "Submit." Above the dark blue bar, select "Other Active Opportunities." To see the Solicitation Summary, single click the Opp. No. (Project Number) and the summary will open. Single quick click each blue bar to open detailed information. The Bidder must read and accept the Original Solicitation Documents and complete all identified requirements. The Bidder should download and save all of the Original Solicitation Documents on its computer so that the Bidder can prepare its response to these documents. The Bidder should upload its completed response to the downloaded documents as an attachment to the electronic solicitation response.
- D. Step-by-step instructions for how a registered vendor responds to a solicitation electronically are provided in Section 001116 – Invitation For Bid.
- E. The Bidder shall submit its bid on the forms provided by the Owner on MissouriBUYS with each space fully and properly completed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner may reject bids that are not on the Owner's forms or that do not contain all requested information.
- F. No Contractor shall stipulate in his bid any conditions not contained in the specifications or standard bid form contained in the contract documents. To do so may subject the Contractor's bid to rejection.
- G. The completed forms shall be without interlineations, alterations or erasures.

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

- A. Bidder may withdraw his bid at any time prior to scheduled closing time for receipt of bids, but no bidder may withdraw his bid for a period of twenty (20) working days after the scheduled closing time for receipt of bids.
- B. The Bidder shall modify his or her original bid by submitting a revised bid on MissouriBUYS.

9.0 - AWARD OF CONTRACT

- A. The Owner reserves the right to reject any and/or all bids and further to waive all informalities in bidding when deemed in the best interest of the State of Missouri.
- B. The Owner reserves the right to let other contracts in connection with the work, including but not by way of limitation, contracts for the furnishing and installation of furniture, equipment, machines, appliances and other apparatus.

- C. The Owner shall award a contract to the lowest, responsive, responsible Bidder in accordance with Section 8.250, RSMo. No contract will be awarded to any Bidder who has had a contract with the Owner terminated within the preceding twelve months for material breach of contract or who has been suspended or debarred by the Owner.
- D. Award of alternates, if any, will be made in numerical order unless all bids received are such that the order of acceptance of alternates does not affect the determination of the lowest, responsive, responsible bidder.
- E. No bid shall be considered binding upon the Owner until the written contract has been properly executed, a satisfactory bond has been furnished, evidence of required insurance coverage, submittal of executed Section 004541, Affidavit of Work Authorization form, documentation evidencing enrollment and participation in a federal work authorization program has been received and an affirmative action plan submitted. Failure to execute and return the contract and associated documents within the prescribed period of time shall be treated, at the option of the Owner, as a breach of bidder's obligation and the Owner shall be under no further obligation to bidder.
- F. If the successful bidder is doing business in the State of Missouri under a fictitious name, he shall furnish to Owner, attached to the Bid Form, a properly certified copy of the certificate of Registration of Fictitious Name from the State of Missouri, and such certificate shall remain on file with the Owner.
- G. Any successful bidder which is a corporation organized in a state other than Missouri shall furnish to the Owner, attached to the Bid Form, a properly certified copy of its current Certificate of Authority to do business in the State of Missouri, such certificate to remain on file with the Owner. No contract will be awarded by the Owner unless such certificate is furnished by the bidder.
- H. Any successful bidder which is a corporation organized in the State of Missouri shall furnish at its own cost to the Owner, if requested, a Certificate of Good Standing issued by the Secretary of State, such certificate to remain on file with the Owner.
- I. Transient employers subject to Sections 285.230 and 285.234, RSMo, (out-of-state employers who temporarily transact any business in the State of Missouri) may be required to file a bond with the Missouri Department of Revenue. No contract will be awarded by the Owner unless the successful bidder certifies that he has complied with all applicable provisions of Section 285.230-234.
- J. Sections 285.525 and 285.530, RSMo, require business entities to enroll and participate in a federal work authorization program in order to be eligible to receive award of any state contract in excess of \$5,000. Bidders should submit with their bid an Affidavit of Work Authorization (Section 004541) along with appropriate documentation evidencing such enrollment and participation. Section-004541, Affidavit of Work Authorization is located on the MissouriBUYS solicitation for this project. Bidders must also submit an E-Verify Memorandum before the Owner may award a contract to the Bidder. Information regarding an E-Verify is located at <https://www.uscis.gov/e-verify/>. The contractor shall be responsible for ensuring that all subcontractors and suppliers associated with this contract enroll in E-Verify.

10.0 - CONTRACT SECURITY

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

11.0 - LIST OF SUBCONTRACTORS

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

12.0 - WORKING DAYS

- A. Contract duration time is stated in working days and will use the following definition in determining the actual calendar date for contract completion:
 - 1. Working days are defined as all calendar days except Saturdays, Sundays and the following State of Missouri observed holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday, Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day.

13.0 - AMERICAN AND MISSOURI - MADE PRODUCTS AND FIRMS

- A. By signing the bid form and submitting a bid on this project, the Bidder certifies that it will use American and Missouri products as set forth in Article 1.7 of the General Conditions. Bidders are advised to review those requirements carefully prior to bidding.
- B. A preference shall be given to Missouri firms, corporations or individuals, or firms, corporations or individuals that maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less.
- C. Pursuant to Section 34.076, RSMo, a contractor or Bidder domiciled outside the boundaries of the State of Missouri shall be required, in order to be successful, to submit a bid the same percent less than the lowest bid submitted by a responsible contractor or Bidder domiciled in Missouri as would be required for such a Missouri domiciled contractor or Bidder to succeed over the bidding contractor or Bidder domiciled outside Missouri on a like contract or bid being let in the person's domiciliary state and, further, the contractor or Bidder domiciled outside the boundaries of Missouri shall be required to submit an audited financial statement as would be required of a Missouri domiciled contractor or Bidder on a like contract or bid being let in the domiciliary state of that contractor or Bidder.

14.0 – ANTI-DISCRIMINATION AGAINST ISRAEL ACT CERTIFICATION:

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

15.0 - MBE/WBE/SDVE INSTRUCTIONS

- A. Definitions:
 - 1. “**MBE**” means a Minority Business Enterprise.
 - 2. “**MINORITY**” has the same meaning as set forth in 1 C.S.R. 10-17.010.
 - 3. “**MINORITY BUSINESS ENTERPRISE**” has the same meaning as set forth in section 37.020, RSMo.
 - 4. “**WBE**” means a Women’s Business Enterprise.
 - 5. “**WOMEN’S BUSINESS ENTERPRISE**” has the same meaning as set forth in section 37.020, RSMo.
 - 6. “**SDVE**” means a Service-Disabled Veterans Enterprise.
 - 7. “**SERVICE-DISABLED VETERAN**” has the same meaning as set forth in section 34.074, RSMo.
 - 8. “**SERVICE-DISABLED VETERAN ENTERPRISE**” has the same meaning as “Service-Disabled Veteran Business” set forth in section 34.074, RSMo.

B. MBE/WBE/SDVE General Requirements:

1. For all bids greater than \$100,000, the Bidder shall obtain MBE, WBE and SDVE participation in an amount equal to or greater than the percentage goals set forth in the Invitation for Bid and the Bid Form, unless the Bidder is granted a Good Faith Effort waiver by the Director of the Division, as set forth below. If the Bidder does not meet the MBE, WBE and SDVE goals, or make a good faith effort to do so, the Bidder shall be non-responsive, and its bid shall be rejected.
2. The Bidder should submit with its bid all of the information requested in the MBE/WBE/SDVE Compliance Evaluation Form for every MBE, WBE, or SDVE subcontractor or material supplier the Bidder intends to use for the contract work. The Bidder is required to submit all appropriate MBE/WBE/SDVE documentation before the stated time and date set forth in the Invitation for Bid. If the Bidder fails to provide such information by the specified date and time, the Owner shall reject the bid.
3. The Director reserves the right to request additional information from a Bidder to clarify the Bidder's proposed MBE, WBE, and/or SDVE participation. The Bidder shall submit the clarifying information requested by the Owner within two (2) Working Days of receiving the request for clarification.
4. Pursuant to section 34.074, RSMo, a Bidder that is a SDVE doing business as Missouri firm, corporation, or individual, or that maintains a Missouri office or place of business, shall receive a three-point bonus preference in the contract award evaluation process. The bonus preference will be calculated and applied by reducing the bid amount of the eligible SDVE by three percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible SDVE's evaluation is less than the apparent low responsive bidder's bid, the eligible SDVE's bid becomes the apparent low responsive bid. This reduction is for evaluation purposes only, and will have no impact on the actual amount(s) of the bid or the amount(s) of any contract awarded. In order to be eligible for the SDVE preference, the Bidder must complete and submit with its bid the Missouri Service Disabled Veteran Business Form, and any information required by the form. The form is available on the MissouriBUYS solicitation for this project.

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

1. A Bidder who is a MBE, WBE, or SDVE may count 100% of the contract towards the MBE, WBE or SDVE goal, less any amounts awarded to another MBE, WBE or SDVE. (NOTE: A MBE firm that bids as general contractor must obtain WBE and SDVE participation; a WBE firm that bids as a general contractor must obtain MBE and SDVE participation; and a SDVE firm that bids as general contractor must obtain MBE and WBE participation.) In order for the remaining contract amount to be counted towards the MBE, WBE or SDVE goal, the Bidder must complete the MBE/WBE/SDVE Compliance Evaluation Form (Section 004337) identifying itself as an MBE, WBE or SDVE.
2. The total dollar value of the work granted to a certified MBE, WBE or SDVE by the Bidder shall be counted towards the applicable goal.
3. Expenditures for materials and supplies obtained from a certified MBE, WBE, or SDVE supplier or manufacturer may be counted towards the MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE assumes the actual and contractual responsibility for the provision of the materials and supplies.
4. The total dollar value of the work granted to a second or subsequent tier subcontractor or a supplier may be counted towards a Bidder's MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE properly assumes the actual and contractual responsibility for the work.
5. The total dollar value of work granted to a certified joint venture equal to the percentage of the ownership and control of the MBE, WBE, or SDVE partner in the joint venture may be counted towards the MBE/WBE/SDVE goals.
6. Only expenditures to a MBE, WBE, or SDVE that performs a commercially useful function in the work may be counted towards the MBE, WBE and SDVE goals. A MBE, WBE, or SDVE performs a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by actually performing, managing and supervising the work or providing supplies or manufactured materials.

D. Certification of MBE/WBE/SDVE Subcontractors:

1. In order to be counted towards the goals, an MBE or WBE must be certified by the State of Missouri Office of Equal Opportunity and an SDVE must be certified by the State of Missouri, Office of Administration, Division of Purchasing and Material Management or by the Department of Veterans Affairs.
2. The Bidder may determine the certification status of a proposed MBE or WBE subcontractor or supplier by referring to the Office of Equal Opportunity (OEO)'s online MBE/WBE directory (<https://apps1.mo.gov/MWBCertifiedFirms/>). The Bidder may determine the eligibility of a SDVE subcontractor or supplier by referring to the Division of Purchasing and Materials Management's online SDVE directory (<https://oa.mo.gov/sites/default/files/sdvelisting.pdf>) or the Department of Veterans Affairs' directory (<https://vetbiz.va.gov/basic-search/>).
3. Additional information, clarifications, etc., regarding the listings in the directories may be obtained by calling the Division at (573)751-3339 and asking to speak to the Contract Specialist of record as shown in the Supplementary Conditions (Section 007300).

E. Waiver of MBE/WBE/SDVE Participation:

1. If a Bidder has made a good faith effort to secure the required MBE, WBE and/or SDVE participation and has failed, the Bidder shall submit with its bid the information requested in MBE/WBE/SDVE Good Faith Effort (GFE) Determination form. The GFE forms are located on the MissouriBUYS solicitation for this project. The Director will determine if the Bidder made a good faith effort to meet the applicable goals. If the Director determines that the Bidder did not make a good faith effort, the bid shall be rejected as being nonresponsive to the bid requirements. Bidders who demonstrate that they have made a good faith effort to include MBE, WBE, and/or SDVE participation will be determined to be responsive to the applicable participation goals, regardless of the percent of actual participation obtained, if the bid is otherwise acceptable.
2. In determining whether a Bidder has made a good faith effort to obtain MBE, WBE and/or SDVE participation, the Director may evaluate the factors set forth in 1 CSR 30-5.010(6)(C) and the following:
 - a. The amount of actual participation obtained;
 - b. How and when the Bidder contacted potential MBE, WBE, and SDVE subcontractors and suppliers;
 - c. The documentation provided by the Bidder to support its contacts, including whether the Bidder provided the names, addresses, phone numbers, and dates of contact for MBE/WBE/SDVE firms contacted for specific categories of work;
 - d. If project information, including plans and specifications, were provided to MBE/WBE/SDVE subcontractors;
 - e. Whether the Bidder made any attempts to follow-up with MBE, WBE or SDVE firms prior to bid;
 - f. Amount of bids received from any of the subcontractors and/or suppliers that the Bidder contacted;
 - g. The Bidder's stated reasons for rejecting any bids;
3. If no bidder has obtained any participation in a particular category (MBE/WBE/SDVE) or made a good faith effort to do so, the Director may waive that goal rather than rebid.

F. Contractor MBE/WBE/SDVE Obligations

1. If awarded a contract, the Bidder will be contractually required to subcontract with or obtain materials from the MBE, WBE, and SDVE firms listed in its bid, in amounts equal to or greater than the dollar amount bid, unless the amount is modified in writing by the Owner.
2. If the Contractor fails to meet or maintain the participation requirements contained in the Contractor's bid, the Contractor must satisfactorily explain to the Director why it cannot comply with the requirement and why failing meeting the requirement was beyond the Contractor's control. If the Director finds the Contractor's explanation unsatisfactory, the Director may take any appropriate action including, but not limited to:
 - a. Declaring the Contractor ineligible to participate in any contracts with the Division for up to twelve (12) months (suspension); and/or
 - b. Declaring the Contractor be non-responsive to the Invitation for Bid, or in breach of contract and rejecting the bid or terminating the contract.
3. If the Contractor replaces an MBE, WBE, or SDVE during the course of this contract, the Contractor shall replace it with another MBE, WBE, or SDVE or make a good faith effort to do so. All MBE, WBE and SDVE substitutions must be approved by the Director.
4. The Contractor shall provide the Owner with regular reports on its progress in meeting its MBE/WBE/SDVE obligations. At a minimum, the Contractor shall report the dollar-value of work completed by each MBE, WBE, or SDVE during the preceding month and the cumulative total of work completed by each MBE, WBE or SDVE to date with each monthly application for payment. The Contractor shall also make a final report, which shall include the total dollar-value of work completed by each MBE, WBE, and SDVE during the entire contract.

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

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

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

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

<https://o eo.mo.gov/sdve-certification-program/>

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



State of Missouri Construction Contract

THIS AGREEMENT is made (DATE) by and between:

Contractor Name and Address

hereinafter called the "Contractor,"

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

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

ARTICLE 1. STATEMENT OF WORK

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

Project Name: **Replace Steam, Water and Sewer Lines, Building 3
Maryville Treatment Center
Maryville, Missouri**

Project Number: **C1921-01**

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 **360 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: \$
Alternate No. 1: \$
Alternate No. 2: \$

TOTAL CONTRACT AMOUNT: (\$CONTRACT AMOUNT)

UNIT PRICES: The Owner accepts the following Unit Prices:

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

ARTICLE 5. PREVAILING WAGE RATE

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

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

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

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

Total \$

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

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

ARTICLE 7. CONTRACT DOCUMENTS

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

1. Division 0 – Procurement and Contracting Information, including, but not limited to:
 - a. Invitation for Bid (Section 001116)
 - b. Instructions to Bidders (Section 002113)
 - c. Supplementary Instructions to Bidders (if applicable) (Section 002213)
 - d. The following documents as completed and executed by the Contractor and accepted by the Owner, if applicable:
 - i. Bid Form (Section 004113)
 - ii. Unit Prices (Section 004322)
 - iii. Proposed Contractors Form (Section 004336)
 - iv. MBE, WBE, SDVE Compliance Evaluation Form(s) (Section 004337)
 - v. MBE, WBE, SDVE Eligibility Determination Form for Joint Ventures (Section 004338)
 - vi. MBE, WBE, SDVE Good Faith Effort (GFE) Determination Form (Section 004339)
 - vii. Missouri Service Disabled Veteran Business Form (Section 004340)
 - viii. Affidavit of Work Authorization (Section 004541)
 - ix. Affidavit for Affirmative Action (Section 005414)
 - e. Performance and Payment Bond, completed and executed by the Contractor and surety (Section 006113)
 - f. General Conditions (Section 007213)
 - g. Supplementary Conditions (Section 007300)
 - h. Supplementary General Conditions for Federally Funded/Assisted Construction Projects (Section 007333)
 - i. Wage Rate(s) (Section 007346)
2. Division 1 – General Requirements
3. All Drawings identified in the Project Manual
4. All Technical Specifications included in the Project Manual
5. Addenda, if applicable

ARTICLE 8 – CERTIFICATION

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

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

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

APPROVED:

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

Contractor's Authorized Signature

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

Corporate Secretary



STATE OF MISSOURI
 OFFICE OF ADMINISTRATION
 DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION
AFFIDAVIT FOR AFFIRMATIVE ACTION

PROJECT NUMBER

NAME

First being duly sworn on oath states: that

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

NAME

a sole proprietorship partnership
 limited liability company (LLC)

or corporation, and as such, said proprietor, partner, or officer is duly authorized to make this

affidavit on behalf of said sole proprietorship, partnership, or corporation; that under the contract known as

PROJECT TITLE

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

PRINT NAME & SIGNATURE

DATE

--

NOTARY INFORMATION

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

SECTION 006113 - PERFORMANCE AND PAYMENT BOND FORM

KNOW ALL MEN BY THESE PRESENTS, THAT we _____

as principal, and _____

_____ as Surety, are held and firmly bound unto the

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

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

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

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

(Insert Project Title and Number)

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

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

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

AS APPLICABLE:

AN INDIVIDUAL

Name: _____

Signature: _____

A PARTNERSHIP

Name of Partner: _____

Signature of Partner: _____

Name of Partner: _____

Signature of Partner: _____

CORPORATION

Firm Name: _____

Signature of President: _____

SURETY

Surety Name: _____

Attorney-in-Fact: _____

Address of Attorney-in-Fact: _____

Telephone Number of Attorney-in-Fact: _____

Signature Attorney-in-Fact: _____

NOTE: Surety shall attach Power of Attorney



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

PROJECT NUMBER

PROJECT TITLE AND LOCATION

CHECK APPROPRIATE BOX

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

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

FROM: BIDDER/CONTRACTOR (PRINT COMPANY NAME)

TO: ARCHITECT/ENGINEER (PRINT COMPANY NAME)

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

SPECIFIED PRODUCT OR SYSTEM

SPECIFICATION SECTION NO.

SUPPORTING DATA

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

Sample Sample will be sent, if requested

QUALITY COMPARISON

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

PREVIOUS INSTALLATIONS

PROJECT	ARCHITECT/ENGINEER
LOCATION	DATE INSTALLED

SIGNIFICANT VARIATIONS FROM SPECIFIED PRODUCT

REASON FOR SUBSTITUTION

DOES PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK?

YES NO

IF YES, EXPLAIN

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

YES NO

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

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

BIDDER/CONTRACTOR

DATE

REVIEW AND ACTION

Resubmit Substitution Request with the following additional information:

Substitution is accepted.

Substitution is accepted with the following comments:

Substitution is not accepted.

ARCHITECT/ENGINEER

DATE



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	\$	\$	

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

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- 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, tool, 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, and in the best manner known to each respective trade.
15. **"WORKING DAYS"**: are all calendar days except Saturdays, Sundays and the following holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday (observed), Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day (observed), Thanksgiving Day, Christmas Day.

ARTICLE 1.2 DRAWINGS AND SPECIFICATIONS

- A. In case of discrepancy between drawings and specifications, specifications shall govern. Should discrepancies in architectural drawings, structural drawings and mechanical drawings occur, architectural drawings shall govern and, in case of conflict between structural and mechanical drawings, structural drawings shall govern.
- B. Specifications are separated into titled divisions for convenience of reference only and to facilitate letting of contracts and subcontracts. The Contractor is responsible for establishing the scope of work for subcontractors, which may cross titled divisions. Neither the Owner nor Designer will establish limits and jurisdiction of subcontracts.
- C. Figured dimensions take precedence over scaled measurements and details over smaller scale general drawings. In the event of conflict between any of the documents contained within the contract, the documents shall take precedence and be controlling in the following sequence: addenda, supplementary general conditions, general conditions, division 1 specifications, technical division specifications, drawings, bid form and instructions to bidders.
- D. Anything shown on drawings and not mentioned in these specifications or vice versa, as well as any incidental work which is obviously necessary to complete the project within the limits established by the drawings and specifications, although not shown on or described therein, shall be performed by the Contractor at no additional cost as a part of his contract.
- E. Upon encountering conditions differing materially from those indicated in the contract documents, the Contractor shall promptly notify the Designer and Construction Representative in writing before such conditions are disturbed. The Designer shall promptly investigate said conditions and report to the Owner, with a recommended course of action. If conditions do materially differ and cause an increase or decrease in contract cost or time required for completion of any portion of the work, a contract change will be initiated as outlined in Article 4 of these General Conditions.
- E. Only work included in the contract documents is authorized, and the Contractor shall do no work other than that described therein or in accordance with appropriately authorized and approved contract changes.

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

- A. Since the Owner is the State of Missouri, municipal or political subdivisions, zoning ordinances, construction codes (other than licensing of trades), and other like ordinances are not applicable to construction on Owner's property, and Contractor will not be required to submit drawings and specifications to any municipal or political subdivision, authority, obtain construction permits or any other licenses (other than licensing of trades) or permits from or submit to inspections by any municipality or political subdivision relating to the construction for this project. All permits or licenses required by municipality or political subdivision for operation on property not belonging to Owner shall be obtained by and paid for by Contractor. Each Contractor shall comply with all applicable laws, ordinances, rules and regulations that pertain to the work of this contract.
- B. Contractors, subcontractors and their employees engaged in the businesses of electrical, mechanical, plumbing, carpentry, sprinkler system work, and other construction related trades shall be licensed to perform such work by the municipal or political subdivision where the project is located, if such licensure is required by local code. Local codes shall dictate the level (master, journeyman, and apprentice) and the number, type and ratio of licensed tradesmen required for this project within the jurisdiction of such municipal or political subdivision.
- C. Equipment and controls manufacturers and their authorized service and installation technicians that do not maintain an office within the jurisdiction of the municipal or political subdivision but are a listed or specified contractor or subcontractor on this project are exempt from Paragraph 1.3 B above.
- D. The Contractor shall post a copy of the wage determination issued for the project and included as a part of the contract documents, in a prominent and easily accessible location at the site of construction for the duration of the project.
- E. Any contractor or subcontractor to such contractor at any tier signing a contract to work on this project shall provide a ten-hour Occupational Safety and Health Administration (OSHA) construction safety program for their on-site employees which includes a course in construction safety and health approved by OSHA or a similar program approved by the Department of Labor and Industrial Relations which is at least as stringent as an approved OSHA program. The contractor shall

forfeit as a penalty to the public body on whose behalf the contract is made or awarded, two thousand five hundred dollars plus one hundred dollars for each employee employed by the contractor or subcontractor, for each calendar day, or portion thereof, such employee is employed without the required training.

ARTICLE 1.4 - NONDISCRIMINATION IN EMPLOYMENT

A. The Contractor and his subcontractors will not discriminate against individuals based on race, color, religion, national origin, sex, disability, or age, but may use restrictions which relate to bona fide occupational qualifications. Specifically, the Contractor and his subcontractors shall not discriminate:

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

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

B. The Contractor and his subcontractors shall develop, implement, maintain and submit in writing to the Owner an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed Affidavit for Affirmative Action

in the form included in the contract specifications. For the purpose of this section, an "affirmative action program" means positive action to influence all employment practices (including, but not limited to, recruiting, hiring, promoting and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between age 40 and 70), disabled and Vietnam-era veteran status, and disability. Such "affirmative action program" shall include:

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

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

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

ARTICLE 1.5 - ANTI-KICKBACK

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

insurance contract, or any other contract pertaining to the project.

ARTICLE 1.6 - PATENTS AND ROYALTIES

- A. The Contractor shall hold and save the Owner and its officers, agents, servants and employees harmless from liabilities of any nature or kind, including cost and expenses, for, or on account of, any patented or unpatented invention, process, article or appliance manufactured or used in the performance of this contract, including its use by the Owner, unless otherwise specifically stipulated in the contract documents.
- B. If the Contractor uses any design, device or materials covered by letters, patent or copyright, the Contractor shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood, without exception, that the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this contract and shall indemnify the Owner for any cost, expense or damage it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

ARTICLE 1.7 - PREFERENCE FOR AMERICAN AND MISSOURI PRODUCTS AND SERVICES

- A. By virtue of statutory authority a preference will be given to Missouri labor and to products of mines, forests and quarries of the state of Missouri when they are found in marketable quantities in the state, and all such materials shall be of the best quality and suitable character that can be obtained at reasonable market prices, all as provided for in Section 8.280, Missouri Revised Statutes and Cumulative Supplements.
- B. Furthermore, pursuant to Section 34.076 Missouri Revised Statutes and Cumulative Supplements, a preference shall be given to those persons doing business as Missouri firms, corporations, or individuals, or which maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less. In addition, in order for a non-domiciliary bidder to be successful, his bid must be that same percentage lower than a domiciliary Missouri bidder's bid, as would be

required for a Missouri bidder to successfully bid in the non-domiciliary state.

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

ARTICLE 1.8 - COMMUNICATIONS

- A. All notices, requests, instructions, approvals and claims must be in writing and shall be delivered to the Designer and copied to the Construction Representative for the project except as required by Article 1.12 Disputes and Disagreements, or as otherwise specified by the Owner in writing as stated in Section 012600. Any such notice shall be deemed to have been given as of the time of actual receipt.
- B. The Contractor shall attend on-site progress and coordination meetings, as scheduled by the Construction Representative, no less than once a month.
- C. The Contractor shall ensure that major subcontractors and suppliers shall attend monthly progress meetings as necessary to coordinate the work, and as specifically requested by the Construction Representative.

ARTICLE 1.9 - SEPARATE CONTRACTS AND COOPERATION

- A. The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.
- B. The Contractor shall consult the drawings for all other contractors in connection with this work. Any work conflicting with the above shall be brought to the attention of the Owner's Representative before the work is performed. If the Contractor fails to do this, and constructs any

work which interferes with the work of another contractor, the Contractor shall remove any part so conflicting and rebuild same, as directed by the Owner's Representative at no additional cost to the Owner.

- C. Each contractor shall be required to coordinate his work with other contractors so as to afford others reasonable opportunity for execution of their work. No contractor shall delay any other contractor by neglecting to perform contract work at the proper time. If any contractor causes delay to another, they shall be liable directly to that contractor for such delay in addition to any liquidated damages which might be due the Owner.
- D. Should the Contractor or project associated subcontractors refuse to cooperate with the instructions and reasonable requests of other Contractors or other subcontractors in the overall coordinating of the work, the Owner may take such appropriate action and issue directions, as required, to avoid unnecessary and unwarranted delays.
- E. Each Contractor shall be responsible for damage done to Owner's or other Contractor's property by him/her or workers in his employ through their fault or negligence.
- F. Should a Contractor sustain any damage through any act or omission of any other Contractor having a contract with the Owner, the Contractor so damaged shall have no claim or cause of action against the Owner for such damage, but shall have a claim or cause of action against the other Contractor to recover any and all damages sustained by reason of the acts or omissions of such Contractor. The phrase "acts or omissions" as used in this section shall be defined to include, but not be limited to, any unreasonable delay on the part of any such contractors.

ARTICLE 1.10 - ASSIGNMENT OF CONTRACT

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

ARTICLE 1.11 - INDEMNIFICATION

- A. Contractor agrees to indemnify and save harmless Owner and its respective commissioners, officers, officials, agents, consultants and employees and Designer, their agents, servants and employees, from and against any and all liability for damage arising from injuries to persons or damage to property occasioned by any acts or omissions of Contractor, any subcontractors, agents, servants or employees, including any and all expense, legal or otherwise, which may be incurred by Owner or Designer, its agents, servants or employees, in defense of any claim, action or suit.
- B. The obligations of the Contractor under this paragraph shall not extend to the liability of the Designer, his agents or employees, arising out of (1) the preparation or approval of maps, drawings, opinions, reports, surveys, contract changes, design or specifications, or (2) giving of or the failure to give directions or instructions by the Designer, his agents or employees as required by this contract documents provided such giving or failure to give is the primary cause of the injury or damage.

ARTICLE 1.12 - DISPUTES AND DISAGREEMENTS

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

ARTICLE 2 -- OWNER/DESIGNER RESPONSIBILITIES

- A. The Owner shall give all orders and directions contemplated under this contract relative to the execution of the work. During progress of work the Owner will be represented at the project site by the Construction Representative and/or Designer, whose responsibilities are to see that this contract is properly fulfilled.
- B. The Owner shall at all times have access to the work whenever it is in preparation or progress. The Contractors shall provide proper facilities for such access and for inspection and supervision.
- C. All materials and workmanship used in the work shall be subject to the inspection of the Designer and Construction Representative, and any work which is deemed defective shall be removed, rebuilt or made good immediately upon notice.

The cost of such correction shall be borne by the Contractor. Contractor shall not be entitled to an extension of the contract completion date in order to remedy defective work. All rejected materials shall be immediately removed from the site of the work.

- D. If the Contractor fails to proceed at once with the correction of rejected defective materials or workmanship, the Owner may, by separate contract or otherwise, have the defects remedied or rejected. Materials removed from the site and charge the cost of the same against any monies which may be due the Contractor, without prejudice to any other rights or remedies of the Owner.
- E. Failure or neglect on the part of Owner to observe faulty work, or work done which is not in accordance with the drawings and specifications shall not relieve the Contractor from responsibility for correcting such work without additional compensation.
- F. The Owner shall have the right to direct the Contractor to uncover any completed work.
 - 1. If the Contractor fails to adequately notify the Construction Representative and/or Designer of an inspection as required by the Contract Documents, the Contractor shall, upon written request, uncover the work. The Contractor shall bear all costs associated with uncovering and again covering the work exposed.
 - 2. If the Contractor is directed to uncover work, which was not otherwise required by the Contract Documents to be inspected, and the work is found to be defective in any respect, no compensation shall be allowed for this work. If, however, such work is found to meet the requirements of this contract, the actual cost of labor and material necessarily involved in the examination and replacement plus 10% shall be allowed the Contractor.
- G. The Designer shall give all orders and directions contemplated under this contract relative to the scope of the work and shall give the initial interpretation of the contract documents.
- H. The Owner may file a written notice to the Contractor to dismiss immediately any subcontractors, project managers, superintendents, foremen, workers, watchmen or other employees whom the Owner may deem incompetent, careless or a hindrance to proper or timely execution of the work. The Contractor shall comply with such notice as promptly as practicable without detriment to the work or its progress.

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

ARTICLE 3 -- CONTRACTOR RESPONSIBILITIES

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

ARTICLE 3.1 -- ACCEPTABLE SUBSTITUTIONS

- A. The Contractor may request use of any article, device, product, material, fixture, form or type of construction which in the judgment of the Owner and Designer is equal in all respects to that named. Standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner and Designer that they are equal in design, strength, durability, usefulness and convenience for the purpose intended.
- B. Any changes required in the details and dimensions indicated on the drawings for the substitution of products other than those specified shall be properly made at the expense of the Contractor requesting the substitution or change.
- C. The Contractor shall submit a request for such substitutions in writing to the Owner and Designer within twenty (20) working days after the date of the "Notice to Proceed." Thereafter no consideration will be given to alternate forms of accomplishing the work. This Article does not preclude the Owner from exercising the provisions of Article 4 hereof.
- D. Any request for substitution by the Contractor shall be submitted in accordance with SECTION 002113 - INSTRUCTIONS TO BIDDERS.
- E. When a material has been approved, no change in brand or make will be permitted unless:
 - 1. Written verification is received from the manufacturer stating they cannot make delivery on the date previously agreed, or
 - 2. Material delivered fails to comply with contract requirements.

ARTICLE 3.2 -- SUBMITTALS

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

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

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

- B. All subcontractors' shop drawings and schedules shall be submitted by the Contractor and shall bear evidence that Contractor has received, reviewed, and approved them. Any shop drawings and schedules submitted without this evidence will be returned to the Contractor for resubmission.
- C. The Contractor shall include with the shop drawing, a letter indicating any and all deviations from the drawings and/or specifications. Failure to notify the Designer of such deviations will be grounds for subsequent rejection of the related work or materials. If, in the opinion of the Designer, the deviations are not acceptable, the Contractor will be required to furnish the item as specified and indicated on the drawings.
- D. The Designer shall check shop drawings and schedules with reasonable promptness and approve them only if they conform to the design concept of the project and comply with the information given in the contract documents. The approval shall not relieve the Contractor from the responsibility to comply with the drawings and specifications, unless the Contractor has called the Designer's attention to the deviation, in writing, at the time of submission and the Designer has knowingly approved thereof. An approval of any such modification will be given only under the following conditions:
 - 1. It is in the best interest of the Owner
 - 2. It does not increase the contract sum and/or completion time
 - 3. It does not deviate from the design intent
 - 4. It is without prejudice to any and all rights under the surety bond.
- E. No extension of time will be granted because of the Contractor's failure to submit shop drawings and schedules in ample time to allow for review,

possible resubmission, and approval. Fabrication of work shall not commence until the Contractor has received approval. The Contractor shall furnish prints of approved shop drawings and schedules to all subcontractors whose work is in any way related to the work under this contract. Only prints bearing this approval will be allowed on the site of construction

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

ARTICLE 3.3 – AS-BUILT DRAWINGS

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

ARTICLE 3.4 – GUARANTY AND WARRANTIES

- A. General Guaranty
 - 1. Neither the final certificate of payment nor any provision in the contract documents nor partial use or occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with contract requirements.
 - 2. The Contractor or surety shall remedy any defects in the work and pay for any damage to property resulting there from which shall appear within a period of one (1) year from the date of substantial completion unless a longer period is otherwise specified or a differing guaranty period has been established in the substantial completion certificate. The Owner will give notice of observed defects with reasonable promptness.
 - 3. In case of default on the part of the Contractor in fulfilling this part of this contract, the Owner may correct the work or repair the

damage and the cost and expense incurred in such event shall be paid by or recoverable from the Contractor or surety.

4. The work will be free from defects not inherent in the quality required or permitted, and that the Work will conform to the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's guaranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment

B. Extended Warranty

Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year. Where a longer period is offered at no additional cost or called for in the specific equipment specifications, the longer period shall govern.

ARTICLE 3.5 -- OPERATION AND MAINTENANCE MANUALS

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

1. Start-up and Shut-down Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available; they may be incorporated into the operating manual for reference.
2. Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.
3. Equipment List: List of all major equipment as installed shall be prepared to include model number, capacities, flow rate, name place data, shop drawings and air and water balance reports.
4. Service Instructions: Provide the following information for all pieces of equipment.

- a. Recommended spare parts including catalog number and name of local supplier or factory representative.
- b. Belt sizes, types, and lengths.
- c. Wiring diagrams.

5. Manufacturer's Certificate of Warranty as described in Article 3.4.

6. Prior to the final payment, furnish to the Designer three (4) copies of parts catalogs for each piece of equipment furnished by him/her on the project with the components identified by number for replacement ordering.

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

1. Manuals shall be in quadruplicate, and all materials shall be bound into volumes of standard 8½" x 11" hard binders. Large drawings too bulky to be folded into 8½" x 11" shall be separately bound or folded and in envelopes, cross referenced and indexed with the manuals.

2. The manuals shall identify project name, project number, and include the name and address of the Contractor, subcontractors and manufacturers who were involved with the activity described in that particular manual.

3. Internally subdivide the binder contents with permanent page dividers, logically organized with tab titles clearly printed under reinforced laminated plastic tabs.

4. Contents: Prepare a Table of Contents for each volume, with each product or system description identified.

ARTICLE 3.6 – OTHER CONTRACTOR RESPONSIBILITIES

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

and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him/her.

- C. The Contractor shall supply sufficient labor, material, plant and equipment and pay when due any laborer, subcontractor or supplier for supplies furnished and otherwise prosecute the work with diligence to prevent work stoppage and insure completion thereof within the time specified.
- D. The Contractor and each of his subcontractors shall submit to the Construction Representative, through the Designer such schedules of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the Owner may request concerning work performed or to be performed under this contract.
- E. The Contractor, subcontractors, and material suppliers shall upon written request, give the Owner access to all time cards, material invoices, payrolls, estimates, profit and loss statements, and all other direct or indirect costs related to this work.
- F. The Contractor shall be responsible for laying out all contract work such as layout of architectural, structural, mechanical and electrical work, which shall be coordinated with layouts of subcontractors for general construction work. The Contractor is also responsible for unloading, uncrating and handling of all materials and equipment to be erected or placed by him/her, whether furnished by Contractor or others. No extra charges or compensation will be allowed as a result of failure to verify dimensions before ordering materials or fabricating items.
- G. The Contractor must notify the Construction Representative at least one working day before placing concrete or burying underground utilities, pipelines, etc.
- H. Contractors shall prearrange time with the Construction Representative for the interruption of any facility operation. Unless otherwise specified in these documents, all connections, alterations or relocations as well as all other portions of the work will be performed during normal working hours.
- I. The Contractor shall coordinate all work so there will not be prolonged interruptions of existing equipment operation. Any existing plumbing, heating, ventilating, air conditioning or electrical disconnections necessary for the project, which affect portions of this construction or building or any other building must be scheduled with the Construction Representative to minimize or avoid any disruption of facility operations. In no case,

unless previously approved in writing by the Construction Representative, shall utilities be left disconnected at the end of a work day or over a weekend. Any interruption of utilities either intentionally or accidentally shall not relieve the Contractor responsible for the interruption from the responsibility to repair and restore the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

- J. Contractors shall limit operations and storage of materials to the area within the project, except as necessary to connect to existing utilities, and shall not encroach on neighboring property. The Contractor shall be responsible for repair of their damage to property on or off the project site occurring during construction of project. All such repairs shall be made to the satisfaction of the property owner.
- K. Unless otherwise permitted, all materials shall be new and both workmanship and materials shall be of the best quality.
- L. Unless otherwise provided and stipulated within these specifications, the Contractor shall furnish, construct, and/or install and pay for materials, devices, mechanisms, equipment, all necessary personnel, utilities including, but not limited to water, heat, light and electric power, transportation services, applicable taxes of every nature, and all other facilities necessary for the proper execution and completion of the work.
- M. Contractor shall carefully examine the plans and drawings and shall be responsible for the proper fitting of his material, equipment and apparatus into the building.
- N. The Contractor or subcontractors shall not overload, or permit others to overload, any part of any structure during the performance of this contract.
- O. All temporary shoring, bracing, etc., required for the removal of existing work and/or for the installation of new work shall be included in this contract. The Contractor shall make good, at no cost to the Owner, any damage caused by improper support or failure of shoring in any respect. Each Contractor shall be responsible for shoring required to protect his work or adjacent property and improvements of Owner and shall be responsible for shoring or for giving written notice to adjacent property owners. Shoring shall be removed only after completion of permanent supports.

- P. The Contractor shall provide at the proper time such material as is required for support of the work. If openings are required, whether shown on drawings or not, the Contractor shall see that they are properly constructed.
- Q. During the performance of work the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences and other devices appropriately located on site which will give proper and understandable warning to all persons of danger of entry onto land, structure or equipment.
- R. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials.
- S. The Contractor shall be responsible for care of the finished work and shall protect same from damage or defacement until substantial completion by the Owner. If the work is damaged by any cause, the Contractor shall immediately begin to make repairs in accordance with the drawings and specifications. Contractor shall be liable for all damage or loss unless attributable to the acts or omissions of the Owner or Designer. Any claim for reimbursement shall be submitted in accordance with Article 4. After substantial completion the Contractor will only be responsible for damage resulting from acts or omissions of the Contractor or subcontractors through final warranty.
- T. In the event the Contractor encounters an unforeseen hazardous material, the Contractor shall immediately stop work in the area affected and report the condition to the Owner and Designer in writing. The Contractor shall not be required, pursuant to Article 4, to perform, any work relating to hazardous materials.
- U. In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 4.
- V. Before commencing work, Contractors shall confer with the Construction Representative and facility representative and review any facility rules and regulations which may affect the conduct of the work.
- W. Project signs will only be erected on major projects and only as described in the specifications. If no sign is specified, none shall be erected.

ARTICLE 3.7 -- SUBCONTRACTS

- A. Subcontractor assignments as identified in the bid form shall not be changed without written approval of the Owner. The Owner will not approve changes of a listed subcontractor unless the Contractor documents, to the satisfaction of the Owner that the subcontractor cannot or will not perform the work as specified.
- B. The Contractor is fully responsible to the Owner for the acts and omissions of all subcontractors and of persons either directly or indirectly employed by them.
- C. Every subcontractor shall be bound by the applicable terms and provisions of these contract documents, but no contractual relationship shall exist between any subcontractor and the Owner unless the right of the Contractor to proceed with the work is suspended or this contract is terminated as herein provided, and the Owner in writing elects to assume the subcontract.
- D. The Contractor shall upon receipt of "Notice to Proceed" and prior to submission of the first payment request, notify the Designer and Construction Representative in writing of the names of any subcontractors to be used in addition to those identified in the bid form and all major material suppliers proposed for all parts of the work.

ARTICLE 4 -- CHANGES IN THE WORK

4.1 CHANGES IN THE WORK

- A. The Construction Representative, without giving notice to the surety and without invalidating this contract, may order extra work or make changes by altering, adding to or deducting from the work, this contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract. A claim for extension of time caused by any change must be adjusted at the time of ordering such change. No future request for time will be considered.
- B. Each Contract Change shall include all costs required to perform the work including all labor, material, equipment, overheads and profit, delay, disruptions, or other miscellaneous expenses. No subsequent requests for additional compensation including claims for delay, disruption, or reduced efficiency as a result of each change will be considered. Values from the Schedule of Values will not be binding as a basis for additions to or deductions from the contract price.
- C. The amount of any adjustment in this contract price for authorized changes shall be agreed upon

before such changes become effective and shall be determined, through submission of a request for proposal, as follows:

1. By an acceptable fixed price proposal from the Contractor. Breakdowns shall include all takeoff sheets of each Contractor and subcontractor. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.
2. By a cost-plus-fixed-fee (time and material) basis with maximum price, total cost not to exceed said maximum. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.
3. By unit prices contained in Contractor's original bid form and incorporated in the construction contract.

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

1. The overhead and profit charge by the Contractor and all subcontractors shall be considered to include, but is not limited to: incidental job burdens, small truck (under 1 ton) expense, mileage, small hand tools, warranty costs, company benefits and general office overhead. Project supervision including field supervision and job site office expense shall be considered a part of overhead and profit unless a compensable time extension is granted.
2. The percentages for overhead and profit charged on Contract Changes shall be 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 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.
 - 4. Written Affirmative Action Plans as required in Article 1.4.
- Above referenced items must be received by the Owner within ten (10) working days after the effective date of the contract. If not received, the Owner may treat the failure to timely submit them as a refusal by the Contractor to accept a contract for this work and may retain as liquidated damages the Contractor's bid bond, cashier's check or certified check as provided in the Instructions to Bidders. Upon receipt the Owner will issue a "Notice to Proceed" with the work to the Contractor.
- B. Within the time frame noted in Section 013200 - Schedules, following receipt of the "Notice to Proceed", the Contractor shall submit to the Owner a progress schedule and schedule of values, showing activities through the end of the contract period. Should the Contractor not receive written notification from the Owner of the disapproval of the schedule of values within fifteen (15) working days, the Contractor may consider it approved for purpose of determining when the first monthly Application and Certification for Payment may be submitted.
 - C. The Contractor may commence work upon receipt of the Division of Facilities Management, Design and Construction's "Notice to Proceed" letter. Contractor shall prosecute the work with faithfulness and energy, and shall complete the entire work on or before the completion time stated in the contract documents or pay to the Owner the damages resulting from the failure to timely complete the work as set out within Article 5.4.

ARTICLE 5.2 -- PROJECT CONSTRUCTION

- A. Each Contractor shall submit for the Owner's approval, in reproducible form, a progress schedule showing the rate of progress and the order of the work proposed to carry on various phases of the project. The schedule shall be in conformance with the requirements outlined in Section 013200 – Schedules.
- B. Contractor shall employ and supply a sufficient force of workers, material, and equipment and shall pay when due, any worker, subcontractor or supplier and otherwise prosecute the work with such diligence so as to maintain the rate of progress indicated on the progress schedule, prevent work stoppage, and insure completion of the project within the time specified.

ARTICLE 5.3 -- PROJECT COMPLETION

- A. Substantial Completion. A Project is substantially complete when construction is essentially complete and work items remaining to be completed can be done without interfering with the Owner's ability to use the Project for its intended purpose.
 1. Once the Contractor has reached what they believe is Substantial Completion, the Contractor shall notify the Designer and the Construction Representative of the following:
 - a. That work is essentially complete with the exception of certain listed work items. The list shall be referred to as the "Contractor's Punch."
 - b. That all Operation and Maintenance Manuals have been assembled and submitted in accordance with Article 3.5A.
 - c. That the Work is ready for inspection by the Designer and Construction Representative. The Owner shall be entitled to a minimum of ten working days notice before the inspection shall be performed.
 2. If the work is acceptable, the Owner shall issue a Certificate of Substantial Completion, which shall set forth the responsibilities of the Owner and the Contractor for utilities, security, maintenance, damage to the work and risk of loss. The Certificate shall also identify those remaining items of work to be performed by the Contractor. All such work items shall be complete within 30 working days of the date of the Certificate, unless the Certificate specifies a different time. If the

Contractor shall be required to perform tests that must be delayed due to climatic conditions, it is understood that such tests and affected equipment will be identified on the Certificate and shall be accomplished by the Contractor at the earliest possible date. Performance of the tests may not be required before Substantial Completion can be issued. The date of the issuance of the Certificate of Substantial Completion shall determine whether or not the work was completed within the contract time and whether or not Liquidated Damages are due.

3. If the work is not acceptable, and the Owner does not issue a Certificate of Substantial Completion, the Owner shall be entitled to charge the Contractor with the Designer's and Owner's costs of re-inspection, including time and travel.
- B. Partial Occupancy. Contractor agrees that the Owner shall be permitted to occupy and use any completed or partially completed portions of the Project, when such occupancy and use is in the Owner's best interest. Owner shall notify Contractor of its desire and intention to take Partial Occupancy as soon as possible but at least ten (10) working days before the Owner intends to occupy. If the Contractor believes that the portion of the work the Owner intends to occupy is not ready for occupancy, the Contractor shall notify the Owner immediately. The Designer shall inspect the work in accordance with the procedures above. If the Contractor claims increased cost of the project or delay in completion as a result of the occupancy, he shall notify the Owner immediately but in all cases before occupancy occurs.
- C. Final Completion. The Project is finally complete when the Certificate of Substantial Completion has been issued and all work items identified therein as incomplete have been completed, and when all administrative items required by the contract have been completed. Final Completion entitles the Contractor to payment of the outstanding balance of the contract amount including all change orders and retainage. Within five (5) working days of the date of the Certificate of Substantial Completion, the Contractor shall identify the cost to complete any outstanding items of work. The Designer shall review the Contractor's estimate and either approve it or provide an independent estimate for all such items. If the Contractor fails to complete the remaining items within the time specified in the Certificate, the Owner may terminate the contract and go to the surety for project completion in accordance with Article 7.2 or release the contract balance to the Contractor less 150% of the

approved estimate to complete the outstanding items. Upon completion of the outstanding items, when a final cost has been established, any monies remaining shall be paid to the Contractor. Failure to complete items of work does not relieve the Contractor from the obligation to complete the administrative requirements of the contract, such as the provisions of Article 5.3 FAILURE TO COMPLETE ALL ITEMS OF WORK UNDER THE CONTRACT SHALL BE CONSIDERED A DEFAULT AND BE GROUNDS FOR CONTRACT TERMINATION AND DEBARMENT.

- D. Liquidated Damages. Contractor agrees that the Owner may deduct from the contract price and retain as liquidated damages, and not as penalty or forfeiture, the sum stipulated in this contract for each work day after the Contract Completion Day on which work is not Substantially Complete. Assessment of Liquidated Damages shall not relieve the Contractor or the surety of any responsibility or obligation under the Contract. In addition, the Owner may, without prejudice to any other rights, claims, or remedies the Owner may have including the right to Liquidated Damages, charge the Contractor for all additional expenses incurred by the Owner and/or Designer as the result of the extended contract period through Final Completion. Additional Expenses shall include but not be limited to the costs of additional inspections.
- E. Early Completion. The Contractor has the right to finish the work before the contract completion date; however, the Owner assumes no liability for any hindrances to the Contractor unless Owner caused delays result in a time extension to the contract completion date. The Contractor shall not be entitled to any claims for lost efficiencies or for delay if a Certificate of Substantial Completion is given on or before the Contract Completion Date.

ARTICLE 5.4 -- PAYMENT TO CONTRACTOR

- A. Payments on account of this contract will be made monthly in proportion to the work which has been completed. Request for payment must be submitted on the Owner's forms. No other pay request will be processed. Supporting breakdowns must be in the same format as Owner's forms and must provide the same level of detail. The Designer will, within 5 working days from receipt of the contractor's request for payment either issue a Certificate for Payment to the Owner, for such amount as the Designer determines is properly due, or notify the Contractor in writing of reasons for withholding a Certificate. The Owner shall make payment within 30 calendar days after the

"Application and Certification for Payment" has been received and certified by the Designer. The following items are to be attached to the contractor's pay request:

1. Updated construction schedule
 2. Certified payrolls consisting of name, occupation and craft, number of hours worked and actual wages paid for each individual employee, of the Contractor and all subcontractors working on the project
- B. The Owner shall retain 5 percent of the amount of each such payment application, except as allowed by Article 5.4, until final completion and acceptance of all work covered by this contract.
 - C. Each payment made to Contractor shall be on account of the total amount payable to Contractor and all material and work covered by paid partial payment shall thereupon become the sole property of Owner. This provision shall not be construed as relieving Contractor from sole responsibility for care and protection of materials and work upon which payments have been made or restoration of any damaged work or as a waiver of the right of Owner to require fulfillment of all terms of this contract.
 - D. Materials delivered to the work site and not incorporated in the work will be allowed in the Application and Certification for Payment on the basis of one hundred (100%) percent of value, subject to the 5% retainage providing that they are suitably stored on the site or in an approved warehouse in accordance with the following requirements:
 1. Material has previously been approved through submittal and acceptance of shop drawings conforming to requirements of Article 3.2 of General Conditions.
 2. Delivery is made in accordance with the time frame on the approved schedule.
 3. Materials, equipment, etc., are properly stored and protected from damage and deterioration and remain so - if not, previously approved amounts will be deleted from subsequent pay applications.
 4. The payment request is accompanied by a breakdown identifying the material equipment, etc. in sufficient detail to establish quantity and value.
 - E. The Contractor shall be allowed to include in the Application and Certification for Payment, one hundred (100%) of the value, subject to retainage,

of major equipment and material stored off the site if all of the following conditions are met:

1. The request for consideration of payment for materials stored off site is made at least 15 working days prior to submittal of the Application for Payment including such material. Only materials inspected will be considered for inclusion on Application for Payment requests.
 2. Materials stored in one location off site are valued in excess of \$25,000.
 3. That a Certificate of Insurance is provided indicating adequate protection from loss, theft conversion or damage for materials stored off site. This Certificate shall show the State of Missouri as an additional insured for this loss.
 4. The materials are stored in a facility approved and inspected, by the Construction Representative.
 5. Contractor shall be responsible for, Owner costs to inspect out of state facilities, and any delays in the completion of the work caused by damage to the material or for any other failure of the Contractor to have access to this material for the execution of the work.
- F. The Owner shall determine the amount, quality and acceptability of the work and materials which are to be paid for under this contract. In the event any questions shall arise between the parties, relative to this contract or specifications, determination or decision of the Owner or the Construction Representative and the Designer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this contract affected in any manner or to any extent by such question.
- G. Payments Withheld: The Owner may withhold or nullify in whole or part any certificate to such extent as may be necessary to protect the Owner from loss on account of:
1. Defective work not remedied. When a notice of noncompliance is issued on an item or items, corrective action shall be undertaken immediately. Until corrective action is completed, no monies will be paid and no additional time will be allowed for the item or items. The cost of corrective action(s) shall be borne by the Contractor.
 2. A reasonable doubt that this contract can be completed for the unpaid balance.
3. Failure of the Contractor to update as-built drawings monthly for review by the Construction Representative.
 4. Failure of the Contractor to update the construction schedule.
- When the Construction Representative is satisfied the Contractor has remedied above deficiencies, payment shall be released.
- H. Final Payment: Upon receipt of written notice from the Contractor to the Designer and Project Representative that the work is ready for final inspection and acceptance, the Designer and Project Representative, with the Contractor, shall promptly make such inspection. If the work is acceptable and the contract fully performed, the Construction Representative shall complete a final acceptance report and the Contractor will be directed to submit a final Application and Certification for Payment. If the Owner approves the same, the entire balance shall be due and payable, with the exception of deductions as provided for under Article 5.4.
1. Where the specifications provide for the performance by the Contractor of (certain tests for the purpose of balancing and checking the air conditioning and heating equipment and the Contractor shall have furnished and installed all such equipment in accordance with the specifications, but said test cannot then be made because of climatic conditions, such test shall may be considered as required under the provisions of the specifications, Section 013300 and this contract may be substantial Full payment will not be made until the tests have been made and the equipment and system is finally accepted. If the tests are not completed when scheduled, the Owner may deduct 150% of the value of the tests from the final payment.
 2. The final payment shall not become due until the Contractor delivers to the Construction Representative:
 - a) A complete file of releases, on the standard form included in the contract documents as "Final Receipt of Payment and Release Form", from subcontractors and material suppliers evidencing payment in full for services, equipment and materials, as the case may require, if the Owner approves, or a consent from the Surety to final payment accepting liability for any unpaid amounts.

- b) An Affidavit of Compliance with Prevailing Wage Law, in the form as included in this contract specifications, properly executed by each subcontractor, and the Contractor
 - c) Certified copies of all payrolls
 - d) As-built drawings
3. If any claim remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a claim including all costs and a reasonable attorney's fee.
 4. Missouri statute requires prompt payment from the Owner to the Contractor within thirty calendar days and from the Contractor to his subcontractors within fifteen calendar days. Failure to make payments within the required time frame entitles the receiving party to charge interest at the rate of one and one half percent per month calculated from the expiration of the statutory time period until paid.
 5. The value of all unused unit price allowances and/or 150% of the value of the outstanding work items, and/or liquidated damages may be deducted from the final pay request without executing a Contract Change. Any unit price items which exceed the number of units in the contract may be added by Contract Change.

ARTICLE 6 -- INSURANCE AND BONDS

ARTICLE 6.1 -- BOND

- A. Contractor shall furnish a performance/payment bond in an amount equal to 100% of the contract price to guarantee faithful performance of the contract and 100% of the contract price to guarantee the payment of all persons performing labor on the project and furnishing materials in connection therewith under this contract as set forth in the standard form of performance and payment bond included in the contract documents. The surety on such bond shall be issued by a surety company authorized by the Missouri Department of Insurance to do business in the state of Missouri.
- B. All Performance/Payment Bonds furnished in response to this provision shall be provided by a bonding company with a rating of B+ or higher as established by A.M. Best Company, Inc. in their most recent publication.

ARTICLE 6.2 – INSURANCE

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

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

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

Business Automobile Liability Insurance, ISO Coverage form number or equivalent CA 00 01 covering automobile liability, code 1 "ANY AUTO".
 3. Workers' Compensation and Employer's Liability

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

Insurance upon the work and all materials, equipment, supplies, temporary structures and similar items which may be incident to the performance of the work and located at or adjacent to the site, against loss or damage from fire and such other casualties as are included in extended coverage in broad "All Risk" form, including coverage for Flood and Earthquake, in an amount not less than the replacement cost of the work or this 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: Matthew Lee
IMEG Corp
1600 Baltimore Ave, Suite 300
Kansas City, MO 64108
Telephone: 816-842-8437
Email: Matthew.j.lee@imegcorp.com

Construction Representative: Michael Varhola
Division of Facilities Management, Design and Construction
615 E. 13th St. Room 505
Kansas City, MO 64106
Telephone: 816-889-2492
Email: Michael.Varhola@oa.mo.gov

Project Manager: Christopher Lloyd
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
Telephone: 573-526-0160
Email: Christopher.Lloyd@oa.mo.gov

Contract Specialist: Mandy Roberson
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
Telephone: 573-522-0074
Email: mandy.roberson@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 7 complete sets of drawings and specifications at no charge.
- B. The Owner will furnish the Contractor with approximately 7 sets of explanatory or change drawings at no charge.
- C. The Contractor may make copies of the documents as needed with no additional cost to the Owner.

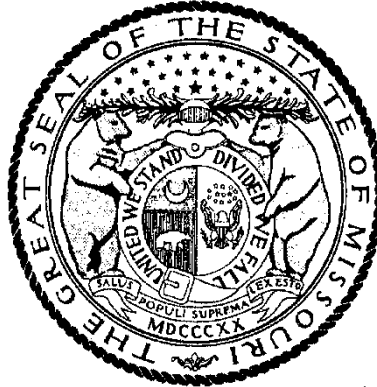
5.0 SAFETY REQUIREMENTS

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

Missouri

Division of Labor Standards

WAGE AND HOUR SECTION



MICHAEL L. PARSON, Governor

Annual Wage Order No. 30

Section 074
NODAWAY COUNTY

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

Original Signed by _____

Todd Smith, Director
Division of Labor Standards

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

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

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$23.20*
Boilermaker	\$23.20*
Bricklayer	\$23.20*
Carpenter	\$56.74
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$23.20*
Plasterer	
Communications Technician	\$23.20*
Electrician (Inside Wireman)	\$23.20*
Electrician Outside Lineman	\$23.20*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$23.20*
Glazier	\$23.20*
Ironworker	\$66.34
Laborer	\$42.92
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$23.20*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$23.20*
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$23.20*
Plumber	\$69.26
Pipe Fitter	
Roofer	\$23.20*
Sheet Metal Worker	\$73.68
Sprinkler Fitter	\$23.20*
Truck Driver	\$23.20*
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
NODAWAY County

Section 074

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$51.61
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$23.20*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$44.26
General Laborer	
Skilled Laborer	
Operating Engineer	\$55.17
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$23.20*
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 hazardous material abatement and mechanical, electrical, and plumbing (MEP) work to serve Building 3, and the associated boiler/laundry building, at the Project Location listed below.
 1. Project Location: Maryville Treatment Center, 30227 US Hwy 136, Maryville, MO 64468.
 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 February 7, 2024 were prepared for the Project by IMEG Corp., 1600 Baltimore, Suite 300, Kansas City, MO 64108. Contact Matthew Lee, 816-842-8437.
- C. The Work consists of hazardous material abatement in tunnels and plumbing chases; replacement of domestic water and/or sanitary waste & vent piping mains in main plumbing chases and tunnels; replacement of the old steam heating system throughout the buildings with a new 2-pipe hydronic system; replacement of main plumbing equipment; and electrical upgrades as required to accommodate the new mechanical & plumbing equipment.
 1. The Work includes new hot water boilers, primary & secondary pumps, and hydronic accessories in the boiler building, and new terminal heat transfer units throughout both buildings.
 2. The Work includes provisions for operating the new hydronic system in cooling mode, including cooling condensate drain piping throughout both buildings, and an Alternate to include an air-cooled chiller.
 3. The Work includes new domestic water softeners, water heaters, master mixing valves, circulating pump, and accessories in the boiler building.
 4. The Work includes new direct digital controls (DDC) for new equipment in both buildings, plus extension of the State's existing Facility Management and Control System (FMCS) to serve both buildings.
- D. The Work will be constructed under a single prime contract.

1.3 WORK SEQUENCE

- A. Work in occupied areas of the main building (including but not limited to installation of terminal heat transfer units, and associated ductwork, piping, controls, conduits, and wiring) shall be conducted in multiple phases, so that Owner can relocate occupants to other areas of the main building while work is ongoing. Owner anticipates approximately eight (8) phases will be required, similar to those described below. The phasing described below is preliminary. Contractor shall carefully coordinate phasing with the Owner. Contractor shall provide Owner a minimum of four (4) weeks notice prior to commencement of first phase, and a minimum of one (1) week notice prior to each transition to the subsequent phase.

1. Phase 1: Install new work in west or "A" wing of basement level.
2. Phase 2: Install new work in east or "C" wing of basement level.
3. Phase 3: Install new work in west or "A" wing of level 01.
4. Phase 4: Install new work in east or "C" wing of level 01.
5. Phase 5: Install new work in west or "A" wing of level 02.
6. Phase 6: Install new work in east or "C" wing of level 02.
7. Phase 7: Install new work in west or "A" wing of level 03.
8. Phase 8: Install new work in east or "C" wing of level 03.
9. Phasing note: The asbestos abatement work, and work in other areas, including the chapel or "B" wing of the main building, the tunnels, and the boiler building, may occur concurrent with one or more of the phases listed above.

1.4 CONTRACTOR USE OF PREMISES

- A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
 1. Owner Occupancy: Allow for Owner occupancy and use by the public.
 2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.5 OCCUPANCY REQUIREMENTS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 011000

SECTION 012100 – ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
 - 1. Weather allowances.
- C. Related Sections include the following:
 - 1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders for allowances.
 - 2. Division 1 Section "Unit Prices" for procedures for using unit prices.

1.3 WEATHER ALLOWANCE

- A. Included within the completion period for this project are a specified number of "bad weather" days (see Schedule of Allowances).
- B. The Contractor's progress schedule shall clearly indicate the bad weather day allowance as an "activity" or "activities". In the event weather conditions preclude performance of critical work activities for 50% or more of the Contractor's scheduled workday, that day shall be declared unavailable for work due to weather (a "bad weather" day) and charged against the above allowance. Critical work activities will be determined by review of the Contractor's current progress schedule.
- C. The Contractor's Representative and the Construction Representative shall agree monthly on the number of "bad weather" days to be charged against the allowance. This determination will be documented in writing and be signed by the Contractor and the Construction Representatives. If there is a failure to agree on all or part of the "bad weather" days for a particular month, that disagreement shall be noted on this written document and signed by each party's representative. Failure of the Contractor's representative to sign the "bad weather" day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the "bad weather" day determination contained in that document.
- D. There will be no modification to the time of contract performance due solely to the failure to deplete the "bad weather" day allowance.
- E. Once this allowance is depleted, a no cost Change Order time extension will be executed for "bad weather" days, as defined above, encountered during the remainder of the Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES

- A. Weather Allowance: Included within the completion period for this Project five (5) "bad weather" days.

END OF SECTION 012100

SECTION 012200 – UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.
- B. Quantities of Units to be included in the Base Bid are indicated in Section 004322 – Unit Prices.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Unit Prices.
- B. Related Sections include the following:
 - 1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

- A. Unit Price is an amount proposed by bidders, stated on the Bid Form Attachment 004322 and is a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

- A. Unit Price No. 1 – ACBM mudded fitting 2” to 6” outside diameter:
 - 1. Description: Asbestos Containing Building Materials removal/disposal according to Division 028211 Section "Asbestos Abatement."
 - 2. Unit of Measurement: Per fitting.

3. Base bid quantity: Refer to ACBM Schedules in Appendix F.
- B. Unit Price No. 2 – ACBM mudded fitting 8” to 16” outside diameter:
1. Description: Asbestos Containing Building Materials removal/disposal according to Division 028211 Section "Asbestos Abatement."
 2. Unit of Measurement: Per fitting.
 3. Base bid quantity: Refer to ACBM Schedules in Appendix F.
- C. Unit Price No. 3 – ACBM pipe wrap 2” to 6” outside diameter:
1. Description: Asbestos Containing Building Materials removal/disposal according to Division 028211 Section "Asbestos Abatement."
 2. Unit of Measurement: Per lineal foot of pipe wrap.
 3. Base bid quantity: Refer to ACBM Schedules in Appendix F.
- D. Unit Price No. 4 – ACBM pipe wrap 8” to 16” outside diameter:
1. Description: Asbestos Containing Building Materials removal/disposal according to Division 028211 Section "Asbestos Abatement."
 2. Unit of Measurement: Per lineal foot of pipe wrap.
 3. Base bid quantity: Refer to ACBM Schedules in Appendix F.

END OF SECTION 012200

SECTION 012300 - ALTERNATES

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 governing Alternates.

1.3 DEFINITIONS

- A. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents..

- 1. The cost for each alternate is the net addition to the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

- B. No additional time will be allowed for alternate work unless the number of work days is so stated on the bid form.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate the Alternate Work into the Project.

- 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

- B. Notification: The award of the Contract will indicate whether alternates have been accepted or rejected.

- C. Execute accepted alternates under the same conditions as other Work of this Contract.

- D. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Include site work and air-cooled chiller, additional pumps, piping, accessories, and controls required to enable operation of the new 2-pipe hydronic system in cooling mode.

- 1. Include site work indicated on sheet C100.

2. Include outdoor air-cooled chiller CHLR-1, associated outdoor & indoor chilled water piping and accessories shown on sheets M201 and M501, and associated controls shown on sheet M520.
3. Include heating water pumps P-6 and P-7 (i.e. the small system pumps), expansion tank ET-2, and associated heating water piping and accessories shown on sheet M200 and M501, which are required to provide heating water to the domestic water heaters whenever the large system pumps are handling chilled water in cooling mode. Also include associated controls shown on sheet M520.
4. Include power connections for chiller CHLR-1 and pumps P-6 and P-7 shown on electrical drawings.
5. In addition to notations on the Drawings, Specification Sections that include requirements for this Alternate include, but are not limited to, Sections in Division 23 for the chiller and pumps, and Division 31 and 32 for site work associated with the chiller.

END OF SECTION 012300

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 Owner and Designer the meeting minutes.
- C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of Manufacturers and Fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Designer and Construction Representative of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration including requirements for the following:
 - a. Contract Documents
 - b. Options
 - c. Related RFIs
 - d. Related Change Orders
 - e. Purchases
 - f. Deliveries
 - g. Submittals
 - h. Possible conflicts
 - i. Compatibility problems
 - j. Time schedules
 - k. Weather limitations
 - l. Manufacturer's written recommendations
 - m. Warranty requirements
 - n. Compatibility of materials
 - o. Acceptability of substrates
 - p. Temporary facilities and controls
 - q. Space and access limitations
 - r. Regulations of authorities having jurisdiction
 - s. Testing and inspecting requirements
 - t. Installation procedures
 - u. Coordination with other Work
 - v. Required performance results
 - w. Protection of adjacent Work
 - x. 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.

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.
1. 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.

2. 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.
 3. 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 Engineer 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, Engineer, 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
028211	Abatement Licences, Permits and Notifications	Certification
028211	Abatement Federal, State, Local Citations on Previous Projects	Certification
028211	Abatement Qualifications	Certification
028211	Abatement Certificate of Worker Acknowledgement	Certification
028211	Abatement Initial Exposure Assessment	Test Report
028211	Abatement Initial Exposure Assessment	Test Report
028211	Abatement First Aid and CPR Trained Person Certification	Certification
028211	Abatement Material Safety Data Sheets	Product Data
028211	Abatement Drawings	Shop Drawings
028211	Abatement Safety and Health Program and Plans	Shop Drawings
028211	Abatement Records of the Respiratory Protection Program	Shop Drawings
028211	Abatement Materials and Equipment	Product Data
028211	Abatement Certificates	Certification
028211	Abatement Encapsulant	Product Data
028211	Abatement Disposal Facility, Transporter	Certification
028211	Abatement Rental Equipment	Certification
220503	Through Penetration Firestopping	Certification
220503	Through Penetration Firestopping	Shop Drawings
220513	Motors	Product Data
220513	Motors	Operation / Maintenance Manual
220529	Plumbing Supports and Anchors	Shop Drawings
220529	Plumbing Supports and Anchors	Product Data

SPEC SECTION	TITLE	CATEGORY
220548	Plumbing Vibration Isolation	Shop Drawings
220553	Plumbing Identification	Shop Drawings
220593	Plumbing TAB Qualifications, Procedures, and Report Forms	Test Report
220593	Plumbing TAB Report	Test Report
220716	Plumbing Equipment Insulation	Shop Drawings
220719	Plumbing Piping Insulation	Shop Drawings
220900	Instrumentation	Shop Drawings
221000	Plumbing Piping	Shop Drawings
221000	Plumbing Piping	Product Data
221000	Plumbing Piping	Test Report
221023	Natural Gas Piping	Product Data
221023	Natural Gas Piping	Test Report
221023	Natural Gas Piping	Certification
221030	Plumbing Specialties	Product Data
221123	Domestic Water Pumps	Product Data
221123	Domestic Water Pumps	Operation / Maintenance Manual
223000	Plumbing Equipment	Shop Drawings
223000	Plumbing Equipment	Certification
223000	Plumbing Equipment	Operation / Maintenance Manual
230503	Through Penetration Firestopping	Certification
230503	Through Penetration Firestopping	Shop Drawings
230513	Motors	Product Data
230513	Motors	Operation / Maintenance Manual
230515	Variable Frequency Drives	Shop Drawings
230515	Variable Frequency Drives	Product Data
230515	Variable Frequency Drives	Certification
230515	Variable Frequency Drives	Operation / Maintenance Manual
230516	HVAC Expansion Compensation	Shop Drawings
230529	HVAC Supports and Anchors	Shop Drawings
230529	HVAC Supports and Anchors	Product Data
230548	HVAC Vibration Isolation	Shop Drawings
230553	HVAC Identification	Shop Drawings
230593	TAB Qualifications, Procedures, and Report Forms	Test Report
230593	TAB Report	Test Report
230713	Ductwork Insulation	Shop Drawings
230716	HVAC Equipment Insulation	Shop Drawings

SPEC SECTION	TITLE	CATEGORY
230719	HVAC Piping Insulation	Shop Drawings
230900	Controls	Shop Drawings
230900	Controls	Product Data
230900	Controls	Operation / Maintenance Manual
230900	Controls	Warranty
230913	Instrumentation	Shop Drawings
231113	Facility Fuel-Oil Piping	Shop Drawings
231113	Facility Fuel-Oil Piping	Product Data
231213	Facility Fuel-Oil Pumps	Product Data
231213	Facility Fuel-Oil Pumps	Operation / Maintenance Manual
232100	Hydronic Piping	Product Data
232100	Hydronic Piping	Shop Drawings
232100	Hydronic Piping	Test Report
232116	Hydronic Specialties	Product Data
232123	HVAC Pumps	Product Data
232123	HVAC Pumps	Operation / Maintenance Manual
232500	Chemical (Water) Treatment	Shop Drawings
232500	Chemical (Water) Treatment	Product Data
232500	Chemical (Water) Treatment	Test Report
232500	Chemical (Water) Treatment	Operation / Maintenance Manual
233100	Ductwork	Shop Drawings
233300	Ductwork Accessories	Product Data
233700	Air Inlets and Outlets	Product Data
235100	Breechings, Chimneys, and Stacks	Shop Drawings
235100	Breechings, Chimneys, and Stacks	Product Data
235100	Breechings, Chimneys, and Stacks	Certification
235239	Fire Tube Boilers	Product Data
235239	Fire Tube Boilers	Test Report
235239	Fire Tube Boilers	Operation / Maintenance Manual
236430	Air Cooled Water Chillers	Product Data
236430	Air Cooled Water Chillers	Certification
236430	Air Cooled Water Chillers	Operation / Maintenance Manual
236430	Air Cooled Water Chillers	Warranty
238200	Terminal Heat Transfer Units	Shop Drawings
238200	Terminal Heat Transfer Units	Product Data
238200	Terminal Heat Transfer Units	Operation / Maintenance Manual

SPEC SECTION	TITLE	CATEGORY
260503	Through Penetration Firestopping	Certification
260503	Through Penetration Firestopping	Shop Drawings
260500	Wire and Cable	Product Data
260526	Grounding and Bonding	Product Data
260526	Grounding and Bonding	Shop Drawings
260533	Conduit and Boxes	Product Data
260553	Electrical Identification	Product Data
260553	Electrical Identification	Shop Drawings
260573	Power System Study	Shop Drawings
260573	Power System Study	Certification
260573	Power System Study	Test Report
262200	Dry-Type Transformers	Product Data
262416	Panelboards	Shop Drawings
262416	Panelboards	Product Data
262416	Panelboards	Operation / Maintenance Manual
262813	Fuses	Product Data
262816	Disconnect Switches	Product Data

SECTION 013513.16 - SITE SECURITY AND HEALTH REQUIREMENTS (DOC)

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. Revise list to include all required submittals.
 - 4. 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.
 - 5. Tuberculin skin test results for all employees required to be tested as set forth below.

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. The Contractor shall provide Facility Representatives notice twenty-four (24) hours prior to any possible vehicle entry and/or required escort. The Contractor shall maintain a time log of any delays in gaining entrance to the Facility due to lack of an escort, which is to be submitted monthly with the Contractor's pay request materials. The purpose of this log is to establish a basis for a contract change, if required. The log shall contain the date and time of delay, date and time of request of entry, workers delayed (name and occupation), and name of the Facility Representative to whom the request was made, if possible. Any delay in entry must be validated by sallyport and pass office personnel at the Facility. Only delays greater than thirty (30) minutes will be considered for a contract change. A 30-minute delay upon arrival with a vehicle to enter the sallyport should be expected.

3.2 RULES OF THE FACILITY

- A. The Contractor and its workers shall observe the following rules:
 - 1. There shall be no fraternization with inmates.
 - 2. No intoxicating beverages or illegal drugs shall be brought onto Facility grounds.
 - 3. No firearms, other weapons, or explosives shall be carried onto Facility grounds.
 - 4. No prescription drugs above one day's dosage shall be carried on Facility grounds.
 - 5. Any vehicle or individual is subject to search at any time while on Facility grounds.
 - 6. The vehicles of the Contractor and its workers shall be locked whenever unattended.
 - 7. All tools and equipment shall be tightly secured during non-working hours in the Contractor's storage trailer or assigned area.
 - 8. The Facility will not be responsible for the Contractor's tools, equipment, or materials. The Contractor shall keep and maintain a current tool inventory. The tool inventory shall be made available to Facility Representatives and the Owner upon request.
 - 9. The Contractor shall report any missing tools to Facility Representatives immediately.
 - 10. Smoking shall be permitted only in accordance with the regulations of the Facility.
 - 11. Possession or use of smokeless tobacco or smokeless non-tobacco alternatives is strictly prohibited.
- B. All workers shall be required to sign an acknowledgement of receipt of these rules.

3.3 SECURITY CLEARANCES AND RESTRICTIONS

- A. DOC SECURITY CLEARANCE REQUIREMENTS
 - 1. Prior to the commencement of any onsite work, the Contractor shall submit a list containing the name, date of birth, and Missouri driver's license number or social security number of all construction personnel to the Missouri Department of Corrections for the purpose of obtaining security clearances. The required information shall be submitted at the pre-construction meeting, or as otherwise directed by Department of Corrections' personnel. Any construction personnel with pending warrants or felony convictions within the last five (5) years or other offenses deemed to create a security risk by Department of Corrections shall not be allowed onsite. The Department of Corrections reserves the right to refuse admission to any individual they feel may be detrimental to the security of the Facility.

3.4 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. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

3.5 TUBERCULOSIS TESTING REQUIREMENTS

- A. All workers who will be in the confines of the Facility for more than ten (10) consecutive working days must provide proof of a negative tuberculin skin test. The test results must be no more than six (6) months old at the commencement of construction. The Contractor or the worker, not the Owner, shall pay the cost of the test.
- B. The Contractor shall submit to Facility Representatives current tuberculin skin test results for all workers who are required to have such a test in accordance with paragraph A above. If the contract period extends for more than twelve (12) months, the Contractor must provide new test results for all workers prior to the anniversary of the contract commencement date.
- C. Any worker required to have a tuberculin skin test under paragraph A above who fails or refuses to do so will be denied admission to the facility until such time as proof of the test results are provided.
- D. If any worker has a tuberculin skin test with positive results, the worker shall be denied access to the facility until the worker produces a certification from a physician licensed to practice in the State of Missouri that the worker does not have infectious tuberculosis.
- E. The Contractor shall not be entitled to any additional time or compensation if any of its workers are denied access to the facility because of failure to produce negative tuberculin skin test results.
- F. Failure or refusal of the Contractor to maintain and produce the required tuberculin skin test records shall be a material breach of this contract, which shall subject the Contractor to a declaration of default.

3.6 PREA FOR CONTRACTORS AND EMPLOYEES

- A. The contractor and all of the contractor's employees and agents providing services in any Department of Corrections institution must be at least 18 years of age. A Missouri Uniform Law Enforcement System (MULES) check or other background investigation may be required on the contractor, the contractor's employees and agents before they are allowed entry into the institution. The contractor, its employees and agents understand and agree that the Department may complete criminal background records checks annually for the contractor and the contractor's employees and agents that have the potential to have contact with inmates.
- B. The institution shall have the right to deny access into the institution for the contractor and any of the contractor's employees and agents for any reason, at the discretion of the institution.
- C. The contractor, its employees and agents under active federal or state felony or misdemeanor supervision must receive written division director approval prior to providing services pursuant to a Department contract. Similarly, contractors/employees/agents with prior felony convictions and not under active supervision must receive written division director approval in advance.
- D. The contractor, its employees and agents shall at all times observe and comply with all applicable state statutes, Department rules, regulations, guidelines, internal management policies and procedures, and general orders of the Department that are applicable, regarding operations and activities in and about all Department property. Furthermore, the contractor, its employees and agents, shall not obstruct the Department or any of its designated officials from performing their duties in response to court orders or in the maintenance of a secure and safe correctional environment. The contractor shall comply with the Department's policies and procedures relating to employee conduct.
 - 1. The Department has a zero tolerance policy for any form of sexual misconduct to include staff/contractor/volunteer on offender, or offender on offender, sexual harassment, sexual assault, sexual abuse and consensual sex.
 - a. Any contractor or contractor's employee or agent who witnesses any form of sexual misconduct must immediately report it to the warden of the institution. If a contractor or contractor's employee or agent fails to report or knowingly condones sexual harassment or sexual contact with or between offenders, the Department may cancel the contract, or at the Department's sole discretion, require the contractor to remove the employee/agent from providing services under the contract.
 - b. Any contractor or contractor's employee or agent who engages in sexual abuse shall be prohibited from entering the institution and shall be reported to law enforcement agencies and licensing bodies, as appropriate.
- E. The contractor, its employees and agents shall not interact with the offenders except as is necessary to perform the requirements of the contract. The contractor, its employees and agents shall not give anything to nor accept anything from the offenders except in the normal performance of the contract.
- F. If any contractor or contractor's employee or agent is denied access into the institution for any reason or is denied approval to provide service to the Department for any reason stated herein, it shall not relieve the contractor of any requirements of the contract. If the contractor is unable to perform the requirements of the contract for any reason, the contractor shall be considered in breach.

3.7 DISRUPTION OF UTILITIES

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

3.8 CELL PHONES AND ELECTRONIC DEVICES

- A. Cell Phones, pagers, smart watches (that can send/receive messages), fitness wrist bands (that can send/receive messages) or other electronic devices are not permitted.
 - 1. Contractors, repairpersons, or information technology services department staff may be permitted to bring in a cell phone and portable wireless router (Wi-Fi, MiFi, etc.) if approved by the Chief Administrative Officer (CAO) when the phone is necessary to complete job duties relating to repairs on a case by case basis.
 - 2. Tablets (iPad, etc.) are not allowed with the exception of for re-entry purposes approved via the division of adult institutions (DAI) director and the re-entry manager.
 - 3. Laptop computers may be permitted by the CAO on a case by case basis.

3.9 PROTECTION OF PERSONS AND PROPERTY

A. SAFETY PRECAUTIONS AND PROGRAMS

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

B. SAFETY OF PERSONS AND PROPERTY

1. The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:
 - a. clients, staff, the public, construction personnel, and other persons who may be affected thereby;
 - b. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and
 - c. other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.
2. The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.
3. The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.
4. When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.
5. The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in this Section caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under this Section, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.
6. The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its subcontractors of any tier.
7. The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.
8. The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.
9. The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.
10. The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.

11. In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.
12. The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for clients, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

END OF SECTION 013513.16

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 job-built temporary office, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.
 2. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sized and thicknesses indicated.

3. For fences and vision barriers, provide minimum 3/9" (9.5mm) thick exterior plywood.
 4. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" (16mm) thick exterior plywood.
- C. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.
- D. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary office, shops, and shed.
- E. Paint: Comply with requirements of Division 9 Section "Painting".
1. For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.
 2. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.
 3. For interior walls of temporary offices, provide two (2) quarts interior latex-flat wall paint.
- F. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.
- G. Water: Provide potable water approved by local health authorities.
- H. 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 Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.
- H. 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.
- I. 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: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
1. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP gas or fuel-oil heaters with individual space thermostatic control.
 2. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.
- F. Temporary 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.
- G. Temporary Telephones: The Owner will provide telephones within the facility. All construction personnel will be allowed access only to those specific telephones designated by the Construction Representative.
- H. Temporary Toilets: Use of the Owner's existing toilet facilities will be permitted, so long as facilities are cleaned and maintained in a condition acceptable to the Owner. All construction personnel will be allowed access only to those specific facilities designed by the Construction Representative. At substantial completion, restore these facilities to the condition prevalent at the time of initial use.
- I. 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.
- J. Drinking-Water Facilities: The Owner will provide drinking water facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.
- K. 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: Install storage sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere onsite.
- D. 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.
- E. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.
- F. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.
- G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
 - 1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and materials drying or curing requirements to avoid dangerous conditions and effects.
 - 2. Install tarpaulins securely with incombustible wood framing and other materials. Close openings of 25SqFt (2.3SqM) or less with plywood or similar materials.
 - 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
 - 4. Where temporary wood or plywood enclosure exceeds 100SqFt (9.2SqM) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.
- H. 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.
- I. Temporary Elevator Use: The building has no working elevators.

- J. 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.
- K. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.
- L. 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.
- M. Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished, permanent stairs with a protective covering of plywood or similar material so finishes will be undamaged at the time of acceptance.

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: If the existing, permanent fire-protection facilities must be interrupted to allow for construction, 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: If the existing, permanent fire-protection facilities are interrupted for construction as described above, then at the earliest feasible date in each area of the Project, restore operation of the permanent fire-protection 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. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at the temporary entrances as required by the governing authority.

3. 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 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 operation in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.
 - 1. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - 2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

- A. General
 - 1. Retain all stored items in an orderly arrangement allowing maximum access, not impending drainage or traffic, and providing the required protection of materials.
 - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
 - 3. At least once each month, 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 outside. Re-stack, tidy, or otherwise service all material arrangements.
 - 3. Maintain the site in a neat and orderly condition at all times.

C. Structure

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. Where work is required in areas with finished floors, clean the finish floor daily while work is being performed. "Clean" for the purpose of this subparagraph, shall be interpreted as meaning free from all foreign material which, in the opinion of the 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. Remove labels that are not permanent labels.
 11. 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.

12. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other foreign substances.
 13. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 14. Clean ducts, blowers, and coils if units were operated without filters during construction.
 15. Leave the Project clean and ready for occupancy.
- C. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.
- D. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.
1. Where extra materials of value remain after Final Acceptance by the Owner, they become the Owner's property.

END OF SECTION 017400

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Engineer.
 - 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 Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.

2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.

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

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

5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.

7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.

- f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 007213 "General Conditions".
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish 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

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PART 1 GENERAL

1.1 DESCRIPTION OF WORK

General: this section includes all Work necessary to reduce airborne fiber concentrations of asbestos to the specified level and maintain the specified asbestos control limits during the life of this Contract. The term "Contractor" when used in this specification shall always refer to the Asbestos Abatement Contractor. The term "Owners IH or Representative" shall refer to the third party Owner's Representative, independent of the Contractor, responsible for Work surveillance and who will be under separate contract to the Owner.

Regarding Asbestos Abatement, the Work includes the following;

Floor tile and Mastic

The all dimensions and numbers for the removal of all asbestos-containing materials (ACM) for each address is indicated on the Abatement Drawings (Appendix E) & are identified in the form of an ACBM Schedule, found in Appendix F, "Asbestos Containing Building Materials (ACBM) Schedule(s)."

This Specification describes procedures and equipment required to protect workers and occupants of the regulated area from contact with airborne asbestos fibers and ACM dust and debris.

Activities include OSHA Class I, II and III work operations involving ACM. The Work also includes containment, storage, transportation and disposal of the generated ACM wastes at an approved landfill. The Work will be conducted in one phase.

1.1.1 Abatement Work Tasks

The Contractor shall be responsible for removing and disposing of all asbestos-containing and asbestos contaminated materials in the areas designated on the Plans and referred to in the Specifications. The specific types of ACM to be abated are identified in the Specifications or on the Plans and Project Drawings (Appendix E). Refer to Appendix F for locations and estimated quantities of floor tile, floor tile mastic, linoleum & backing, duct wrap, mud tape, drywall and window & door glazing to be removed as part of the Work. No replacement materials for the abated materials are required. Abatement Contractor shall dispose of all demolition debris relating to his/her Work. Dumpster(s) can be placed in regulated area(s) assigned to this Contractor by the Owner. Contractor shall protect parking surface from dumpster damage.

Contractor shall be aware of and comply with the schedule and planned sequence for abatement and demolition activities. For the purpose of this Specification, Drawings are not intended to be used for anything other than a “reference” to the work areas. Information is not specific to quantities or to the exact location of ACM. **The Contractor is required to field verify the conditions, locations, and quantities referenced prior to submittal of its bid.**

1.1.2 Asbestos Abatement Contractor Responsibility

The Contractor shall assume full responsibility and liability for compliance with this Specification and all applicable Federal, State, and Local regulations related to any and all aspects of the Work. The Contractor is responsible for providing and maintaining training, accreditations, medical examinations, medical records, and personal protective equipment as required by applicable Federal, State and Local regulations for all persons working on this project. The Contractor will defend, indemnify and hold the Owner and Owner’s Representative harmless for Contractor’s failure to comply with any applicable packaging, transporting, disposal,

Work, safety, health, or environmental requirements on the part the Contractor, his employees, or his Subcontractors. The Contractor will incur all costs of all sampling and analytical cost to ensure compliance with OSHA/EPA/State requirements, as well as any fines, costs, or fees related to Contractor’s failure to comply with the regulations applicable to the Work.

1.1.3 Unexpected Discovery of Asbestos

For any previously untested building components suspected to contain asbestos and located in areas impacted by the Work, the Contractor shall notify the Owner’s Representative. Contractor shall cease Work in the area impacted until directions are received from the Owner or the Owner’s Representative. Any additional components identified as ACM that have been approved by the Owner’s Representative for removal shall be removed by the Contractor and will be paid for by an equitable adjustment to the contract price under the GENERAL CONDITIONS, ARTICLE 7 titled “CHANGES IN THE WORK”. Sampling activities undertaken to determine the presence of additional ACM shall be conducted by personnel who have successfully completed the EPA Model Accreditation Plan (MAP) "Building Inspector" training course required by 40 CFR 763, Subpart E, and Appendix C.

1.1.4 Stop Asbestos Removal

If the Owner or Owner’s Representative presents a “Stop Asbestos Removal Order”, the Contractor shall immediately stop all asbestos removal and maintain HEPA filtered air flow and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activities until authorized to do so by the Owner or Owner’s IH. Work stoppage will continue until conditions have been corrected to the satisfaction of the

Owner or the Owner's IH. Any and all delay costs, standby time and costs for corrective actions will be borne by the Contractor. The occurrence of any of the following events shall be reported immediately by the Contractor in writing to the Owner's IH and shall require the Contractor to immediately stop asbestos removal activities and initiate fiber reduction activities:

- 1.1.4.1 \geq 0.01 f/cc outside a regulated area,
- 1.1.4.2 breach/break in regulated area barrier(s),
- 1.1.4.3 loss of negative pressure in the regulated area (<0.02" of water),
- 1.1.4.4 serious injury / death within the regulated area,
- 1.1.4.5 fire/safety emergency within the regulated area,
- 1.1.4.6 respiratory system failure,
- 1.1.4.7 power failure, or
- 1.1.4.8 excessive airborne fibers (>0.5 f/cc) in the regulated area when wet methods are being used. An overloaded sample will be considered as a failure.

1.1.5 Work Site Conditions

1.1.5.1 Use of Existing Facilities

Maryville Treatment Center pipe chases will not be occupied at any time.

1.1.5.2 Means of Egress

Contractor shall establish and maintain emergency and fire exits from the work areas.

1.1.5.3 Access to Work Areas

Access to the work areas shall be through decontamination areas. Contractor's workforce, Owner's Representatives, inspectors and maintenance personnel shall have access to the work areas.

1.1.5.4 Visitors

No visitors except those authorized by the Owner. A logbook of all visitors to the work area shall be kept. This logbook shall be provided to the Owner as a closeout submittal for the Project.

1.2 SUBMITTALS

The Contractor shall, within ten (10) days of notification of selection for the award of a Contract for the Work and in accordance with this Specification, submit data on the following items specified herein. Submit to the Owner's Representative for review a minimum of two (2) copies bound into 3 ring binders, tabbed according to the submittal lettering system sequence utilized herein. **Any submittals received in any order other than that defined in section 1.2.1 herein, shall be rejected upon receipt.**

- 1.2.1 REQUIRED FOR REVIEW
- 1.2.1.1 Licenses, Permits and Notifications. See Section 1.12.
- 1.2.1.2 Federal, State, Local Citations on Previous Projects. See Section 1.3.3
- 1.2.1.3 Qualifications. See Section 1.3.2.
- 1.2.1.4 Certificate of Worker Acknowledgment. Attach the following required information listed in Section 1.3.2.3 to the Certificate of Worker Acknowledgment.
 - Training Certificates - See Section 1.9.
 - Current Medical Opinion - See Section 1.8.
 - Current Fit Test. See Section 3.10.
 - OSHA Training / Public Work Certificate. See Section 1.9.3.
- 1.2.1.5 Initial Exposure Assessment. See Section 3.9.2.
 - Negative Exposure Assessment. See Section 3.9.3.
- 1.2.1.6 First Aid and CPR Trained Person. See Section 1.3.2.5
- 1.2.1.7 Material Safety Data Sheets. See Section 1.11.
- 1.2.1.8 Drawings. Descriptions, detail project drawings, and site layout to include Work site containment area techniques, local exhaust ventilation system locations, decontamination units and load-out units, other temporary waste storage facility, access tunnels, location of temporary utilities (electrical, water, sewer) and boundaries of each regulated area.
- 1.2.1.9 Safety and Health Program and Plans. See Section 1.5.
- 1.2.1.10 Records of the Respiratory Protection Program. See Section 1.10.
- 1.2.1.11 Materials and Equipment. Submit manufacturer's catalog data for all materials and equipment to be used in the Work, including brand name, model, capacity, performance characteristics and any other pertinent information.
- 1.2.1.12 Certificates. See Section 1.18.
- 1.2.1.13 Encapsulant. See Section 2.1.
- 1.2.1.14 Disposal Facility, Transporter. See Section 1.3.2.7
- 1.2.1.15 Rental Equipment. See Section 1.12.2

1.3 QUALIFICATIONS

1.3.1 Written Qualifications and Organization Report

The Contractor shall furnish a written qualifications and organization report providing evidence of qualifications of the Contractor (Certification and State Asbestos Contractor License), Contractor's Project Supervisor, Designated

Competent Person, other supervisors and workers; independent testing laboratory (including name of firm who will perform analyses); all Subcontractors to be used including disposal transportation and disposal facility firms, Subcontractor supervisors, Subcontractor workers; and any others assigned to perform asbestos abatement and support activities. The report shall include an organization chart showing the Contractor's staff organization for this Project by name and title, chain of command and reporting relationship with all Subcontractors. The report shall be signed by the Contractor, the Contractor's onsite Project Supervisor, Designated Competent Person and the principals of all Subcontractors to be used.

The Contractor shall include the following statement in the report:

"By signing this report I certify that the personnel I am responsible for during the course of this Work fully understand the contents of 29 CFR 1926.1101, 40 CFR 61, Subpart M, other federal, state and local requirements specified herein, and that the personnel understand the nature and scope of those asbestos abatement activities that they will be involved in."

1.3.2 Specific Requirements

The Contractor shall designate in writing, personnel meeting the following qualifications:

1.3.2.1 Project and Other Supervisors

The Contractor shall provide the name, address, telephone number, and resume of the Project Supervisor and other supervisors who have responsibility to implement the Health and Safety Plan, including the Abatement Work Plan and the authority to direct Work performed under this Contract and verify compliance of the Work with the Contract Documents and all applicable laws, rules and regulations, and have EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C. The Project Supervisor and other supervisors shall provide, and the Contractor shall submit, the Missouri State Certificate for Asbestos Related Occupations and the most recent certificate for required refresher training. Attach the training certificate and the Missouri State Certificate for Asbestos Related Occupations to the "Certificate of Worker Acknowledgment" found in Appendix "C". See 1.3.2.3.

The Contractor shall submit evidence that the Project Supervisor has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA competent person requirements. The Project Supervisor shall be onsite at all times during the conduct of the Work.

The Project Supervisor shall be experienced in the administration and supervision of asbestos abatement projects, including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, etc.

Additional duties of the Project Supervisor shall include the following: controlling entry to and exit from the regulated area; supervising any employee exposure monitoring required by 29 CFR 1926.1101; ensuring that all employees working within a regulated area wear the appropriate personal protective equipment (PPE), are trained in the use of appropriate methods of exposure control, and use the hygiene facilities and decontamination procedures specified; and ensuring that engineering controls in use are in proper operating conditions and are functioning properly. The Project Supervisor shall be responsible for compliance with applicable federal, state and local requirements, the Contractor's Health and Safety Plan and Abatement Work Plan.

Other supervisors have a minimum of 1 year on-the-job asbestos abatement experience commensurate with the responsibilities they will have on this Project.

1.3.2.2 Asbestos Abatement Workers:

Asbestos abatement workers shall meet the requirements contained in 29 CFR 1926.1101, 40 CFR 61, Subpart M, and other applicable federal, state and local requirements. The Contractor shall submit the "Worker" course completion certificate, Missouri State Certificate for Asbestos Related Occupations and the most recent certificate for required refresher training. Attach the training certificate and the Missouri State Certificate for Asbestos Related Occupations to the "Certificate of Worker Acknowledgment" found in Appendix "C". See 1.3.2.3.

1.3.2.3 Certification of Worker Acknowledgment

Training documentation is required for each employee who will perform OSHA Class I, Class II, Class III, or Class IV asbestos abatement operations. The following documentation shall be attached to the "Certificate of Workers Acknowledgment" form.

1. Most recent refresher training certificate (1.9.1);
2. Current State of Missouri Certificate for Asbestos Related Occupations (1.9.1);
3. Current Written Medical Opinion per Paragraph 1.8 below and
4. Current fit test record per Paragraph 1.10 below.

All Contractor employees are required to have current refresher training certificates, current State of Missouri Certificate, for Asbestos Related Occupations, current written medical opinion and fit test. Any Contractor employee with outdated information will not be allowed to perform any work on site.

1.3.2.4 First Aid and CPR Trained Persons

The name of at least 1 person who is currently trained in first aid and CPR by the American Red Cross or other approved agency shall be designated and **shall be onsite at all times during site operations**. The person shall be trained in universal precautions and the use of PPE as described in the Blood borne Pathogens Standard of 29 CFR 1910.1030 and shall be included in the Contractor's Blood borne Pathogen Program. This person may perform other duties but shall be immediately available to render first aid when needed. A copy of each designated person's current valid First Aid and CPR certificate shall be provided.

1.3.2.5 Disposal Facility, Transporter

The Contractor shall provide written evidence that the landfill to be used for disposal of ACM for this Project is approved for asbestos disposal by the State of Missouri regulatory agencies.

Copies of signed agreements between the Contractor (including Subcontractors and transporters) and the asbestos waste disposal facility to accept and dispose of all asbestos containing waste generated during the performance of this Contract shall be provided. Qualifications shall be provided for each Subcontractor or transporter to be used, indicating previous experience in transport and disposal of asbestos waste to include all required state and local waste hauler requirements for asbestos. The Contractor and transporters shall meet the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and other applicable state or local requirements. The disposal facility shall meet the requirements of 40 CFR 61.154 or .155, as required in 40 CFR 61.150(b) and other applicable state or local requirements.

1.3.3 Federal, State or Local Citations on Previous Projects.

The Contractor and all Subcontractors shall submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations).

If there are none, a negative declaration signed by an officer of the company shall be provided.

1.4 REGULATORY REQUIREMENTS

In addition to detailed requirements of this Specification, Work performed under this Contract shall comply with all applicable federal, state, and local laws, ordinances, criteria, rules and regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. This includes, but is not limited to, OSHA standards, 29 CFR 1926, especially Section 1101, 40 CFR 61, Subpart M and 40 CFR 763. This also includes Missouri House Bill 1549, Section 285.525 – 285.550. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting Work. Where the requirements of this Specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply. The Contractor shall follow federal, state and local laws, rules and regulations regarding demolition, removal, encapsulation, construction, repair, maintenance, renovation, spill/emergency cleanup, housekeeping, handling, storing, transporting and disposing of asbestos materials.

1.5 HEALTH AND SAFETY PLAN

The Contractor shall develop and submit a written comprehensive **site-specific** Health and Safety Plan. The Health and Safety shall address requirements covering onsite Work to be performed by the Contractor and his Subcontractors.

The plan shall incorporate topics including but not limited to respirator program, cold/heat stress, hazard communication program, confined space entry program, slips, trips and fall protection, lockout/ tag out, scaffolding safety, hearing protection, eye and face protection, head protection, and electrical safety. A copy of the written Health and Safety Plan shall be maintained onsite. Should any unforeseen hazard become evident during the performance of the Work, the Designated Project Supervisor shall bring such hazard to the attention of the Owner's Representative and the Owner, both verbally and in writing, for resolution as soon as possible. In the interim, all necessary action shall be taken by the Contractor to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Changes and modifications to the accepted Health and Safety Plan shall be made with the knowledge and concurrence of the Project Supervisor, Designated Competent Person, and the Owner's Representative. Any portions of the Contractor's overall Health and Safety Plan that are referenced in the Abatement Work Plan shall be included as appendices to the Abatement Work Plan. The plan shall take into consideration all the individual asbestos abatement work tasks identified in the Scope of Work.

1.6 ABATEMENT WORK PLAN

The Contractor shall meet with the Owner and Owner's Representative prior to beginning Work for a preconstruction conference to discuss the details of the Contractor's submitted Abatement Work Plan. The purpose of the meeting is to discuss the Abatement Work Plan and any revisions that might be required. Once the Abatement Work Plan has been accepted, the Contractor shall follow his Work plan. Once accepted by the Owner's Representative, the Abatement Work Plan will be enforced as if an addition to the Contract. Disregarding the provisions of this Contract or the accepted Abatement Work Plan will be cause for stopping of Work, at the discretion of the Owner's Representative, until the matter has been rectified.

The Plan shall be prepared, signed and dated by the Contractor's Designated Competent Person, or Project Supervisor.

1.6.1 Abatement Work Plan – (May include coordination with demolition contractor)

The Abatement Work Plan shall include, but not be limited to the following:

- 1.6.1.1 The personal protective equipment to be used;
- 1.6.1.2 The location and description of regulated areas including clean and dirty areas, access tunnels, and decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit);
- 1.6.1.3 Initial exposure assessment in accordance with 29 CFR 1926.1101;
- 1.6.1.4 Level of supervision;
- 1.6.1.5 Method of notification of other employers at the Worksite;
- 1.6.1.6 Abatement method to include containment and control procedures;
- 1.6.1.7 Interface of trades involved in the construction;
- 1.6.1.8 Sequencing of asbestos related Work;
- 1.6.1.9 Storage and disposal procedures and plan;
- 1.6.1.10 Type of wetting agent and asbestos encapsulant to be used;
- 1.6.1.11 Drawings showing locations of local exhaust equipment;
- 1.6.1.12 Air monitoring methods (personal)
- 1.6.1.13 A detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber concentrations;
- 1.6.1.14 Fire and medical emergency response procedures;

1.6.1.15 The security procedures to be used for all regulated areas.

1.7 SECURITY

A log book shall be kept documenting entry into and out of the regulated areas. Entry into regulated areas shall only be by personnel authorized by the Owner, Owner's Representative and the Contractor. Personnel authorized to enter regulated areas shall be trained, be medically evaluated, and wear the required personal protective equipment for the specific regulated area to be entered. The log book shall become a part of the Closeout Documents submitted to the Owner.

1.8 MEDICAL REQUIREMENTS

Medical requirements shall conform to 29 CFR 1926.1101, Medical Examinations. Before being exposed to airborne asbestos fibers, workers shall be provided with a medical examination as required by 29 CFR 1926.1101 and other pertinent state or local requirements. This requirement shall have been satisfied within the last 12 months.

1.8.1 Written Medical Opinion

For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:

- 1.8.1.1 Summary of the results of the examination.
- 1.8.1.2 The potential for an existing physiological condition that would place the employee at an increased risk of health impairment from exposure to asbestos.
- 1.8.1.3 The ability of the individual to wear personal protective equipment, including respirators, while performing strenuous work tasks under cold and/or heat stress conditions.
- 1.8.1.4 A statement that the employee has been informed of the results of the examination, provided with a copy of the results, informed of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos exposure, and informed of any medical condition that may result from asbestos exposure. **Attach medical form to "Certificate of Workers Acknowledgment" found in Appendix C.**

1.8.2 Medical and Exposure Records

Complete and accurate records shall be maintained of each employee's medical examinations, medical records, and exposure data, as required by 29 CFR 1910.20 and 29 CFR 1926.1101. A copy of the required medical certification for each employee shall be maintained on file at the Project site for review.

1.9 TRAINING PROGRAM

1.9.1 General Training Requirements

The Contractor shall establish a training program as specified by EPA Model Accreditation Plan (MAP), training requirements at 40 CFR 763, Subpart E, Appendix C, the State of Missouri regulation 10 CSR 10-6, OSHA requirements at 29 CFR 1926.1101(k)(9), and this Specification. Contractor employees shall complete the required training for the type of Work they are to perform and such training shall be documented and provided to the Owner's Representative as specified in paragraph QUALIFICATIONS (1.3). **Submit new or refresher training and Missouri certificate(s) with submittal.**

1.9.2 Project Specific Training

Prior to commencement of Work, each worker shall be instructed by the Contractor's Designated Competent Person in the following project specific training:

- 1.9.2.1 The hazards and health effects of the specific types of ACM to be abated;
 - 1.9.2.2 The content and requirements of the Contractor's Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and site-specific safety and health precautions;
 - 1.9.2.3 Hazard Communication Program;
 - 1.9.2.4 Hands-on training for each asbestos abatement technique to be employed;
 - 1.9.2.5 Heat and/or cold stress monitoring specific to this Work;
 - 1.9.2.6 Air monitoring program and procedures;
 - 1.9.2.7 Confined Space Entry Program (If Applicable);
 - 1.9.2.8 The association of cigarette smoke and asbestos-related disease;
 - 1.9.2.9 Security procedures;
 - 1.9.2.10 Specific Work practice controls and engineering controls required for each Class of Work in accordance with 29 CFR 1926.1101.
- ### 1.9.3 OSHA Training / Public Work

Prior to commencement of Work, each worker shall receive the (10) hour OSHA construction safety program training. Submit completion certificate with submittal.

1.10 RESPIRATORY PROTECTION PROGRAM

The Contractor's Designated Person shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926.1101 and 29 CFR 1910.134. The Contractor's respiratory protection program shall include, but not be limited to, the following elements:

- 1.10.1 The company policy, used for the assignment of individual responsibility, accountability, and implementation of the respiratory protection program.
- 1.10.2 The standard operating procedures covering the selection and use of respirators. Respiratory selection shall be determined by the hazard to which the worker is exposed.
- 1.10.3 Medical evaluation of each user to verify that the worker may be assigned to an activity where respiratory protection is required.
- 1.10.4 Training in the proper use and limitations of respirators.
- 1.10.5 Respirator fit-testing, i.e., quantitative, qualitative and individual functional fit checks.
- 1.10.6 Regular cleaning and disinfection of respirators.
- 1.10.7 Routine inspection of respirators during cleaning and after each use when designated for emergency use.
- 1.10.8 Storage of respirators in convenient, clean, and sanitary locations.
- 1.10.9 Surveillance of regulated area conditions and degree of employee exposure (e.g., through air monitoring). Regular evaluation of the continued effectiveness of the respiratory protection program.
- 1.10.10 Recognition and procedures for the resolution of special problems as they affect respirator use (e.g., no facial hair that comes between the respirator face piece and face or interferes with valve function; prescription eye wear usage; contact lenses usage; etc.).
- 1.10.11 Proper training in putting on and removing respirators.

1.10.12 Respiratory Fit Testing

A qualitative or quantitative fit test conforming to 29 CFR 1926.1101, Appendix C shall be conducted by the Contractor for each worker required to wear a respirator, and for any and all authorized visitors who enter a regulated area where respirators are required to be worn. Provide a copy of the current fit test as required in Section 1.2.1.4. A respirator fit test shall be performed for each worker wearing a negative-pressure respirator prior to initially wearing a respirator on this Project. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn or of full-face piece air purifying respirators where they are worn at levels at which half-face piece air purifying respirators are permitted. If physical changes develop that will affect the fit, a new fit test for the worker shall be performed. Functional fit checks shall be performed by employees each time a respirator is put on and in accordance with the manufacturer's recommendation. Submit current fit test with submittal.

1.10.13 Respirator Selection and Use Requirements

The Contractor shall provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with the manufacturer's recommendations. Respirators shall be approved by the National Institute for Occupational Safety and Health (NIOSH) for use in environments containing airborne asbestos fibers. Personnel, who handle ACM, enter regulated areas that require the wearing of a respirator, or who are otherwise carrying out abatement activities that require the wearing of a respirator, shall be provided with approved respirators that are fully protective of the worker at the measured or anticipated airborne asbestos concentration level to be encountered. For air-purifying respirators, the particulate filter portion of the cartridges or canister approved for use in airborne asbestos environments shall be high-efficiency particulate air (HEPA). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type shall be made by the Contractor's Designated Competent Person based on the measured or anticipated airborne asbestos fiber concentrations to be encountered. Respirators shall be used in the following circumstances:

- a. During all Class I asbestos jobs.
- b. During all Class II Work where the ACM is not removed in a substantially intact state.
- c. During all Class II and III Work that is not performed using wet methods. Respirators need not be worn during removal of ACM from sloped roofs when a negative exposure assessment has been made and ACM is removed in an intact state.
- d. During all Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment.
- e. During all Class III jobs where TSI or surfacing ACM is being disturbed.

- f. During all Class IV Work performed within regulated areas where employees performing other work are required to wear respirators.
- g. During all Work where employees are exposed above the PEL-TWA or PEL Excursion Limit.
- h. In emergencies

1.10.14 Class I Work

The Contractor shall provide: (1) a tight-fitting, powered air purifying respirator equipped with high efficiency filters, or (2) a full-face piece supplied air respirator operated in the pressure demand mode, equipped with HEPA egress cartridges, or (3) an auxiliary positive pressure self-contained breathing apparatus, for all employees within the regulated area where Class I Work is being performed; provided that a negative exposure assessment has not been produced, and that the exposure level will not exceed 1 f/cc as an 8-hour time weighted average. If the exposure assessment indicates exposure levels above 1 f/cc as an 8-hour time weighted average, a full-face piece supplied air respirator, operated in the pressure demand mode, equipped with an auxiliary positive pressure self-contained breathing apparatus shall be provided and used by all persons in the regulated area.

1.10.15 Class II and III Work

The Contractor shall provide an air purifying respirator, other than a disposable respirator, equipped with high-efficiency filters whenever the employee performs Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment, and on Class III jobs where TSI or surfacing ACM is being disturbed.

1.10.16 Sanitation

Employees who wear respirators shall be permitted to leave work areas to wash their faces and respirator face pieces whenever necessary to prevent skin irritation associated with respirator use.

1.11 HAZARD COMMUNICATION PROGRAM

A hazard communication program shall be established and implemented in accordance with 29 CFR 1926.59. Material safety data sheets (MSDSs) shall be provided for all hazardous materials brought onto the Project site. One copy shall be provided to the Owner's Representative and 1 copy shall be included in the Contractor's Hazard Communication Program.

1.12 LICENSES, PERMITS AND NOTIFICATIONS

1.12.1 General Legal Requirements

All necessary licenses, permits and notifications shall be obtained in conjunction with the Project's asbestos abatement, transportation and disposal actions, and timely notification furnished of such actions as required by federal, state, regional, and local authorities. The Contractor shall notify the appropriate regulatory office responsible for asbestos air emissions and the Owner's Representative in writing, at least 10 days prior to the commencement of Work, in accordance with 40 CFR Part 61.146 of Subsection M, and state and local requirements. Notification shall be by Certified Mail, Return Receipt Requested. The Contractor shall furnish copies of the notice to the Owner and the Owner's Representative prior to commence of Work. For licenses, permits, and notifications that the Contractor is responsible for obtaining, the Contractor shall pay any associated fees or other costs incurred. Provide Owner and Owner's Representative with a copy of the Notice.

1.12.2 Rental Equipment

If rental equipment is to be used, written notification shall be provided to the rental agency, concerning the intended use of the equipment, the possibility of asbestos contamination of the Equipment and the steps that will be taken to decontaminate such equipment. A written acceptance of the terms of the Contractor's notification shall be obtained from the rental agency. A copy of the rental company's written acknowledgment and agreement shall be provided.

1.12.3 Litigation and Notification

The Contractor shall notify the Owner's Representative if any of the following occur:

1.12.3.1 The Contractor or any of the Subcontractors are served with notice of violation of any law, regulation, permit or license which relates to this Contract or the Project;

1.12.3.2 Proceedings are commenced which could lead to revocation of related permits or licenses; permits, licenses or other Owner authorizations relating to this Contract or the Project are revoked;

1.12.3.3 Litigation is commenced which would affect this Contract or Contractor's ability to timely complete the Work;

The Contractor or any of the Subcontractors become aware that their equipment or facilities are not in compliance or may fail to comply in the future with applicable laws or regulations.

1.13 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment shall be made available to the Owner's Representative and authorized visitors for entry to the regulated area as needed. Owner's Representative and authorized visitors shall have appropriate training in the selection, fitting, and use of the required personal protective equipment. Owner's Representative and authorized visitors shall abide by the site safety and health requirements. Contractor's workers shall be provided with personal protective clothing and equipment and the Contractor shall ensure that it is worn properly. The Contractor's Designated Competent Person shall select and approve all the required personal protective clothing and equipment to be used.

1.13.1 Respirators

Respirators shall be in accordance with paragraph RESPIRATORY PROTECTION PROGRAM.

1.13.2 Whole Body Protection

Personnel exposed to airborne concentrations of asbestos that exceed the PELs, or for personnel working on any OSHA Class of Work for which a required negative exposure assessment is not produced, shall be provided with whole body protection and such protection shall be worn properly. The Contractor's Designated Competent Person shall select and approve the whole body protection to be used. The Project Supervisor shall examine work suits worn by employees at least once per work shift for rips or tears that may occur during performance of Work. When rips or tears are detected while an employee is working, rips and tears shall be immediately mended, or the work suit shall be immediately replaced. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the regulated area. Whole body protection used for asbestos abatement shall not be removed from the worksite by a worker to be cleaned. Recommendations made by the Contractor's Designated Competent Person to downgrade whole body protection shall be submitted in writing to the Owner's Representative. The Contractor's Designated Competent Person, in consultation with the Project Supervisor, has the authority to take immediate action to upgrade or downgrade whole body protection when there is an immediate danger to the health and safety of the wearer. Reusable whole body protection is not permitted.

1.13.2.1 Coveralls

Disposable-breathable coveralls with a zipper front shall be provided. Sleeves shall be secured at the wrists, and foot coverings secured at the ankles. Attached hood type head covering shall be provided.

1.13.2.2 Work Clothing

An additional coverall shall be provided when the abatement and control method employed does not provide for the exit from the regulated area directly into an attached decontamination unit. Cloth work clothes for wear under the protective coverall, and foot coverings, shall be provided when Work is being conducted in low temperature conditions. Cloth work clothes shall be either disposed of as asbestos contaminated waste or properly laundered in accordance with EPA, DOT and OSHA regulations.

1.13.2.3 Gloves

Gloves shall be provided to protect the hands. Where there is the potential for hand injuries (i.e., scrapes, punctures, cuts, etc.) a suitable glove shall be provided and used.

1.13.2.4 Foot Coverings

Cloth socks shall be provided and worn next to the skin. Footwear, as required by OSHA that is appropriate for safety and health hazards in the area shall be worn. Rubber boots shall be used in moist or wet areas. Reusable footwear removed from the regulated area shall be thoroughly decontaminated or disposed of as ACM waste. Disposable protective foot covering shall be disposed of as ACM waste. If rubber boots are not used, disposable foot covering shall be provided.

1.13.2.5 Head Covering

Protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the regulated area after being thoroughly decontaminated.

1.13.2.6 Protective Eye Wear

Eye protection provided shall be in accordance with ANSI Z87.1.

1.14 HYGIENE FACILITIES AND PRACTICES

The Contractor shall establish a decontamination area for the decontamination of employees, material and equipment. The Contractor shall ensure that employees enter and exit the regulated area through the decontamination area.

1.14.1 Shower Facilities

Shower facilities, when provided, shall comply with 29 CFR 1910.141(d) (3).

1.14.2 3-Stage Decontamination Area

A temporary negative pressure decontamination unit that is adjacent and attached in a leak-tight manner to the regulated area shall be provided. Utilization of prefabricated units shall have prior approval of the Owner's Representative. The decontamination unit shall have an equipment room and a clean room separated by a shower that complies with 29 CFR 1910.141 (unless the Contractor can demonstrate that such facilities are not feasible). Shower enclosures shall be leak proof, opaque and constructed of disposable or easily washable materials. Sheet plastic used in the construction of the decontamination unit shall be polyethylene of 6 mil minimum thickness. Sheet plastic shall conform to ASTM D 4397.

Equipment and surfaces of containers filled with ACM shall be cleaned prior to removing them from the equipment room or area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste. Two separate lockers shall be provided for each asbestos worker, one in the equipment room and one in the clean room. Hot water service may be secured from the building hot water system provided back flow protection is installed by the Contractor at the point of connection. Should sufficient hot water be unavailable, the Contractor shall provide a minimum 40 gallon electric water heater with minimum recovery rate of 20 gallons per hour and a temperature controller for each showerhead. The Contractor shall provide **one (1) shower for every ten (10) workers as a minimum** for each sex. Instantaneous type in-line water heater may be incorporated at each shower head in lieu of hot water heater, upon approval by the Owner's Representative. Flow and temperature controls shall be located within the shower and shall be adjustable by the user. The wastewater pump shall be sized for 1.25 times the showerhead flow-rate at a pressure head sufficient to satisfy the filter head loss and discharge line losses. Contractor shall ensure the water supply to the shower is shut off at the end of each work shift.

Used shower water shall be collected and filtered to remove asbestos contamination. Filters and residue shall be disposed of as asbestos contaminated material. Filtered water shall be discharged to the sanitary system. Wastewater filters shall be installed in series with the first stage pore size of 20 microns and the second stage pore size of 5 microns. The floor of the decontamination unit's clean room shall be kept dry and clean at all times. Water from the shower shall not be allowed to wet the floor in the clean room. Surfaces of the clean room and shower shall be wet-wiped twice after each shift change with a disinfectant solution. Proper housekeeping and hygiene requirements shall be maintained. Soap and towels shall be provided for showering, washing and drying. Any cloth towels provided shall be disposed of as ACM waste or shall be laundered in accordance with 29 CFR 1926.1101.

1.14.3 Load-Out Unit

Provide a temporary load-out unit that is adjacent and connected to the regulated area. Utilization of prefabricated units shall have prior approval of the Owner's Representative. The load-out unit shall be attached in a leak-tight manner to each regulated area. Surfaces of the load-out unit and access tunnel shall be adequately wet-wiped 2 times after each shift change. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

1.14.4 Single Stage Decontamination Area

A decontamination area (equipment room/area) shall be provided for Class I Work involving less than 25 feet or 10 square feet of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment produced before the operation. The equipment room or area shall be adjacent to the regulated area for the decontamination of employees, material, and their equipment which is contaminated with asbestos. The equipment room or area shall consist of an area covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

1.14.5 Decontamination Requirements for Class IV Work

The Contractor shall ensure that employees performing Class IV Work within a regulated area comply with the hygiene practice required of employees performing Work which has a higher classification within that regulated area, or the Contractor shall provide alternate decontamination area facilities for employees cleaning up debris and material which is TSI or surfacing ACM.

1.14.6 Decontamination Area Entry and Exit Procedures

The Contractor shall ensure that employees enter and exit the decontamination area through the clean room or clean area as required in 29 CFR 1926.1101 (j).

1.14.7 Employee Break Area

The Contractor shall provide a separate, controlled break area for employees use such as rest and eating in which the airborne concentrations of asbestos are below 0.01 f/cc.

1.14.8 Smoking

Smoking, if allowed by the Contractor, shall only be permitted in designated areas approved by the Owner. No smoking is allowed in any Building.

1.15 REGULATED AREAS

All Class I, II, and III Asbestos Work shall be conducted within regulated areas. The regulated area shall be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they shall demarcate the regulated area. Access to regulated areas shall be limited to authorized persons. The Contractor shall control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

1.16 WARNING SIGNS AND TAPE

Warning signs and tape printed in English, and other languages as needed, shall be provided at the regulated boundaries and entrances to regulated areas. The Contractor shall ensure that all personnel working in areas contiguous to regulated areas comprehend the warning signs. Signs shall be located to allow personnel to read the signs and take the necessary protective steps required before entering the area. Warning signs shall be in vertical format conforming to 29 CFR 1910 and 29 CFR 1926.1101, a minimum of 20 by 14 inches, and displaying the following:

DANGER
ASBESTOS
CANCER AND LUNG
DISEASE HAZARD
AUTHORIZED
PERSONNEL ONLY

RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA

Warning tape shall be provided as needed. Warning tape shall be fastened on a minimum of 10 foot centers and at least 3 feet off ground/floor height.

Decontamination unit signage shall be as shown.

Sign A: NO FOOD
BEVERAGES OR
TOBACCO
PERMITTED

Sign B: ALL PERSONS SHALL
REMOVE STREET CLOTHING
AND PUT ON PROTECTIVE CLOTHING
AND RESPIRATOR BEFORE ENTERING THE
WORK AREA

Sign C: ALL PERSONS SHALL SHOWER IMMEDIATELY
AFTER EXITING WORK AREA AND BEFORE
ENTERING THE CLEAN ROOM

Provide signs in English and other languages required by contract. Install at eye level.

1.17 WARNING LABELS

Warning labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements are acceptable. Warning labels shall conform to 29 CFR 1926.1101 and shall be of sufficient size to be clearly legible displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

1.18 LOCAL EXHAUST VENTILATION

Local exhaust ventilation units shall conform to ANSI Z9.2 and 29 CFR 1926.1101. Filters on local exhaust system equipment shall conform to ANSI Z9.2 and UL 586. Filter shall be UL labeled.

1.19 TOOLS

Vacuums shall be leak proof to the filter, equipped with HEPA filters, of sufficient capacity and necessary capture velocity at the nozzle or nozzle attachment to efficiently collect, transport and retain the ACM waste material. Power tools shall not be used to remove ACM unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation capture and collection system, or has otherwise been approved for use by the Owner's Representative. Residual asbestos shall be removed from reusable tools prior to storage and reuse. Reusable tools shall be thoroughly decontaminated prior to being removed from regulated areas. Tools must be locked in a metal container with a keyed or combination lock for overnight storage. The storage container must be stored on the east side of the facility, near the water tower.

1.20 AIR MONITORING EQUIPMENT

The Owner's Designated Competent Person shall approve air monitoring equipment to be used to collect samples. The Contractor shall follow the requirements found in 29 CFR 1926.1101 (f) "Exposure Assessment and Monitoring".

1.21 EXPENDABLE SUPPLIES

1.21.1 Glove bags

Glove bags shall be provided as described in 29 CFR 1926.1101. The glove bag assembly shall be 6 mil thick plastic, prefabricated and seamless at the bottom with preprinted OSHA warning label.

1.21.2 Duct Tape

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container shall be provided.

1.21.3 Disposal Containers

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926.1101.

1.21.4 Disposal Bags

Leak-tight bags, 6 mil thick, shall be provided for disposal of asbestos generated waste.

1.21.5 Fiberboard Drums

Fiberboard drums shall be lined with a leak tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal bag(s) for ACM wastes as required by 29 CFR 1926.1101.

1.21.6 Cardboard Boxes

Heavy-duty corrugated cardboard boxes, coated with plastic or wax to retard deterioration from moisture, shall be provided. Boxes shall fit into selected ACM disposal bags. Filled boxes shall be sealed leak-tight with duct tape.

1.21.7 Sheet Plastic

Sheet plastic shall be polyethylene of 6 mil minimum thickness (except as noted elsewhere) for wall and floor applications and shall be provided in the largest sheet size necessary to minimize seams, as indicated on the Project Drawings. Film shall be clear and conform to ASTM D 4397, except as specified below:

1.21.7.1 Flame Resistant

Where a potential for fire exists, flame-resistant sheets shall be provided. Film shall be frosted or black and shall conform to the requirements of NFPA 701.

1.21.7.2 Reinforced

Reinforced sheets shall be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock shall consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film shall meet flame resistant standards of NFPA 701.

1.21.8 Amended Water

Amended water shall meet the requirements of ASTM D 1331.

1.21.9 Mastic Removing Solvent (as applicable)

Mastic removing solvent shall be nonflammable and shall not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite shall have a flash point greater than 60 Degrees C. 140 degrees F. Mastic removal solvents shall be a soy-based low odor mastic removal solvent.

1.21.10 Leak-tight Wrapping

Two separate layers of 6 mil minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as window sashes, cement asbestos board, insulated pipe segments and other materials too large to be placed in disposal bags. Upon placement of the ACM component or material, each layer shall be individually leak-tight with offsetting seams sealed with duct tape.

1.21.11 Viewing Inspection Window

Where feasible, a minimum of 1 clear, 1/8 inch thick, acrylic sheet, 18 by 24 inches, shall be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows shall be sealed leak-tight with industrial grade duct tape.

1.21.12 Wetting Agents

Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulant are specified in paragraph ENCAPSULANTS.

1.22 MISCELLANEOUS ITEMS

A sufficient quantity of other items, such as, but not limited to: scrapers, brushes, brooms, staple guns, tarpaulins, shovels, rubber squeegees, dust pans, other tools, scaffolding, staging, enclosed chutes, wooden ladders, lumber necessary for the construction of containments, UL approved temporary electrical equipment, material and cords, ground fault circuit interrupters, water hoses of sufficient length, fire extinguishers, first aid kits, portable toilets, logbooks, log forms, markers with indelible ink, spray paint in bright color to mark areas, work boundary fencing, etc., shall be provided.

PART 2 PRODUCTS

2.1 ENCAPSULANTS

A sealant shall penetrate the asbestos containing material (ACM), withstand moderate impact, be flexible and flame retardant, resist deterioration over time, have pigmentation and be non-toxic. Apply sealant with airless spray equipment.

2.2 EQUIPMENT

Equipment, including protective clothing and respirators, used in the execution of this Contract and provided to visitors to the site, shall comply with ASTM E 849 and with the applicable Federal, State and local regulations. Respirators and the Contractor's employee Respirator Program shall conform to the OSHA requirements in 29 CFR 1910.134.

2.3 AMENDED WATER

A wetting agent shall consist of a minimum of 50% polyoxyethylene ester and 50% polyoxyethylene ether. There shall be one ounce of wetting agent per five (5) gallons of water.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Asbestos Abatement Work tasks shall be performed as shown on the Plans and Drawings, as summarized in paragraph DESCRIPTION OF WORK, the Contractor's Accident Prevention Plan and the Asbestos Hazard Abatement Plan.

The Contractor shall use the engineering controls and work practices required in 29 CFR 1926.1101(g) in all operations regardless of the levels of exposure. Personnel shall wear and utilize protective clothing and equipment as specified. The Contractor shall not permit eating, smoking, drinking, chewing or applying cosmetics in the regulated area.

Personnel of other trades, not engaged in asbestos abatement activities, shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions of the Contractor's Accident Prevention Plan are complied with. Power to the regulated area shall be locked-out and tagged in accordance with 29 CFR 1910, and temporary electrical service with ground fault circuit interrupters shall be provided as needed. Temporary electrical service shall be disconnected when necessary for wet removal. The Contractor shall stop Work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceed 1.0 f/cc inside the regulated area. The Contractor shall correct the condition to the satisfaction of the Owner's Representative, including visual inspection and air sampling. Work shall resume only upon notification by the Owner's Representative. Corrective actions shall be documented.

3.2 PROTECTION OF ADJACENT WORK OR AREAS TO REMAIN

Asbestos abatement shall be performed without damage to or contamination of adjacent work or area. Where such work or area is damaged or contaminated, as verified by the Owner's Representative using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no expense to the Owner, as deemed appropriate by the Owner's Representative. This includes inadvertent spill of dirt, dust or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, Work shall stop in all affected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and air sampling analysis results are obtained and have been evaluated by the Contractor's Designated IH and the Owner's Representative, Work shall proceed.

3.3 OBJECTS

3.3.1 Removal of Mobile Objects

Mobile objects, furniture, and equipment should be removed from the area of Work by the Owner before asbestos abatement work begins.

3.3.2 Stationary Objects

Stationary objects and equipment shall remain in place and shall be pre-cleaned using HEPA vacuum followed by adequate wet wiping. Stationary objects and furnishings shall be covered with 2 layers of polyethylene and edges sealed with duct tape.

3.4 BUILDING VENTILATION SYSTEM AND CRITICAL BARRIERS

Building ventilating systems supplying air into or returning air out of a regulated area shall be shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1910.147. Air-tight critical barriers shall be installed on building ventilating openings located inside the regulated area that supply or return air from the building ventilation system or serve to exhaust air from the building. The critical barriers shall consist of air-tight rigid covers for building ventilation supply and exhaust grills where the ventilation system is required to remain in service during abatement or 2 layers of 6 mil polyethylene. Edges to wall, ceiling and floor surfaces shall be sealed with industrial grade duct tape.

3.5 PRECLEANING

Surfaces shall be cleaned by HEPA vacuum and adequately wet wiped prior to establishment of containment.

3.6 METHODS OF COMPLIANCE

3.6.1 Mandated Practices

The Contractor shall employ proper handling procedures in accordance with 29 CFR 1926 and 40 CFR 61, Subpart M, and the specified requirements. The specific abatement techniques and items identified shall be detailed in the Contractor's Asbestos Abatement Work Plan including, but not limited to, details of construction materials, equipment, and handling procedures. The Contractor shall use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

3.6.1.1 Vacuum cleaners equipped with HEPA filters to collect debris and dust containing ACM.

3.6.1.2 Wet methods or wetting agents to control employee exposures during asbestos handling, mixing, removal, cutting, application, and cleanup; except where it can be demonstrated that the use of wet methods is unfeasible due to, for example, the creation of electrical hazards, equipment malfunction, and in roofing.

3.6.1.3 Prompt clean-up and disposal in leak-tight containers of wastes and debris contaminated with asbestos.

3.6.1.4 Inspection and repair of polyethylene in work areas and high traffic areas.

3.6.1.5 Cleaning of equipment and surfaces of containers filled with ACM prior to removing them from the equipment room or area.

3.6.2 Control Methods

The Contractor shall use the following control methods to comply with the Personnel Exposure Limit (PELs):

3.6.2.1 Local exhaust ventilation equipped with HEPA filter dust collection systems;

3.6.2.2 Enclosure or isolation of processes producing asbestos dust;

3.6.2.3 Ventilation of the regulated area to move contaminated air away from the breathing zone of employees and toward a filtration or collection device equipped with a HEPA filter;

3.6.2.4 Use of other work practices and engineering controls;

3.6.2.5 Where the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the PELs, the Contractor shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with paragraph, RESPIRATORY PROTECTION PROGRAM.

3.6.3 Unacceptable Practices

The following work practices and engineering controls shall not be used for Work related to asbestos or for Work which disturbs ACM, regardless of measured levels of asbestos exposure or the results of initial exposure assessments:

3.6.3.1 High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

3.6.3.2 Compressed air used to remove asbestos, or materials containing asbestos, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

3.6.3.3 Dry sweeping, shoveling, or other dry clean-up of dust and debris containing ACM.

3.6.3.4 Employee rotation as a means of reducing employee exposure to asbestos.

3.6.4 Class I Work Procedures

In addition to requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

3.6.4.1 A Competent Person shall supervise the installation and operation of the control system.

3.6.4.2 For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, the Contractor shall place critical barriers over all openings to the regulated area.

3.6.4.3 HVAC systems shall be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.

3.6.4.4 Impermeable drop cloths (6 mil or greater thickness) shall be placed on surfaces beneath all removal activity.

3.6.4.5 Objects within the regulated area shall be handled as specified in paragraph OBJECTS.

3.6.4.6 Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area shall be ventilated to move contaminated air away from the employee's breathing zone toward a HEPA unit or collection device.

For jobs involving the removal of more than 25 feet or 10 square feet of TSI, surfacing or miscellaneous material, a negative pressure decontamination unit that is adjacent and attached in a leak-tight manner to the regulated area shall be provided. Utilization of prefabricated units shall have prior approval of the Owner's Representative. The decontamination unit shall have an equipment room and a clean room separated by a shower that complies with 29 CFR 1910.141 (unless the Contractor can demonstrate that such facilities are not feasible).

3.6.5 Specific Control Methods for Class I Work

In addition to requirements of paragraph Class I Work Procedures, Class I Asbestos Work shall be performed using the control methods identified in the subparagraphs below.

3.6.5.1 Negative Pressure Enclosure (NPE) System

The NPE system shall provide at least 4 air changes per hour inside the containment. The local exhaust unit equipment shall be operated 24 hours per day until the containment is removed, and shall be leak-proof to the filter and equipped with HEPA filters. Air movement shall be directed away from the employees and toward a HEPA filtration device. The NPE shall be smoke tested for leaks at the beginning of each shift. Local exhaust equipment shall be sufficient to maintain a minimum pressure differential of minus 0.02 inch of water column relative to adjacent, unsealed areas. Pressure differential shall be monitored continuously, 24 hours per day, with an automatic manometric recording instrument. Pressure differential recordings shall be provided daily on the same day collected. Readings shall be reviewed by the Contractor's Designated Competent Person and IH prior to submittal. The Owner's Representative shall be notified immediately if the pressure differential falls below the prescribed minimum. The building ventilation system shall not be used as the local exhaust System for the regulated area. The local exhaust system shall terminate outdoors unless an alternate arrangement is allowed by the Owner's Representative. All filters used shall be new at the beginning of the Work and shall be periodically changed as necessary and disposed of as ACM waste.

3.6.5.2 Glove bag Systems

The glove bag system shall be used to remove ACM from straight runs of piping and elbows and other connections. Glove bags shall be used without modification and shall be smoke-tested for leaks and any leaks sealed prior to use. Glove bags shall be installed to completely cover the circumference of pipe or other structures where the Work is to be done. Glove bags shall be used only once and shall not be moved. Glove bags shall not be used on surfaces that have temperatures exceeding 66 degrees C. 150 degrees F. Prior to disposal, glove bags shall be collapsed by removing air within them using a HEPA vacuum. Before beginning the operation, loose and friable material adjacent to the glove bag operation shall be wrapped and sealed in 2 layers of plastic or otherwise rendered intact. At least 2 persons shall perform Class I glove bag removal. Asbestos Regulated work areas shall be established as specified and shown on detailed drawings and plans for glove bag abatement. Designated boundary limits for the Asbestos Work shall be established with rope or other continuous barriers and all other requirements for asbestos control areas shall be maintained, including area signage and boundary warning tape. Contractor shall cut fiberglass pipe insulation a minimum of six (6) inches away from any asbestos containing joint compound. All cuts to fiberglass insulation shall be made with a sharp tool capable of cutting through the insulation.

- a. In addition to requirements for negative pressure glove bag systems above, the Contractor shall attach HEPA vacuum systems or other devices to the bag to prevent collapse during removal of ACM from straight runs of piping and elbows and other connections.
- b. The negative pressure glove boxes used to remove ACM from pipe runs shall be fitted with gloved apertures and a bagging outlet and constructed with rigid sides from metal or other material which can withstand the weight of the ACM and water used during removal. A negative pressure shall be created in the system using a HEPA filtration system. The box shall be smoke tested for leaks prior to each use.

3.6.5.3 Mini-Enclosures

Mini-containment (small walk-in enclosure) to accommodate no more than 2 persons may be used if the disturbance or removal can be completely contained by the enclosure with the following specifications and work practices. The mini-enclosure shall be inspected for leaks and smoke tested before each use. Air movement shall be directed away from the employee's breathing zone within the mini-enclosure.

3.6.5.4 Wrap and Cut Procedures

Use the procedures for glove bagging found in Section 3.6.5.2 to remove the asbestos from the cut area of pipe insulation. All cuts to the piping shall be made at least 6 inches from any asbestos on that component. A single glove bag shall be used for each cut to be made.

Wet the length of component to be removed prior to wrapping. The wrapping shall be leak tight and shall consist of two layers of 6 mil polyethylene, each individually sealed with duct tape, and all RACM between the cuts shall be sealed inside the wrap. The component must be supported while the cutting process takes place. Once the component has been cut free, lower the component to the floor. Do not drop or throw the component to the floor.

The wrapping shall remain intact and leak-tight throughout the removal and disposal process. Label the removed component with the appropriate asbestos labels.

3.6.6 Class II Work

In addition to the requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

3.6.6.1 A Competent Person shall supervise the Work.

3.6.6.2 For indoor work, critical barriers shall be placed over all openings to the regulated area.

3.6.6.3 Impermeable drop cloths shall be placed, as needed, on surfaces beneath all removal activity.

3.6.7 Specific Control Methods for Class II Work

In addition to requirements of paragraph Class II Work, Class II Work shall be performed using the following methods:

3.6.7.1 Sheet Vinyl Flooring Materials (as applicable)

1. When removing sheet vinyl flooring materials which contain ACM, the Contractor shall use the following practices. All furniture, furnishings, equipment and other items shall be removed from the work area. Also remove and dispose of all non-ACM rubber or vinyl cove base materials, along with sheet flooring. Items that are visibly contaminated with asbestos dust or debris shall be wet cleaned and HEPA vacuumed by the Contractor if possible or disposed of as contaminated waste. Items cleaned to the satisfaction of the Owners Representative, shall be removed or covered with poly sheeting.
2. The Contractor shall setup a decontamination facility at the entrance to the work area. The decontamination facility shall consist of a change room, shower room, and equipment room separated by overlapping, three-flap poly airlocks, as a minimum. Shower water shall be filtered prior to disposal with a minimum 5 micron filter. A load out chamber shall be set up at a separate doorway to the work area made of 6-mil poly, consisting of two rooms jointed by an overlapping 3-flap airlock, with an airlock at each end of the chamber.

3. Contractor shall physically isolate the area.
 - A. All openings to the work area including but not limited to, doors and windows, ventilation diffusers, floor and ceiling penetrations shall be sealed with a minimum of 6-mil thick poly and duct tape.
 - B. Plenums above lay-in ceilings, connecting other spaces to the removal area, shall be separated with two layers of 6-mil poly, taped in place.
4. Contractor shall line the walls and cover the ceiling of removal area with 6-mil poly.
5. Contractor shall maintain barriers by visually inspecting and repairing any defects at the beginning of each work period. Any damages to barriers throughout the work period shall be immediately repaired before asbestos removal proceeds in that area.
6. All ventilation (HVAC) to and from the removal area shall be shut off throughout removal, until clearance criteria is achieved. Following shut-down, the Contractor shall remove, package and dispose of as asbestos, all heating and ventilation, and air-conditioning system filters.
7. Contractor shall cut off and lock out all electrical power in the removal area, and shall protect all electrical outlets and connections with poly and duct tape. Power for all exhaust units, lights, etc., shall be brought in with grounded extension cords. All temporary power systems used in removal areas shall be protected with ground fault circuit interrupters. No internal combustion generators shall be brought in to the area.
8. Following work area preparation, removal procedures shall not commence until the work area preparation has been inspected and approved by the Owners Representative.
9. Contractor shall provide High Efficiency Particulate Absolute (HEPA) filtered exhaust units to maintain a net vacuum in the work area with respect to other parts of the building. A minimum of four (4) air changes an hour is required with the air drawn across the entire work area. The work area shall be under a net vacuum during preparation where asbestos could be disturbed, through removal and cleanup and until final inspection and air sampling has been completed.
 - A. Make-up air shall be provided through the decontamination chamber and loading areas, maintaining air-flow inward through these areas all the time.
 - B. Exhaust units shall be equipped with audible shut off alarms and status lights shall be visible to workers. A unit that shuts off shall be reset before Work proceeds in that area.

- C. Pre-filters and HEPA filters shall be changed whenever the air flow is reduced below the minimum required to maintain 4 air changes per hour, or as required by the manufacture.
10. All asbestos shall be removed and maintained in a thoroughly wet state, using amended water. Resilient sheeting shall be removed by adequately wet methods. Resilient sheeting or its backing shall not be sanded. Scraping of residual adhesive and/or backing shall be performed using wet methods. Dry sweeping is prohibited. The Contractor shall use vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) to clean floors.
 11. No encapsulation of existing floor is required when ACM sheet vinyl has been removed. When the floor is completely dry and clean, approved by the Owner's Representative, air monitoring may be performed.

3.6.7.2 Floor Tile Removal (as applicable)

When removing floor tile materials which contain ACM, the Contractor shall use the following practices. All furniture, furnishings, equipment and other items shall be removed from the work area. Items that are visibly contaminated with asbestos dust or debris shall be wet cleaned and HEPA vacuumed by the Contractor if possible or disposed of as contaminated waste. Items cleaned to the satisfaction of the Owners Representative, shall be removed or covered with poly sheeting. The Contractor shall isolate the work area and regulate access for the duration of the removal by sealing off all air movement into and out of the work area with a minimum of 6-mil poly. Asbestos barrier tape may be substituted for WARNING signs to prevent accidental unauthorized work site entry.

The Contractor shall setup a decontamination facility at the entrance to the work area. The decontamination facility shall consist of a change room, shower room, and equipment room separated by overlapping, three-flap poly airlocks, as a minimum. Shower water shall be filtered prior to disposal with a minimum 5 micron filter. A load out chamber shall be set up at a separate doorway to the work area made of 6-mil poly, consisting of two rooms jointed by an overlapping 3-flap airlock, with an airlock at each end of the chamber.

As a minimum, a change room of poly, fitted with 2, overlapping, three-flap airlocks shall be installed at one entrance to the work area. One airlock connecting the work area to the room shall be constructed at an available second entrance to the area. Use of a remote decontamination facility shall be subject to prior approval.

1. Contractor shall physically isolate the area.
 - A. All openings to the work area including but not limited to, doors and windows, ventilation diffusers, floor and ceiling penetrations shall be sealed with a minimum of 6-mil thick poly and duct tape.
 - B. Plenums above lay-in ceilings, connecting other spaces to the removal area, shall be separated with two layers of 6-mil poly, taped in place.

- C. Place splash guards on all walls located within the removal area to a height of 4 feet from the floor with a minimum of one layer of 6-poly, duct taped in place.
 - D. Contractor shall maintain barriers and splash guards by visually inspecting and repairing any defects at the beginning of each work period. Any damages to barriers throughout the work area shall be immediately repaired before asbestos removal proceeds in that area.
2. All ventilation (HVAC) to and from the removal area shall be shut off throughout removal, until clearance criteria is achieved. Following shut-down, the Contractor shall remove, package and dispose of as asbestos, all heating and ventilation, and air-conditioning system filters.
 3. Contractor shall cut off and lock out all electrical power in the removal area, and shall protect all electrical outlets and connections with poly and duct tape. Power for all exhaust units, lights, etc., shall be brought in with grounded extension cords. All temporary power systems used in removal areas shall be protected with ground fault circuit interrupters. No internal combustion generators shall be brought in to the area.
 4. Following work area preparation, removal procedures shall not commence until the preparation has been inspected and approved by the Owners Representative.
 5. Contractor shall provide High Efficiency Particulate Absolute (HEPA) filtered exhaust units to maintain a net vacuum in the work area with respect to other parts of the building. A minimum of four (4) air changes an hour is required with the air drawn across the entire work area. The work area shall be under a net vacuum during preparation where asbestos could be disturbed, through removal and cleanup and until final inspection and air sampling has been completed.
 - A. Make-up air shall be provided through the decontamination chamber and loading areas, maintaining air-flow inward through these areas all the time.
 - B. Exhaust units shall be equipped with audible shut off alarms and status lights shall be visible to workers. A unit that shuts off shall be reset before Work proceeds in that area.
 - C. Pre-filters and HEPA filters shall be changed whenever the air flow is reduced below the minimum required to maintain 4 air changes per hour, or as required by the manufacture.
 6. All asbestos shall be removed and maintained in a thoroughly wet state, using amended water.
 7. Removal of the tiles by physically chipping them is acceptable as long as the substrate is not damaged. If this method is chosen, all electrical power to the area shall be locked out and tagged, to prevent electrical shock. The tile chipping tools shall be thoroughly wetted with amended water before during and during the chipping process.

8. Removal of tile by heating with a pan-style heater is acceptable. If this method is chosen adequate precautions shall be taken by the Contractor to prevent burns or electrical shock. Once the tile has been heated sufficiently to remove it, care shall be taken to prevent the tile from breaking. Contractor shall be responsible for assuring that adequate electrical service is available.
 9. Shot blasting as a method of removing floor tile and mastic is not permitted.
 10. Dry sweeping is prohibited.
 11. Floor tile shall be placed into lined barrels, drums, or bags for disposal. Do not exceed the load limits of the elevators.
 12. No encapsulation of existing floor is required when ACM floor tile has been removed. When the floor is completely dry and clean, and approved by the Owner's Representative, air monitoring may be performed.
 13. Contractor shall observe ceilings on floors under their work area for leaks while removing floor tile above.
- 3.6.7.3 Floor Tile Mastic Removal (as applicable)

1. The Contractor shall isolate the work area and regulate access for the duration of the removal by either shutting off or sealing off all ventilation into and out of the work area with a minimum of 6-mil poly and or duct tape. OSHA WARNING signs shall be posted just outside the work area in prominent locations sufficient to prevent accidental unauthorized entry into the work area. Splash guards of 6-mil poly shall be installed to a minimum height of three (3) feet. Contractor shall protect all columns, walls, doors, door jambs, trim and baseboards from damage.
2. Removal of the mastic by physically scraping is acceptable as long as the substrate is not damaged. If this method is chosen, amended water shall be used to keep all asbestos-containing materials saturated during the removal. The floor surface shall be clear of all mastic residue and floor material ready for replacement of flooring by non-asbestos workers.
3. Removal of the mastic through solvent dissolution and subsequent mopping is acceptable only with prior approval by the Owner's Representative. Only low odor soy-based mastic removers shall be permitted. To further reduce the mastic remover odor, run High Efficiency Particulate Absolute (HEPA) filtered exhaust units to maintain a net vacuum in the work area. Exhaust to the exterior of the building.
4. PPE shall be worn in strict accordance with any applicable MSDS. As a minimum, disposable coveralls fitted with hoods and boots, rubber gloves, eye protection and half-mask air purifying respirator negative pressure respirators equipped with piggy-back organic vapor cartridge (activated charcoal) and type H (HEPA) filters shall be worn. Higher levels of personal protection shall be worn when dictated by the Work, MSDS's or determination through air monitoring.

5. Throughout the removal operation, the work area shall remain separated from adjacent building space during solvent use. The least amount of solvent shall be applied to dissolve the mastic. Contractor shall seal all floor penetrations, cracks, and etc. prior to starting mastic removal. Contractor shall tape in place a poly drop cloth to be stepped on when coming out of the containment.
6. Mops and/or sponges shall be used to collect the dissolved mastic. All materials (sponges, mops, rags) and solvent used to remove the mastic shall be disposed of in air-tight, solvent impervious containers. Contractor shall mop and clean any remaining solvent residue following the Flooring Institute Recommendations.
7. During and after the solvent use, exhaust ventilation shall be used. Air within the work area shall be HEPA filtered and exhausted outside of the building.
8. Following clearance, but prior to removal of any critical barriers, the work area air shall continue to be ventilated to the outside of the building for a sufficient period of time to practically eliminate any solvent odor, as determined by the Owner's Representative. Contractor shall remove all tape residues and spray glue from all surfaces. All wall, baseboards, doors and door jambs shall be cleaned of mastic remover. Damage to painted surfaces caused by the Contractor shall be repainted, repaired, or replaced at the Contractors expense. Replace all doors if doors have been removed. All existing doors are in excellent working condition. Doors that are sprung or damaged by the Contractor shall be repaired/replaced at the Contractor's expense.
9. No encapsulation of existing floor is required when ACM floor tile mastic has been removed. When the floor is completely dry and clean, and approved by the Owner's Representative, air monitoring will be performed.

3.6.7.4 Specific Control Methods for Class III Work

Class III Asbestos Work shall be conducted using engineering and work practice controls which minimize the exposure to employees performing the Asbestos Work and to bystander employees. The Work shall be performed using wet methods and, to the extent feasible, using local exhaust ventilation. The Contractor shall use impermeable drop cloths and shall isolate the operation, using mini-enclosures or glove bag systems, where the disturbance involves drilling, cutting, abrading, sanding, chipping, breaking, or sawing of TSI or surfacing material.

3.6.7.5 Specific Control Methods for Class IV Work

Class IV jobs shall be conducted using wet methods, HEPA vacuums, and prompt clean-up of debris containing ACM. Employees cleaning up debris and waste in a regulated area where respirators are required shall wear the selected respirators.

3.6.7.6 Cleaning After Asbestos Removal

After completion of all asbestos removal Work, surfaces from which ACM has been removed shall be wet wiped or sponged clean, or cleaned by some equivalent method to remove all visible residue. Run-off water shall be collected and filtered through a dual filtration system. A first filter shall be provided to remove fibers 20 micrometers and larger, and a final filter provided that removes fibers 5 micrometers and larger. After the gross amounts of asbestos have been removed from every surface, remaining visible accumulations of asbestos on floors shall be collected using plastic shovels, rubber squeegees, rubber dustpans, and HEPA vacuum cleaners as appropriate to maintain the integrity of the regulated area. When TSI and surfacing material has been removed, Workers shall use HEPA vacuum cleaners to vacuum every surface. Surfaces or locations which could harbor accumulations or residual asbestos dust shall be checked after vacuuming to verify that no asbestos-containing material remains; and shall be re-vacuumed as necessary to remove the ACM.

3.6.7.7 Sealing Contaminated Items Designated for Disposal

Contaminated architectural, mechanical, and electrical appurtenances such as Venetian blinds, full height partitions, carpeting, duct work, pipes and fittings, radiators, light fixtures, conduit panels, metal ceiling tile grid system and other contaminated items designated for removal shall be coated with an asbestos lockdown encapsulant at the demolition site before being removed from the asbestos control area. These items shall be vacuumed prior to application of the lockdown encapsulant. The asbestos lockdown encapsulant shall be tinted a contrasting color and shall be spray applied by airless method. Thoroughness of sealing operation shall be visually gauged by the extent of colored coating on exposed surfaces.

3.7 FINAL CLEANING AND VISUAL INSPECTION

Upon completion of abatement, the regulated area shall be cleaned by collecting, packing, and storing all gross contamination. A final cleaning shall be performed using HEPA vacuum and wet cleaning of all exposed surfaces and objects in the regulated area. The removal of all spray glue and duct tape residue from doors, door frames, walls and other surfaces is not required. Upon completion of the cleaning, the Contractor shall conduct a visual pre-inspection of the cleaned area in preparation for a final inspection before final air clearance monitoring and re-cleaning, as necessary. Upon completion of the final cleaning, the Contractor and the Owner's Representative shall conduct a final visual inspection of the cleaned regulated area in accordance with ASTM E 1368 and document the results on the Final Cleaning and Visual Inspection report. If the Owner's Representative rejects the clean regulated area as not meeting final cleaning requirements, the Contractor shall re-clean as necessary and have a follow-up inspection conducted with the Owner's Representative. Any and all re-cleaning and re-inspections shall be at the Contractor's expense.

In areas where demolition has occurred Contractor shall remove all debris. Broom sweep or vacuum the area(s). In bathrooms remove all debris from sink and stool cavities. Remove all poly from walls and floor. Removal of tape and tape residue from walls, floor, sink and shower drain drains is not required for this project.

3.8 LOCKDOWN

Prior to removal of plastic barriers and after clean-up of gross contamination and final visual inspection, a post removal (lockdown) encapsulant shall be spray applied to ceiling, walls, floors, and other surfaces in the regulated area.

3.9 EXPOSURE ASSESSMENT AND AIR MONITORING

3.9.1 General Requirements for Exposure

Exposure assessment, air monitoring and analysis of airborne concentration of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101, the Contractor's air monitoring plan, and as specified. Personal exposure air monitoring (collected at the breathing zone) that is representative of the exposure of each employee who is assigned to Work within a regulated area shall be performed by the Contractor's Designated Project Supervisor. Breathing zone samples shall be taken for at least 25 percent of the workers in each shift, or a minimum of 2, whichever is greater.

Pre-abatement and abatement environmental air monitoring shall be performed by the Owner's Representative's IH. Final clearance environmental air monitoring, shall be performed by the Owner's Representative's IH. Environmental and final clearance air monitoring shall be performed using NIOSH Pub No. 84-100 Method 7400 (PCM) with optional confirmation of results by the EPA TEM Method specified in 40 CFR 763.

Monitoring may be duplicated by the Owner at the discretion of the Owner's Representative. Results of breathing zone samples shall be posted at the job site and made available to the Owner's Representative. The Contractor shall maintain a fiber concentration inside a regulated area less than or equal to 0.1 f/cc expressed as an 8 hour, time-weighted average (TWA) during the conduct of the asbestos abatement. If fiber concentration rises above 0.1 f/cc, work procedures shall be investigated with the Owner's Representative to determine the cause. At the discretion of the Owner's Representative, fiber concentration may exceed 0.1 f/cc but shall not exceed 1.0 f/cc expressed as an 8-hour TWA. The Contractor's workers shall not be exposed to an airborne fiber concentration in excess of 1.0 f/cc, as averaged over a sampling period of 30 minutes. Should either an environmental concentration of 1.0 f/cc expressed as an 8-hour TWA or a personal excursion concentration of 1.0 f/cc expressed as a 30-minute sample occur inside a regulated work area, the Contractor shall stop Work immediately, notify the Owner's Representative, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the Owner's Representative.

3.9.2 Initial Exposure Assessment

The Contractor's Designated Project Supervisor shall conduct an exposure assessment immediately before or at the initiation of an asbestos abatement operation to ascertain expected exposures during that operation. The assessment shall be completed in time to comply with the requirements which are triggered by exposure data or the lack of a negative exposure assessment, and to provide information necessary to assure that all control systems planned are appropriate for that operation. The assessment shall take into consideration the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the Contractor which indicate the levels of airborne asbestos likely to be encountered on the job.

For Class I Asbestos Work, until the employer conducts exposure monitoring and documents that employees on that job will not be exposed in excess of PELs, or otherwise makes a negative exposure assessment, the Contractor shall presume that employees are exposed in excess of the PEL-TWA and PEL-Excursion Limit.

3.9.3 Negative Exposure Assessment

The Contractor shall provide a negative exposure assessment for the specific asbestos job which will be performed. The negative exposure assessment shall be provided within 2 days of the initiation of the Work and conform to the following criteria:

3.9.3.1 Objective Data: Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the PEL-TWA and PEL-Excursion Limit under those work conditions having the greatest potential for releasing asbestos.

3.9.3.2 Prior Asbestos Jobs: Where the Contractor has monitored prior asbestos jobs for the PEL and the PEL-Excursion Limit within 12 months of the current job, the monitoring and analysis were performed in compliance with asbestos standard in effect; the data were obtained during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the Contractor's current operations; the operations were conducted by employees whose training and experience are no more extensive than that of employees performing the current job; and these data show that under the conditions prevailing and which will prevail in the current workplace, there is a high degree of certainty that the monitoring covered exposure from employee exposures will not exceed the PEL-TWA and PEL-Excursion Limit.

3.9.3.3 Initial Exposure Monitoring: The results of initial exposure monitoring of the current job, made from breathing zone air samples that are representative of the 8-hour PEL-TWA and 30-minute short-term exposures of each employee. The monitoring covered exposure from operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

3.9.4 Independent Environmental Monitoring

The Owner has retained an independent air monitoring firm to perform pre-abatement, during abatement, and final clearance air monitoring. The air monitoring Firm has been provided a copy of the Specifications that govern the Work. The air monitoring firm is required to comply with Contractor's safety and health requirements. Contractor will coordinate all onsite activities with the air monitoring firm. Contractor will provide the air monitoring firm with an up-to-date Schedule for all abatement activities. The air monitoring firm will coordinate with the Contractor during the performance of Owner-required air monitoring. Contractor is responsible for performing exposure assessment and personal air monitoring of Contractor's workers.

3.9.5 Pre-abatement Environmental Air Monitoring

Pre-abatement environmental air monitoring shall be established prior to the masking and sealing operations for each regulated area to determine background concentrations

before Work begins. As a minimum, pre-abatement air samples shall be collected using

NIOSH Pub No. 84-100 Method 7400, PCM at these locations: inside the building, but outside the regulated area perimeter; and inside each regulated work area.

3.9.6 Environmental Air Monitoring During Abatement

Until an exposure assessment is provided to the Owner's Representative, environmental air monitoring shall be conducted at locations and frequencies that will accurately characterize any evolving airborne asbestos fiber concentrations. The assessment shall demonstrate that the product or material containing asbestos minerals, or the abatement involving such product or material, cannot release airborne asbestos fibers in concentrations exceeding 0.01 f/cc as a TWA under those work conditions having the greatest potential for releasing asbestos. The monitoring shall be at least once per shift at locations including, but not limited to, close to the work operations inside a regulated area; pre-abatement sampling locations; outside entrances to a regulated area; close to glove bag operations; representative locations outside of the perimeter of a regulated area; inside clean room; and at the exhaust discharge point of local exhaust system ducted to the outside of a containment (if used). If the sampling outside regulated area shows airborne fiber levels has exceeded background or 0.01 f/cc, whichever is greater, Work shall be stopped immediately, and the Owner's Representative notified. The condition causing the increase shall be corrected. Work shall not restart until authorized by the Owner's Representative.

3.9.7 Final Clearance Air Monitoring

Prior to conducting final clearance air monitoring, the Contractor and the Owner's Representative shall conduct a final visual inspection of the regulated area where asbestos abatement has been completed. Final clearance air monitoring shall not begin until acceptance of the Contractor's final cleaning by the Owner's Representative. The Owner's Representative's IH will conduct final clearance air monitoring using aggressive air sampling techniques as defined in EPA 560/5-85-024 or as otherwise required by federal or state requirements. The sampling and analytical method used will be NIOSH Pub No. 84-100 Method 7400 (PCM).

3.9.7.1 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH Pub No. 84-100 Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, shall be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any confirmation sample result is greater than asbestos f/cc, abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, re-sampling with results to meet the above clearance criteria shall be done.

3.9.7.2 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, the Contractor shall pay all costs associated with the required, reinspection, recleaning, re-sampling, and analysis, until final clearance requirements are met.

3.9.8 Air-Monitoring Results and Documentation

OSHA air sample fiber counting shall be completed and results provided within 24 hours (breathing zone samples). The Owner's Representative shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst.

3.10 CLEARANCE CERTIFICATION

When asbestos abatement is complete, ACM waste is removed from the regulated areas, final clean-up is completed, and final air clearances have passed, the Contractor can then take down the warning signs and boundary warning tape. After final clean-up and acceptable airborne concentrations are attained, but before the HEPA unit is turned off and the containment removed, the Contractor shall remove all pre-filters on the building HVAC system and provide new pre-filters. The Contractor shall dispose of such filters as asbestos contaminated materials. As applicable, HVAC, mechanical, and electrical systems shall be re-established in proper working order. The Contractor and the Owner's Representative shall visually inspect all surfaces within the containment for residual material or accumulated debris. The Contractor shall reclean all areas showing dust or residual materials.

3.11 CLEANUP AND DISPOSAL

3.11.1 Collection and Disposal of Asbestos

All ACM waste shall be collected and placed in leak-tight containers such as double

Plastic bags; sealed double wrapped polyethylene sheet or other approved containers. Waste within the containers shall be wetted in case the container is breached.

Asbestos-containing waste shall be disposed of at a state-approved asbestos landfill. For temporary storage, sealed impermeable containers shall be stored in an asbestos waste load-out unit or in a storage/ transportation conveyance (i.e., dumpster, roll-off waste boxes, etc.) in a manner acceptable to and in an area assigned by the Owner's Representative. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, state, regional, and local standards.

3.11.2 Asbestos Waste Shipment Record

The Contractor shall complete and provide the Owner's Representative final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR 61, Subpart M and other required state waste manifest shipment records, within 15 days of delivery to the landfill. Each Waste Shipment Record shall be signed and dated by the Contractor, the waste transporter and disposal facility operator. Copies shall be submitted to the owner's representative promptly.

3.12 CLOSEOUT DOCUMENTS

The Contractor shall provide the Owner with two sets of closeout documentation listed in Section 1290.

END OF SECTION 028211

SECTION 220500 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
 - 1. Plumbing Work shall include, but is not necessarily limited to:
 - a. Furnish and install all items listed in the Plumbing Material List.
 - b. Replace portions of existing domestic water piping system including cold, hot, and hot water circulating piping within the building, and extend system as indicated on the drawings. Insulate all piping as specified.
 - c. Demolish portions of existing natural gas piping system serving equipment being removed, and extend system to serve new equipment, as indicated on the drawings.
 - d. Demolish old domestic water heating equipment and circulation pumps, and install new packaged water heaters and circulating pump.
 - e. Test, Adjust, and Balance new plumbing equipment as specified.
 - f. Furnish and install makeup water connection to hydronic heating and/or cooling systems including reduced pressure principle type backflow preventer.
 - g. Replace portions of existing sanitary sewer and vent system, and extend system as indicated on the drawings.
 - h. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
 - i. Complete all applicable tests, certifications, forms, and matrices.
 - 2. Heating Work: Refer to Section 230500 "Basic HVAC Requirements".
 - 3. Air Conditioning and Ventilating Work: Refer to Section 230500 "Basic HVAC Requirements".
 - 4. Temperature Control Work: Refer to Section 230500 "Basic HVAC Requirements".

1.3 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.

1.4 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Gravity flow piping.
 - b. Electrical busduct.
 - c. Sheet metal.
 - d. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Gas Trains for Boilers/Burners.
 - b. Packaged Water Heaters.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
 - a. Wiring of all devices needed to make the Temperature Control System functional.
 - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
 - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.

5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.5 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, plumbing piping, hydronic piping, condensate drain (DPP) piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Maintenance clearances and code-required dedicated space shall be included.
 - d. The coordination drawings shall include all in-tunnel, in chase, and vertical trade items.
2. Spaces with open ceilings shall indicate the existing overhead utilities and locate new equipment and piping as required to maintain clearance around and access to existing items such as lights, junction boxes, smoke detectors, security cameras, sprinklers, etc. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all new work in congested areas, to ensure an orderly and coordinated end result, and to provide adequate access to new and existing items for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Engineer and Owner's Representative. The Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Engineer.
9. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
10. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
11. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.6 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Maryville, MO Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State of Missouri Codes, Laws, and Ordinances.
3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
4. If there is a discrepancy between the codes and regulations and these specifications, the Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.7 SUBMITTALS

- A. Submittals shall be required for items, where required elsewhere in the specifications or on the drawings.
- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
 - 1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 - 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
 - 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 - 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
 - 5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.

- c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
- 7. Schedule submittals to expedite the project. Coordinate submission of related items.
 - 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
 - 9. Reproduction of contract documents alone is not acceptable for submittals.
 - 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Engineer.
 - 11. Submittals not required by the contract documents may be returned without review.
 - 12. The Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Engineer to recheck and handle the additional shop drawing submittals.
 - 13. Submittals shall be reviewed and approved by the Engineer **before** releasing any equipment for manufacture or shipment.
 - 14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Engineer's approval.
 - 15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Engineer's review and processing of each submittal.
 - 16. Engineer reserves the right to withhold action on a submittal which, in the Engineer's opinion, requires coordination with other submittals until related submittals are received. The Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 22 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.8 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.9 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 1. Packaged Water Heaters.
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Engineer not later than ten days prior to the bid opening.

- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Engineer, nor the presence of the Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ENGINEER OBSERVATION OF WORK

- A. The Engineer shall have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Engineer so that the final observation can be scheduled.
 - 4. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
 5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Engineer's review and approval. The electronic copy shall be corrected as required to address the Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div22.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Engineer, Two paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 1. Explanation of all system flow diagrams.
 2. Maintenance of equipment.

3. Start-up procedures for all major equipment.
 4. Explanation of seasonal system changes.
 5. Explanation of Owner's Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).
- E. Notify the Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
1. Domestic Hot Water System - 2 hours
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

- A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- E. Record changes daily and keep the marked drawings available for the Engineer's examination at any normal work time.
- F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Engineer.

3.8 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All natural gas piping in boiler room
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Paint all outdoor exposed natural gas piping the color selected by Owner or Engineer.
- D. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
 - 2. Request that the Owner designate an IAQ representative.
 - 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 - 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 - 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 - 6. Request copies of and follow all of the Owner's IAQ and infection control policies.
 - 7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
 - 8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
 - 9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

3.12 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. All packaged water heaters installed and balanced.
4. Pipe insulation complete, pipes labeled and valves tagged.
5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 220500

SECTION 220503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2021 International Building Code

1.4 SUBMITTALS

- A. Submit under provisions of Section 220500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.

3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
4. F ratings for each firestop system.

- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 1. Review foreseeable methods related to firestopping work.
 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

- A. Provide one year warranty on parts and labor.

- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Dow Corning Corp.
10. Fire Trak Corp.
11. International Protective Coating Corp.
12. HoldRite

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:
 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:
 - a. F Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. F Rating = Wall/Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 220503

SECTION 220505 - PLUMBING DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical Demolition.
- B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- C. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- D. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- E. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

- A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

- 3.3 Existing Plumbing System: Maintain service to all plumbing fixtures until new piping is installed. Obtain permission from Owner at least 48 hours before shutting down system for any reason. Make changeover to new piping with minimum outage. Do not disconnect any roof drainage piping until new piping is in place and operational.
- 3.4 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK
- A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.
 - B. Remove, relocate, and extend existing installations to accommodate new construction.
 - C. Remove abandoned piping to source of supply and/or main lines.
 - D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
 - E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
 - F. Repair adjacent construction and finishes damaged during demolition and extension work.
 - G. Extend existing installations using materials and methods compatible with existing installations, or as specified.
 - H. Remove unused sections of domestic water piping back to mains and cap. Capped pipe shall be less than 2 feet from main to prevent "dead legs".
 - I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.
- 3.5 CUTTING AND PATCHING
- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 220529 for additional requirements.
 - B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
 - C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
 - D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Engineer prior to start of work.
 - E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to discipline plans for additional information.
 - F. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means.
 - G. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.6 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. PLUMBING ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.7 SPECIAL REQUIREMENTS

- A. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Engineer before proceeding.

END OF SECTION 220505

SECTION 220513 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Phase and Three Phase Electric Motors.

1.2 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Act of 2007.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 220500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- C. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.
- D. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- G. Each contractor shall set all motors furnished by him.
- H. All motors shall have a minimum service factor of 1.15.
- I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- K. Aluminum end housings are not permitted on motors 15 HP or larger.
- L. Motor Driven Equipment:
 1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
 2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.
- M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

- N. Motors for pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control.

2.2 ELECTRICALLY COMMUTATED MOTORS (ECM)

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
1. Constant Flow
 2. Constant Temperature
 3. Constant Pressure

2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPA legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0
60.0	94.5	95.0	93.6	94.5	95.0	93.6

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

- B. Motor nameplate shall be noted with the above ratings.

2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.
- D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.
1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

2.5 SHEAVES

- A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.
- B. When replacing sheaves, use sheaves of at least the originally supplied sizes.
- C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 220513

SECTION 220529 - PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices
- D. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 220500. Include plastic pipe manufacturers' support spacing requirements.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"
8" through 12"	7/8"	3/4"
14"	1"	7/8"
16" and 18"	1"	N/A
20" and 24"	1-1/4"	N/A

Column #1: Steel, cast iron, and glass pipe.

Column #2: Copper and plastic pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

2.2 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
3. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:

- 1) nVent/M-Co Model #456
- 2) Eaton Fig. 3198HCT
- 3) Anvil Fig. CT138R

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

- 1) Eaton Fig B3373 Series
- 2) nVent 510 Series
- 3) Anvil Fig. 90

2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

- 1) Mason RBA, RCA or RDA
- 2) Mason BR

3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
 - a. Products:
 - 1) Pipeshields E100
4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
5. Unless otherwise indicated, hangers shall be as follows:
 - a. Clevis Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
 - 1) Products: Bare Steel or Insulated Pipe:
 - a) Anvil Fig. 260
 - b) Eaton Fig. 3100
 - c) nVent Model 400
 - 2) Products: Bare Copper Pipe Felt or PVC Coated:
 - a) Eaton Fig. B3104F or B3100CTC
 - b) Anvil Fig. CT65
 - c) nVent Fig. 402
 - b. Adjustable Swivel Ring Type: Bare Metal Pipe - 4 inches and Smaller
 - 1) Products: Bare Steel Pipe:
 - a) Anvil Fig. 69
 - b) Eaton Fig. B3170NF
 - c) nVent Model FCN

- 2) Products: Bare Copper Pipe:
 - a) Eaton Fig. B3170CTC
 - b) nVent 102A0 Series
 - c) Anvil Fig. CT-69

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
 - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
 - 3) Products: Bare Steel Plastic or Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Eaton Fig. B2000 or B2400
 - c) Anvil Fig. AS1200
 - d) nVent USC
 - 4) Products: Bare Copper Pipe:
 - a) Eaton Fig. BVT
 - b) nVent CADDY Cushion Clamp

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
 - b. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
4. Equipment requiring bases is as follows:
 - a. Packaged Water Heaters

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Coordinate all openings with other Contractors.

B. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

C. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

D. Do not cut structural members without written approval of the Engineer.

2.5 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Engineer. Sleeves shall then comply with the Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 PLUMBING SUPPORTS AND ANCHORS

- A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

- B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
3. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
4. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

- C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

- D. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

- E. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

- F. Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel (Std. Weight or Heavier - Liquid Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" & under: 7'-0"
 - 2) 1-1/2": 9'-0"
 - 3) 2": 10'-0"
 - 4) 2-1/2": 11'-0"
 - 5) 3": 12'-0"
 - 6) 4" & larger: 12'-0"
 2. Steel (Std. Weight or Heavier - Vapor Service):
 - a. Maximum Spacing:
 - 1) 1-1/4" and under: 9'-0"
 - 2) 1-1/2": 12'-0"
 - 3) 2" & larger: 12'-0"
 3. Hard Drawn Copper & Brass (Liquid Service):
 - a. Maximum Spacing:
 - 1) 3/4" and under: 5'-0"
 - 2) 1": 6'-0"
 - 3) 1-1/4": 7'-0"
 - 4) 1-1/2" 8'-0"
 - 5) 2": 8'-0"
 - 6) 2-1/2": 9'-0"
 - 7) 3": 10'-0"
 - 8) 4": 12'-0"
 - 9) 6": 12'-0"
 4. Hard Drawn Copper & Brass (Vapor Service):
 - a. Maximum Spacing:
 - 1) 3/4" & under: 7'-0"
 - 2) 1": 8'-0"
 - 3) 1-1/4": 9'-0"
 - 4) 1-1/2": 10'-0"
 - 5) 2": 11'-0"
 - 6) 2-1/2" & larger: 12'-0"
 5. Plastic Pipe:
 - a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

- G. Installation of hangers shall conform to MSS SP-58, 69, 89 and the applicable Plumbing Code.

END OF SECTION 220529

SECTION 220548 - PLUMBING VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Vibration Isolation.

1.2 SUBMITTALS

- A. Submit shop drawings per Section 220500 and the Vibration Isolation Submittal Form at the end of this section.
- B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
- C. Isolator submittals shall include:
 - 1. Equipment served
 - 2. Type of Isolator
 - 3. Load in Pounds per Isolator
 - 4. Recommended Maximum Load for Isolator
 - 5. Spring Constants of Isolators (for Spring Isolators)
 - 6. Load vs. Deflection Curves (for Neoprene Isolators)
 - 7. Specified Deflection
 - 8. Deflection to Solid (at least 150% of calculated deflection)
 - 9. Loaded (Operating) Deflection
 - 10. Free Height
 - 11. Loaded Height
 - 12. K_x/K_y (horizontal to vertical stiffness ratio - for spring isolators)
 - 13. Materials and Coatings
 - 14. Spring Diameters
- D. Make separate calculations for each isolator on equipment where the load is not equally distributed.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENTS

- A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.
- B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.
- C. The lateral to vertical stiffness ratio (K_x/K_y) of spring isolators shall be between 0.8 and 2.0.
- D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

- E. All isolators shall be designed or treated for corrosion resistance. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.
- F. All isolators, except M1, shall have provision for leveling.
- G. All components in contact with potable water shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act and NSF/ANSI-61 Low Lead Requirements for Drinking Water.

2.2 MOUNTINGS

A. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.
3. All mountings shall have leveling bolts.

a. Manufacturers:

- 1) Mason "SLFH"
- 2) Kinetics "FDS"
- 3) VMC/Amber-Booth "SW-3, 4", 5" or 6"
- 4) Vibration Eliminator Co. "OST".

2.3 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.

a. Manufacturers:

- 1) Mason "HD"
- 2) Kinetics "RH"
- 3) Aeroflex "RHD"
- 4) Vibration Eliminator Co. "IC/3C/3CTD"
- 5) Vibro Acoustics "RH"

B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.

4. Provide end connections for hanging ductwork or piping.

a. Manufacturers:

- 1) Mason "30"
- 2) Kinetics "SRH"
- 3) VMC/Amber-Booth "BSRA"
- 4) Aeroflex "RSH"
- 5) Vibration Eliminator Co. "SNC".
- 6) Vibro Acoustics "SH/SHC"

C. Type H3:

1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.

a. Manufacturer:

- 1) Mason "30N"
- 2) Kinetics "SFH"
- 3) VMC/Amber-Booth "BSW"
- 4) Vibration Eliminator Co. "SNRC"
- 5) Vibro Acoustics "SHR"

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Provide vibration isolation as indicated on the drawings and as described herein.
- C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.
- D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.
- E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.
- F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as pipes supported on a strut rack.

3.2 PIPE ISOLATION

- A. The first three hangers from vibration-isolated equipment shall be type H1.
- B. Provide sufficient piping flexibility for vibrating equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.
- C. Support piping to prevent extension of flexible connectors.

3.3 VIBRATION ISOLATION SCHEDULE

- A. Inline Pumps:
 - 1. Base Type: NA
 - 2. Isolator Type: M3 or H2 or H3
 - 3. Static Deflection: 0.75"
 - 4. Flexible Connections: NA

END OF SECTION 220548

VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12		
	MIN DEFL ("mm)	TAG	PROPOSED ISOLATOR						FREE HT ("mm)	Kx/Ky	LOAD (#kg)	DEFL ("mm)	DEFL RATIO
			MODEL	MAX LOAD (#kg)	DEFL @ MAX LOAD ("mm)	DEFL TO SOLID ("mm)							
ITEM SERVED													

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

SECTION 220553 - PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM B-1, B-3, and B-8 for copper conductors.
- C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 2kV Cables.
- D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 220500. Include list of items identified, wording, letter sizes, and color coding.
- B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.
- H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
 1. All valves (except shutoff valves at equipment) shall have numbered tags.
 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
 6. Number all tags and show the service of the pipe.
 7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
 - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
 - b. Apply primer on non-insulated pipes before painting.
 - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Provide engraved plastic tags at all hydronic system makeup water meters.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CONDENSATE DRAIN: White lettering; green background
2. DOMESTIC COLD WATER: White lettering; green background
3. DOMESTIC HOT WATER: White lettering; green background
4. DOMESTIC HOT WATER CIRCULATING: White lettering; green background
5. SANITARY SEWER: Black lettering; yellow background
6. VENT: Black lettering; yellow background
7. NATURAL GAS: Black lettering; yellow background

END OF SECTION 220553

SECTION 220593 - PLUMBING TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of plumbing systems.

1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, 2002.
- B. ASHRAE - 2003 HVAC Applications Handbook; Chapter 37, Testing, Adjusting and Balancing.
- C. TABB - International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.
- B. Electronic Copies:
 - 1. Submit a certified copy of test reports to the Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 - 2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
 - 3. All text shall be searchable.
 - 4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.

- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 8 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the /Engineer prior to performing each test.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g., submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 - 1. General Equipment Requirements:
 - a. Equipment is safe to operate and in normal condition.
 - b. Equipment with moving parts is properly lubricated.
 - c. Temperature control systems are complete and operable.
 - d. Proper thermal overload protection is in place for electrical equipment.
 - e. Direction of rotation of all pumps is correct.
 - f. Access doors are closed and end caps are in place.
 - 2. Pipe System Requirements:
 - a. Hydronic systems have been cleaned, filled, and vented.
 - b. Strainer screens are clean and in place.
 - c. Shutoff, throttling and balancing valves are open.
- B. Report any defects or deficiencies to Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A. $\pm 10\%$ of scheduled values:
 - 1. Adjust piping systems to $\pm 10\%$ of design values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

A. Title Page:

1. Project name.
2. Project location.
3. Project Architect.
4. Project Engineer (IMEG Corp.).
5. Project General Contractor.
6. TAB Company name, address, phone number.
7. TAB Supervisor's name and certification number.
8. TAB Supervisor's signature and date.
9. Report date.

B. Report Index

C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

4.2 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

D. Packaged Water Heater:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Flow rate (gpm): specified and actual.
6. Pressure drop: specified and actual.

END OF SECTION 220593

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment Insulation.
- B. Equipment Insulation Finishes.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate
- C. ANSI/ASTM C534 - Elastomeric Foam Insulation
- D. ANSI/ASTM C921 - Properties of Jacketing Materials for Thermal Insulation
- E. ANSI/ASTM D1668 - Glass Fabric for Waterproofing
- F. ASTM E84 - Surface Burning Characteristics of Building Materials.
- G. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.
- H. NFPA 255 - Surface Burning Characteristics of Building Materials.
- I. UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 220500. Include product description, list of materials and thickness for equipment scheduled.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type C: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all materials per manufacturer's instructions, codes and industry standards.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- C. Do not insulate factory insulated equipment.
- D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.
- F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.
- G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.
- H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.
- I. Insulate all equipment surfaces that are not factory insulated and are intended to operate above 100°F . Verify insulation type and thickness with equipment manufacturer and Engineer.

3.2 INSULATION

- A. Type C:
 - 1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
 - 2. Secure with manufacturer approved adhesive. Seal all joints with manufacturer approved adhesive.

3.3 SCHEDULE

- A. Plate and Frame Heat Exchanger on Packaged Water Heater: 1" thick Type C. See item 3.1.G, above, for further instructions.

END OF SECTION 220716

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- C. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- D. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation.
- E. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- F. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.
- G. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation.
- H. ASTM E84 - Surface Burning Characteristics of Building Materials.
- I. NFPA 255 - Surface Burning Characteristics of Building Materials.
- J. UL 723 - Surface Burning Characteristics of Building Materials.
- K. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 220500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
- B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.2 INSTALLATION

- A. General Installation Requirements:
 - 1. Install materials per manufacturer's instructions, building codes and industry standards.
 - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
- B. Insulated Piping Operating Below 60°F:
 - 1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.

2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., oiler rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, and strainers.
2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.

E. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.3 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
 - a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
 - b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield. Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
 - c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

- d. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
- 1) Products:
 - a) Buckaroo CoolDry
 - b) Cooper/B-Line Fig. B3380 through B3384
 - c) Pipe Shields A1000, A2000
- e. Insulation Couplings:
- 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
 - a) Klo-Shure or equal
 - 3) Vertical:
 - a) Manufacturers: Klo-Shure Titan or equal
- f. Rectangular blocks, plugs, or wood material are not acceptable.
- g. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge

3.4 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
 - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.5 JACKET COVER INSTALLATION

A. Metal Covering:

1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.
4. Use metal covering on the following pipes:
 - a. All exposed piping in areas noted on drawings.

B. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.

4. Use plastic insulation covering on the following pipes:
 - a. All exposed piping in areas noted on drawings.
 - b. All exposed piping below 8'-0" above floor.
 - c. All piping in boiler room and/or tunnels that is subject to damage from normal operations.
(Example: Piping that must be stepped over routinely.)

3.6 SCHEDULE

- A. Refer to drawings for insulation schedule.

END OF SECTION 220719

SECTION 220900 - INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Positive Displacement Meters.
- B. Pressure Gauge.
- C. Pressure Gauge Accessories.
- D. Thermometers.
- E. Test Plugs.

1.2 REFERENCES

- A. ANSI/AWWA C700 - Cold Water Meters - Displacement Type, Bronze Main Case.
- B. ANSI/AWWA C701 - Cold Water Meters - Turbine Type, for Customer Service.
- C. ANSI/AWWA C702 - Cold Water Meters - Compound Type.
- D. ANSI/AWWA C706 - Direct Reading, Remote Registration Systems for Cold Water Meters.
- E. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
- F. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- G. ASTM E1 - Specification for ASTM Thermometers.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 220500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. AWWA C700 positive displacement disc type suitable for fluid with hermetically sealed register, .
- B. Provide water meters with bronze case with cast iron frost-proof, breakaway bottom cap.
- C. Meter shall contain an analog 4-20 mA output, scaled and unscaled pulse outputs for connection to the building automation system.

D. Manufacturers:

1. Neptune
2. Badger
3. Hersey.

2.2 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

1. Manufacturers:

- a. Ashcroft
- b. Marsh
- c. Marshalltown
- d. Miljoco
- e. Terrice
- f. U.S. Gauge Figure 1901
- g. Weiss
- h. Weksler
- i. Wika.

B. Select gauge range for normal reading near center of gauge.

2.3 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.

B. Shutoff Valve: 1/2" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/2" connections, porous metal type.

D. All pressure gauge piping shall be minimum 1/2" 304 stainless steel pipe or copper tube.

2.4 THERMOMETERS

A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
3. Stem lengths as required for application with minimum insertion of 2-1/2".
4. Thermometers for water shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.
5. Manufacturer:
 - a. Ashcroft
 - b. Marsh
 - c. Marshalltown

- d. Miljoco
- e. Tel-Tru
- f. Trerice
- g. U.S. Gauge
- h. Weiss
- i. Weksler
- j. Wika.

B. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.
2. Select thermometer for appropriate temperature range.
3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3-1/2".
4. Thermometers for water shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.
5. Manufacturer:
 - a. Marsh
 - b. Miljoco
 - c. Trerice
 - d. Weiss
 - e. Weksler
 - f. Wika.

C. Select scales to cover expected range of temperatures.

2.5 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.
- C. Manufacturers:
 1. Sisco
 2. Flow Design
 3. Peterson Equipment
 4. MG Piping Products Co.
 5. Miljoco
 6. Trerice
 7. Watts Regulator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install per manufacturer's instructions.
2. Coil and conceal excess capillary on remote element instruments.
3. Install gauges and thermometers in locations where they are easily read from normal operating level.
4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Positive Displacement Meters:

1. Install positive displacement meters with shutoff valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.

C. Pressure Gauges:

1. Connect pressure gauges to suction and discharge side of all pumps.
2. Provide 1/2" tubing for pressure gauge and gauge accessories.
3. Provide snubber for each pressure gauge.

D. Thermometers:

1. Install piping system thermometers in sockets with short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION 220900

SECTION 221000 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Check Valves.

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
- D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 REFERENCES

- A. ANSI/ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above and Below Ground.
- B. ASME A112.6.9 - Siphonic Drain Test; The American Society of Mechanical Engineers.
- C. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- F. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- G. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- H. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- I. ANSI/ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.
- J. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
- K. ANSI/ASTM B32 - Solder Metal.
- L. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- M. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.

- N. ANSI/AWS D1.1 - Structural Welding Code.
- O. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.
- P. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- Q. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- R. ANSI/AWWA C153 - Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.
- S. ASME - Boiler and Pressure Vessel Code.
- T. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- U. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- V. ASTM A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.
- W. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- X. ASTM A312 - Standard for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- Y. ASTM A554 - Standard for Welded Stainless Steel Mechanical Tubing.
- Z. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
- AA. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.
- BB. ASTM B88 - Seamless Copper Water Tube.
- CC. ASTM B306 - Copper Drainage Tube (DWV).
- DD. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- EE. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- FF. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- GG. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- HH. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- II. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- JJ. ASTM D2661 - ABS DWV Pipe & Fittings.
- KK. ASTM D2665 - PVC DWV Pipe & Fittings.

- LL. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
 - MM. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
 - NN. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
 - OO. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
 - PP. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - QQ. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - RR. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
 - SS. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 - TT. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - UU. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
 - VV. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
 - WW. AWS A5.8 - Brazed Filler Metal.
 - XX. AWWA C651 - Disinfecting Water Mains.
 - YY. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
 - ZZ. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
 - AAA. FM 1680 - Couplings Used in Hubless Cast Iron Systems.
 - BBB. NFPA 24 - Private Fire Service Mains and Their Appurtenances.
 - CCC. NFPA 54 - National Fuel Gas Code.
 - DDD. NFPA 58 - Storage and Handling of Liquefied Petroleum Gases.
 - EEE. NSF - National Sanitation Foundation
- 1.4 SUBMITTALS
- A. Submit shop drawings per Section 220500.
 - B. Submit product data under provisions of Section 220500. Include data on pipe materials, fitting, valves, and accessories.
 - C. Test Reports: Provide results of piping system pressure tests.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 220500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 CAST IRON PIPE

- A. Cast Iron; Standard Weight; Hub and Spigot Joints:

1. Pipe: Standard weight hub and spigot cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: Compression gasket, ASTM C564.
4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.

- B. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:

1. Pipe: Standard weight no-hub cast iron soil pipe, bituminous corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: ASTM C1540, FM 1680, and ASTM C-564.
 - a. Super Duty, Shielded Stainless Steel Couplings: Neoprene sleeve gasket, 0.015" thick 304 stainless steel shield, stainless steel 3/8" screw type clamps, minimum of four clamps for 1-1/2" to 4" and six clamps for 5" and larger pipe sizes. Clamps shall be tightened to minimum 80 inch pounds or as manufacturer requires. Husky SD-4000 or equal.
4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 310. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters specifically for the application. Adapter must meet the same requirements as the joints listed above. ASTM C1460. Sticker identifying transition fitting application must be visible to view.

2.2 COPPER PIPE

- A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.

3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

B. Copper Pipe; Type L; Mechanical Press Connection:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
3. Joints: Mechanical press connection.
4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
5. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
6. Special Requirements: Mechanical press fitting manufacturer shall provide Contractor training prior to installation.
7. Manufacturers:
 - a. Viega ProPress
 - b. Elkhart Xpress
 - c. Nibco Press System Fittings and Valves
 - d. Merit Brass
 - e. Mueller Streamline PRS

C. Copper Pipe: Type DWV; Solder Joints:

1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.3 PLASTIC PIPE

A. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
3. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings.

2.4 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

2. Ball Valves:

- a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
- 1) Provide solid extended shaft for all insulated piping.
 - 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

B. Throttling Valves

1. Globe Valves:

- a. GL-1: 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, Nibco T-235Y.

2.5 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.

2.6 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.

2.7 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F and as indicated on the drawings.

2.8 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

2.9 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:
 - 1. Iron and steel connected to each other.
 - 2. Brass, copper, and bronze connected to each other.
 - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed and/or Grooved Joints (acceptable up to 4" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 - 2. Optional: Copper-silicon casting conforming to UNS C87850 with grooved and/or threaded ends.
 - 3. UL classified in accordance with ANSI / NSF-61 for potable water service.
 - 4. Manufacturers:
 - a. Elster Group ClearFlow fittings
 - b. Victaulic Series 647
 - c. Grinnell Series 407
 - d. Matco-Norca
- F. Flanged Joints (any size):
 - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 - 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 - 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
 - 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
 - 5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
 - 6. Manufacturers:
 - a. EPCO
 - b. Central Plastics
 - c. Pipeline Seal and Insulator
 - d. F. H. Maloney
 - e. Calpico

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.

- D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- E. Connect to equipment with flanges or unions. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.
- F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.

3.2 SYSTEM, PIPING AND VALVE SCHEDULE

- A. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Above Ground):
 - 1. Copper Pipe; Type L; Solder Joints: All Sizes
 - 2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
 - 3. Shutoff Valves: BA-1
 - 4. Throttling Valves: GL-1
- B. Check Valves: CK-1 Strainers: ST-1 Sanitary Waste and Vent, Gravity (Above Ground):
 - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
 - 2. Copper Pipe; Type DWV; Solder Joints: 1-1/4" to 4"
 - 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- C. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
 - 1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
 - 2. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- D. Shutoff Valves: BA-1 Condensate/Equipment Drain (DPP) Piping: Refer to Section 232100.

3.3 TESTING PIPING

- A. Sanitary Drainage, Sanitary Vent:
 - 1. Test all piping with water to prove tight.
 - 2. Test piping before insulation is applied.
 - 3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
 - 4. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
 - 5. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.
- B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable:
 - 1. Test pipes underground or in chases and walls before piping is concealed.
 - 2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
 - 3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
 - 4. Hold test pressure for at least 2 hours.
 - 5. Test to be witnessed by the Engineer's representative, if requested by the Engineer.

C. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

3.4 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

3.5 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
9. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

- B. Installation Requirements in Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- C. Valves/Fittings and Accessories:
1. Provide clearance for installation of insulation and access to valves and fittings.
 2. Provide access doors for concealed valves and fittings.
 3. Install valve stems upright or horizontal, not inverted.
- D. Sanitary and Storm Piping:
1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
 2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
 3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
 4. Sway Bracing: Where horizontal sanitary and/or storm pipes 4 inches and larger change flow direction greater than 45°, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.

- J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
- F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- G. All vent and drain piping shall be of same materials and construction for the service involved.

3.8 PLUMBING VENTS

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.

3.9 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

3.10 JOINING OF PIPE

- A. Solder Joints (Copper Pipe):
 1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
 2. Flux shall be non-acid type.

3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

B. Mechanical Press Connection (Copper Pipe):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer.
5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

C. Hub and Spigot Joints - Sanitary Pipe(Cast Iron Pipe):

1. Compression Gasket Joints: Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.

D. Solvent Weld Joints (PVC):

1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.

E. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):

1. Gasket shall be heavy weight class, conforming to ASTM C564.
2. The gasket shall have an internal center stop.
3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.

3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfection of the domestic water piping replaced under this project shall be completed prior to occupancy of the area served by that piping. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed prior to occupancy.
- B. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- C. Before starting work, verify system is complete, flushed and clean.
- D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.

- G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.
- H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.
- I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.
- J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

END OF SECTION 221000

SECTION 221023 - NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Natural Gas Piping System.

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.3 REFERENCES

- A. ANSI/AWS D1.1 - Structural Welding Code.
- B. ANSI AGA-LC1 - Standards for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.
- C. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- D. ASME - Boiler and Pressure Vessel Code - Section 9.
- E. ASME B1.20.1 - Pipe Threads, General Purpose.
- F. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- G. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- H. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- I. ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- J. ASME B16.21 - Nonmetallic Flat Gaskets for Pipes Flanges.
- K. ASME B16.39 - Malleable Iron Threaded Pipe Unions.
- L. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
- M. ASME B18.2.2 - Square and Hex Nuts, Inch Series.
- N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- O. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.

- P. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.
- Q. ASTM A197 - Standard Specification for Cupola Malleable Iron.
- R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- S. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- T. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- U. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
- V. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.
- W. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
- X. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- Y. NFPA 54 - National Fuel Gas Code.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 22 05 00. Include data on pipe materials, fittings, valves, and accessories.
- B. Test Reports: Provide results of piping system pressure test.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 NATURAL GAS (0 to 125 PSI)

- A. Design Pressure: 125 psi. Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
 - 1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
 - 2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)

3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

C. Piping - 2-1/2" and Over:

1. Pipe: Standard weight steel, beveled ends, ASTM A53.
2. Joints: Butt welded or flanged.
3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

D. Shutoff Valves/Throttling Valves:

1. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing.
 - a. Manufacturers:
 - 1) Apollo #80-100
 - 2) Nibco #T580-70-UL or #T585-70-UL
 - 3) Watts #B-6000
2. PL-1: 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port.
 - a. Manufacturers:
 - 1) Walworth #1700
 - 2) DeZurik #425, S-RS49
3. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port.
 - a. Manufacturers:
 - 1) Walworth #1700F
 - 2) DeZurik #425, F-RS49

E. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing.
 - a. Manufacturers:
 - 1) Crane #37
 - 2) Hammond #IB904
 - 3) Stockham #B319-Y
 - 4) Walworth #3406
 - 5) Milwaukee #509
 - 6) Watts #B-5000
 - 7) Nibco Y-413B
2. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.

a. Manufacturers:

- 1) Mueller Steam Specialty Co. #71-AHB-6-H
- 2) Stockham #WG-961 EPDM or #WG970 BUNA
- 3) NIBCO W-920-W
- 4) Crane

F. Strainers:

1. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F.

a. Manufacturers:

- 1) Armstrong #A1FL
- 2) Metraflex #TF
- 3) Mueller Steam Specialty Co.#751
- 4) Sarco #CI-125
- 5) Watts #77F-D

2. ST-4: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F.

a. Manufacturers:

- 1) Armstrong #A1SC
- 2) Metraflex #SM
- 3) Mueller Steam Specialty Co. #11
- 4) Sarco #IT

2.2 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Gases:

- a. 1/4" - 2": 1/32" perforations
- b. 2-1/2" - 10": 3/64" perforations

- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

- C. Use iron body strainers in ferrous piping.

2.3 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

PART 3 - EXECUTION

3.1 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. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

3.2 TESTING PIPING

- A. Low Pressure - Up to 1 psi:
 - 1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.
- B. High Pressure - Above 1 psi:
 - 1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.
- C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

3.3 CLEANING PIPING

- A. Assembly:
 - 1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
 - 2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
 - 3. Notify the Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
 - 4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.4 INSTALLATION

- A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
- B. Install piping to conserve building space, and not interfere with other work.
- C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- F. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
- G. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
- H. Provide clearance for access to valves and fittings.
- I. Provide access doors where valves are not exposed.
- J. Prepare pipe, fittings, supports, and accessories for finish painting.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
- M. Provide shutoff valves to isolate part of systems and vertical risers.
- N. Provide shutoff valves to boilers and water heaters in readily accessible location, maximum 6 feet above finished floor, within 6 feet of boiler connection per ASME CSD-1.
- O. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- P. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

3.5 BONDING AND GROUNDING

- A. Each above ground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
- B. Gas piping shall not be used as a grounding conductor or electrode.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Cut all pipe to exact measurement and install without springing or forcing.
- H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.
- B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.
- C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
 1. Must have at least same pressure rating as the main.
 2. Header or main must be 2-1/2" or over.
 3. Branch line is at least two pipe sizes under header or main size.
- D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

3.9 JOINING OF PIPE

- A. Threaded Joints:
 1. Ream pipe ends and remove all burrs and chips.
 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
 3. Apply gas-rated Teflon tape or thread compound to male threads.
- B. Flanged Joints:
 1. Steel flanges shall be raised face.

2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
 - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
 - b. Maximum pressure rating of at least 250 psig.
 - c. Minimum temperature rating: -10°F.
 - d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

C. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

3.10 PAINTING EXPOSED PIPE

- A. Paint all exposed natural gas piping to match the color of the existing natural gas piping.

END OF SECTION 221023

SECTION 221030 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleanouts.
- B. Traps.
- C. Hub Drains and Standpipes
- D. Backflow Preventers.
- E. Strainers.
- F. Unions.
- G. Balancing Valves.
- H. Dielectric Fittings (Connections Between Dissimilar Metals).
- I. Air Vents.
- J. Drain Valves.

1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 220500.
- B. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Provide cleanouts as shown and specified on the drawings as well as required by code.
- B. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- C. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.2 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
 - 1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
 - 2. Cast iron, deep-seal pattern where concealed in unfinished areas.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.
- C. Each trap shall be completely filled with water and a 1/2" (15mm) minimum layer of mineral oil at the end of construction but before building space turnover to the Owner.

2.3 HUB DRAINS AND STANDPIPES

- A. A hub drain shall be in the form of a hub or pipe without a grate/strainer extending through the floor for receiving indirect waste. A hub drain has a flood level rim above the finished floor.
- B. Provide hub drains as shown and specified on the drawings as well as required by code.

2.4 BACKFLOW PREVENTERS

- A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.5 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
 - 1. Water:
 - a. 1/4" - 2": 3/64" perforations
 - b. 2-1/2" - 10": 1/16" perforations
- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.
- C. Use bronze body strainers in copper piping.

2.6 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.

2.7 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.

- C. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi" or Nibco Globe Style balancing valve.
- D. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.8 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
 1. Iron, steel, and stainless steel connected to each other.
 2. Brass, copper, and bronze connected to each other.
 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.
- F. Flanged Joints (any size):
 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
 5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
 6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.9 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.10 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.11 RELIEF VALVES

- A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Cleanouts:
 1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
 2. Extend cleanouts to the floor with long sweep elbows.
 3. Install a full size, two-way cleanout within 5 feet of the foundation inside of building.
 4. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
- D. Hub Drains and Standpipes:
 1. The top of a hub drain/standpipe shall extend above the finished floor elevation. Refer to drawings for dimensions above the finished floor.
 2. Access shall be provided to drains and standpipes for rodding.
- E. Backflow Preventer:
 1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
 2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
 3. Install unit between 12" and 60" above finish floor.
- F. Balancing Valves:
 1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION 221030

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Domestic Water In-Line Circulators.

1.2 SUBMITTALS

- A. Submit product data under provisions of Section 220500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.
- D. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Domestic hot water pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 220513.
- G. Submitted pump selections must have a diameter impeller that meets or exceeds the scheduled pump. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

2.2 DOMESTIC WATER IN-LINE CIRCULATORS

- A. Provide pumps as specified on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install all products per manufacturer's recommendations.

2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. In-Line Pump:

1. Support in-line pumps individually so there is no strain on the piping. Support pump so no weight is carried on pump casings. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
2. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

C. Pump without VFD or ECM:

1. For pumps not powered by a VFD, trim impeller to meet maximum operating conditions. Coordinate final trimmed diameter with Testing, Adjusting, and Balancing Contractor and Engineer.

END OF SECTION 221123

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Water Heaters.

1.2 QUALITY ASSURANCE

- A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:
 - 1. American Gas Association (AGA).
 - 2. National Sanitation Foundation (NSF).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 5. National Electrical Manufacturers' Association (NEMA).
 - 6. Underwriters' Laboratories (UL).
- B. Conform to ASME Section VIII for construction of water heaters and heat exchangers.

1.3 REFERENCES

- A. ANSI/ASME Section 8D - Pressure Vessels.
- B. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 220500.
- B. Include dimension drawings of packaged water heaters indicating components and connections to other equipment and piping.
- C. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.
- D. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.
- E. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.
- F. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.

PART 2 - PRODUCTS

2.1 PACKAGED WATER HEATERS

- A. All packaged water heaters shall be as scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all items in accordance with manufacturer's instructions.

3.2 PACKAGED WATER HEATER INSTALLATION

- A. Install packaged water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 220529.
- B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

END OF SECTION 223000

SECTION 230500 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
 - 1. Plumbing Work: Refer to Section 220500 "Basic Plumbing Requirements".
 - 2. Mechanical Work shall include, but is not necessarily limited to:
 - a. Demolish steam boilers, accessories, individual boiler breechings, vacuum pumps, condensate pumps, boiler feed pumps, associated controls, and all exposed steam & condensate piping in boiler room and tunnels.
 - b. Furnish and install heating hydronic boilers and accessories.
 - c. Furnish and install complete 2-pipe heating/chilled water system including pumps, piping, insulation, air control equipment, terminal heat transfer units (including some with louvers, ductwork, and dampers), and specialties. Make final connections to all coils.
 - d. Under an Alternate, furnish and install air-cooled chiller and associated chilled water piping, in boiler room and outdoors.
 - e. Furnish and install condensate drain piping from cooling related equipment such as fan coil units and cooling coil drain pans.
 - f. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
 - g. Furnish and install complete outside air and return air ductwork systems including all louvers, dampers, fittings, and insulation.
 - h. Modify and/or furnish and install combustion air dampers as indicated on the drawings.
 - i. Furnish and install gas flues and breechings as required to connect to existing breeching.
 - j. Furnish and install all temperature control systems.
 - k. Test, adjust, and balance all new mechanical equipment, air and hydronic systems.
 - l. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
 - m. Complete all applicable tests, certifications, forms, and matrices.

1.3 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours will be required.

1.4 ALTERNATES

- A. Refer to Division 01 ALTERNATES.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

- A. Definitions:

1. "Mechanical Contractors" refers to the following:
 - a. Plumbing Contractor.
 - b. Heating Contractor.
 - c. Air Conditioning and Ventilating Contractor.
 - d. Temperature Control Contractor.
 - e. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
 - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Gravity flow piping.
 - b. Electrical busduct.
 - c. Sheet metal.
 - d. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
 - a. Boilers/Burners.
 - b. Chiller.
 - c. Fuel Oil Transfer Pump Set and Fuel Oil Trains.
 - d. Terminal Heat Transfer Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
 - a. Wiring of all devices needed to make the Temperature Control System functional.
 - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
 - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, plumbing piping, hydronic piping, condensate drain (DPP) piping, and any item that may impact coordination with other disciplines.
 - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Maintenance clearances and code-required dedicated space shall be included.
 - d. The coordination drawings shall include all in-tunnel, in chase, and vertical trade items.
2. Spaces with open ceilings shall indicate the existing overhead utilities and locate new equipment and piping as required to maintain clearance around and access to existing items such as lights, junction boxes, smoke detectors, security cameras, sprinklers, etc. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all new work in congested areas, to ensure an orderly and coordinated end result, and to provide adequate access to new and existing items for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Engineer and Owner's Representative. The Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Engineer.
9. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
10. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
11. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Maryville, MO Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State of Missouri Codes, Laws, and Ordinances.
3. If there is a discrepancy between the codes and regulations and these specifications, the Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.8 SUBMITTALS

- A. Submittals shall be required for items, where required elsewhere in the specifications or on the drawings.
- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:
 1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
 3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
 4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Engineer's review and processing of each submittal.
16. Engineer reserves the right to withhold action on a submittal which, in the Engineer's opinion, requires coordination with other submittals until related submittals are received. The Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 23 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.9 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 1. Base Mounted Pumps
 2. Boilers, Burners and Boiler Trim
 3. Water Chiller
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Engineer, nor the presence of the Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 ENGINEER OBSERVATION OF WORK

- A. The Engineer shall have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Engineer so that the final observation can be scheduled.
4. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection by State Boiler Inspector.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Engineer required prior to final payment approval.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Engineer's review and approval. The electronic copy shall be corrected as required to address the Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Engineer, Two paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" (12mm) thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 230900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 - 1. Explanation of all system flow diagrams.
 - 2. Explanation of all air handling systems.
 - 3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
 - 4. Maintenance of equipment.
 - 5. Start-up procedures for all major equipment.
 - 6. Explanation of seasonal system changes.
 - 7. Description of emergency system operation.
- E. Notify the Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
 - 1. Heating / Chilled Water Pumping / Piping System - 2 hours.
 - 2. Boiler/Burner Systems: 8 hours
 - 3. Fuel Oil System - 4 hours.
 - 4. Chemical Treatment System - As defined in Section 232500.
 - 5. Combustion Air System - 2 hour.
 - 6. Fan Coil Unit / Air Handling System(s) - 2 hours.
 - 7. Temperature Controls - As defined in Section 230900.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
 - 1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
 - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

- A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.
- B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Refer to Section 230900 for additional requirements for Temperature Control documents.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Engineer.

3.8 PAINTING

- A. This Contractor shall paint the following items:
 - 1. All fuel oil piping in boiler room
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Engineer the color preference and furnish this color.
- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. Paint all outdoor exposed natural gas propane fuel oil piping the color selected by Owner or Engineer.
- G. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
 - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

3.11 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 - d. Protect stored on-site and installed absorptive materials from moisture damage.
 2. Request that the Owner designate an IAQ representative.
 3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 6. Request copies of and follow all of the Owner's IAQ and infection control policies.
 7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
 8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
 9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".
 10. If permanently installed air handlers are used to serve both construction and occupied areas, all return grilles throughout construction areas shall be sealed to prevent air from construction areas being supplied to occupied areas.
 11. If permanently installed air handlers are used during construction to serve only construction areas and do not supply air to adjacent occupied areas, MERV 8 filtration media shall be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media shall be replaced immediately prior to occupancy.
 12. Construction areas shall be maintained at a negative pressure at all times during construction. When areas are under construction, exhaust fan(s) shall be installed in sufficient quantities as required to maintain construction areas at sufficient negative pressure. Exhaust fan discharge shall be ducted outdoors.
 13. For each area under construction, the Contractor shall install a negative pressure indicator equivalent to Lamiflow Model L-102F as manufactured by Lamiflow Technologies. Contractor shall regularly monitor and record the negative pressure condition of the construction areas.

3.12 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

- A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, fan coil units, and the like.

- B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.
- C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.
- D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.
- E. The following steps shall be taken during testing, adjusting, and balancing of each air system:
 - 1. All construction activities in all spaces served by the air system shall stop.
 - 2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.
 - 3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
 - 4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.
- F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2.. All pumps, boilers and chiller operating and balanced.
- 3. All miscellaneous mechanical systems (unit heaters, fan coil units, convectors, etc.) operating.
- 4. All temperature control systems operating, programmed and calibrated.
- 5. Pipe insulation complete, pipes labeled and valves tagged.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 230500

SECTION 230503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2021 International Building Code

1.4 SUBMITTALS

- A. Submit under provisions of Section 230500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.

3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
4. F ratings for each firestop system.

- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 1. Review foreseeable methods related to firestopping work.
 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

- A. Provide one year warranty on parts and labor.

- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Dow Corning Corp.
10. Fire Trak Corp.
11. International Protective Coating Corp.
12. HoldRite

2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:
 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:
 - a. F Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. F Rating = Wall/Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

*Alternate method of firestopping is patching opening to match original rated construction.

H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.

- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Engineer and manufacturer's factory representative. The Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Engineer's discretion and the contractor's expense.

END OF SECTION 230503

SECTION 230505 - HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mechanical demolition.
- B. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- C. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- D. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- E. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.2 PREPARATION

- A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned ducts and piping to source of supply and/or main lines.

- D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.
- H. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 230529 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Engineer prior to start of work.
- E. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to discipline plans for additional information.
- F. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes X-ray or similar non-destructive means.
- G. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

- A. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Engineer before proceeding.

END OF SECTION 230505

SECTION 230513 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single Phase and Three Phase Electric Motors.

1.2 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Security Act of 2007.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 230500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- C. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.
- D. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

PART 2 - PRODUCTS

2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- G. Each contractor shall set all motors furnished by him.
- H. All motors shall have a minimum service factor of 1.15.
- I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- K. Aluminum end housings are not permitted on motors 15 HP or larger.
- L. Motor Driven Equipment:
1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
 2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.
- M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

- N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.2 ELECTRICALLY COMMUTATED MOTORS (ECM)

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with on-board motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
 - 1. Constant Flow
 - 2. Constant Temperature
 - 3. Constant Pressure

2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPA legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
60.0	94.5	95.0	93.6	94.5	95.0	93.6
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

- B. Motor nameplate shall be noted with the above ratings.

2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.
- D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.
1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
 2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

2.5 SHEAVES

- A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.
- B. When replacing sheaves, use sheaves of at least the originally supplied sizes.
- C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 230513

SECTION 230515 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable frequency drives (VFD-#)

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

1.3 REFERENCES

- A. ANSI/UL Standard 508
- B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- C. Standard for Harmonic Control in Electrical Power Systems IEEE 519-2022 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230500.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing PWM configuration (6, 12, 18 pulse, Active Front End AFE), voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Product Data for Accessories and Options: Provide catalog sheets showing voltage, dimensions, ratings, for accessories and options. Include information for passive harmonic filters, active harmonic filters, line reactors, shielded VFD cabling, output filters, etc. as an inclusive submittal package provided by the VFD supplier. The VFD supplier shall act as a single contact of responsibility.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F. Contractor's Letter of Acknowledgement: The contractor shall include a letter acknowledging the following with date and signature. The letter shall include a location for the installing contractor to sign the document:
 - 1. The manufacturer/vendor received a complete copy of the design document specifications, plans, and schedules as related to the variable frequency drive requirements for the project.

2. The contractor and manufacturer have reviewed the distance relationship between the VFD location and the motor(s) served in conjunction with the installing contractor's cable routing plan. The submittal includes compliance with the minimum requirements for each specific application including the addition of harmonic filters and shielded VFD cabling. The contractor is responsible for compiling and documenting information including cable lengths for mutual review with the manufacturer.
3. Leading Power Factor Management: The manufacturer has reviewed the design and identified VFD applications scheduled to operate on a generator power source.

G. VFD Harmonic Analysis:

1. Provide harmonic analysis of each individual variable frequency drive based on the latest IEEE 519 for voltage (THD) and current (TDD) distortion limits at the input terminals of the VFD.
2. Provide a summary of the individual harmonic analysis for each VFD in tabular form to document compliance with the minimum harmonic distortion criteria. Example:
 - a. VFD - TAG
 - b. Current distortion (TDD): percent at terminals of VFD
 - c. Input Line reactor, DC link choke, or LCL filter rating: percent
 - d. Leading Power Factor Control management applied: Yes or No
 - e. Filtering: List application specific options and accessories included for compliance with the contract documents and manufacturer recommendations including filters and shielded VFD cabling.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 230500.
- B. Accept controllers on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230500.
- B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- D. Shop Drawings: For each VFD.
 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.

- d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Variable Torque Applications:
- 1. Toshiba Q9 Series
 - 2. ABB ACH 580 (HVAC) / ACS 580 (other applications) Series
 - 3. Danfoss VLTF100 Series
 - 4. Square D, S-Flex / ATV660 Series
 - 5. Eaton MMX / HMX / SVX Series
 - 6. Yaskawa Z1000 Series
- B. The Variable Frequency Drive Schedule and drawings use equipment tags to define the scope of the project. The equipment tag (example: VFD-5) may be representative of multiple similar applications. Additional options and accessories may be required by the specifications and manufacturer recommendations due to the specific application but not represented in the Variable Frequency Drive Schedule. Refer to the Options, Accessories, and minimum performance requirements of this specification for a complete list of requirements (example: output filters and shielded VFD cables).
- C. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule and Mechanical Schedules when applicable.

2.2 MINIMUM PERFORMANCE, REQUIRED OPTIONS, AND ACCESSORIES

- A. The following minimum performance requirements, options, and accessories supplement the requirements of the Variable Frequency Drive Schedule. In the event of a conflict between the schedule and specification the most stringent requirement will be enforced.
- 1. Manual Speed Adjustment
 - 2. Electronic ThermalOverloads
 - 3. Control Transformer, Fused, 120 volt. Acceptable Alternative, 120 volt / 24 volt power supply available directly from VFD, 100mA minimum.
 - 4. Hand-off-Auto Door Switch
 - 5. Skip Frequency Capability
- B. Line Input Reactor: Provide all VFDs with a minimum input line reactor of (3%). The input line reactor may be integral or individually mounted.
- 1. Exception: The manufacturer may substitute an LCL type harmonic filter with an input harmonic filter; an approximate equivalent (3%) impedance from the harmonic filter is anticipated.
 - 2. Exception: A dual (positive and negative) 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter. Exception: Not required for Active Front End AFE drives with an IGBT front end instead of a diode-bridge configuration.

- C. Forced Ventilation Accessories and Operation: Provide per manufacturer requirements as required for the standard performance of the drive, the application, and environmental conditions.
1. Provide inlet air outlet filter when a fan is provided. Provide an outlet filter if appropriate for the physical construction of the VFD.
 2. Field replaceable blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location. The VFD manufacturer's air change requirements shall be satisfied or exceeded for enclosed applications.
- D. Harmonic Distortion Performance Criteria (PCC defined at VFD): The variable frequency drive shall have the following minimum harmonic distortion performance criteria; reference to the latest edition of IEEE 519. **The Point of Common Coupling PCC shall be considered the input line terminals of the combination VFD, applicable filters, and accessories for the following requirements.**
1. Design Commentary for the benefit of the contractor, vendor, and manufacturer. The IEEE 519 Standard defines harmonic distortion performance based on a "good neighbor" criteria and overlooks good design practice criteria within the end-user's facility. The Harmonic Distortion Performance Criteria associated with this specification exceeds the minimum industry recognized performance criteria by defining the performance at the VFD. The specification defines a combination of acceptable VFD, passive/active filters, and other accessories. The intent is to promote competition while allowing each manufacturer to offer their best value based solution(s) for the benefit of the project. An industry recognized IEEE 519 Harmonic Analysis Report has been listed as a submittal requirement when required for compliance and documentation purposes when required.
 2. The minimum configuration represents the minimum acceptable solution to achieve THD_v and TDD_i performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.
 3. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.
 4. VFD rating 15 HP or less:
 - a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
 5. VFD rating exceeding 15HP to 99HP:
 - a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
 - b. Minimum Performance Criteria:
 - 1) Voltage Total Harmonic Distortion (THD_v) limit: 5 percent
 - 2) Current Total Demand Distortion (TDD_i) limit: 5 percent
 - c. Approved solutions for minimum THD_v and TDD_i performance: The following approved solutions or a combination of the following is acceptable:
 - 1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.

- 2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
- 3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

E. VFD Output Load Terminals - Minimum Design Requirements:

1. Provide external output line reactors, DV/DT, sine filters, and shielded VFD cable when the manufacturer's recommended maximum distance between the VFD and the motor(s) is exceeded.
2. Provide the following minimum design criteria in addition to manufacturer recommendations:
 - a. Output line reactor (3 percent): When recommended by manufacturer.
 - b. DV/DT output line reactor: VFD to motor distance exceeds 75 feet (480 volt) or 150 feet (240/208 volt).
 - c. Sine Wave Output Line Reactor: VFD to motor distance exceeds 150 feet (480 Volt) or 280 feet (240/208 Volt).
 - d. Shielded VFD Motor Cable: Horsepower ratings exceeds 100 HP for any cable length.

F. Leading Power Factor Management: The project includes a packaged engine emergency generator. VFD applications including a capacitor solution (example: Harmonic Filters) shall include provisions to disconnect or step control the capacitor components when the associated motor load is not operating to prevent a leading power factor while operating on the generator power source.

2.3 VFD DESCRIPTION, RATINGS, DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:

1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC motors. The controller shall be suitable for use with standard inverter duty motors without requiring any modifications to the motor or the drive.
2. Drives shall be capable of use with commercially available Internal Permanent Magnet (IPM) motors up to 12 poles.
3. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz.
 - a. 50HP applications and less: If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

B. Short Circuit Current Rating SCCR Default: 100 KA. Provide integral circuit breaker or fuse switch with disconnect switch when required to achieve rating.

C. Drive and controller shall be capable of continuous full load operations throughout the following specified environmental operating conditions. Drive shall be capable of operation in the 'forward' and 'reverse' direction.

1. Operating Ambient Temperature: 0°C to 40°C.
2. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
3. Minimum Elevation without Derating: 3300 feet.
4. The VFD shall incorporate a protective coating on the main control board to conform to IEC60721-3-3 class 3C2 levels.

D. Input Voltage Performance: The drive shall provide full rated output from a line voltage range of -15 / +10% nominal voltage.

- E. Controller shall have the functional components listed below:
1. Door interlocked input circuit breaker/fused switch.
 2. Input rectifier section to supply fixed DC bus voltage.
 3. Smoothing reactor or choke for DC bus.
 4. DC bus capacitors.
 5. Control transformer or switch mode powered from all three phases.
 6. Separate terminal blocks for power and control wiring.
 7. Terminal block for operator controls.
 8. Sine weighted PWM generating inverter section.
- F. Enclosure Fabrication:
1. Enclosure: NEMA 250, Type 1, unless otherwise specified.
 2. Finish: Manufacturer's standard enamel.
 3. Devices shall be factory installed in controller enclosure and functionally tested unless otherwise indicated.
- G. Displays: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current). Include meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Set-point frequency (Hz).
 10. Motor output voltage (V).
- H. Status Indication Door-mounted display shall indicate the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- I. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- J. Panel-Mounted Operator Station or KeyPad, Start-stop, auto-manual selector switches with manual speed control potentiometer, and elapsed time meter: NEMA ICS 2, heavy-duty type.

- K. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- L. Control Relays: Auxiliary and adjustable time-delay relays.
- M. Protection:
1. Input transient protection by means of surge suppressors or equivalent protection.
 2. Snubber networks to protect against malfunctions due to system transients.
 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 4. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
 5. Motor thermal overload relay(s) adjustable and capable of NEMA Class[10][20][30] motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
 6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Skip frequency feature is acceptable.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
 8. Loss-of-phase protection.
 9. Short-circuit protection (fuses or circuit breaker).
 10. Motor overtemperature fault.
 11. Loss of load protection.
- N. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.
- O. The deceleration ramp of the controller shall be programmable for normal and fault conditions. Stop modes shall include: DC injection braking, controlled deceleration to stop and coast to stop.
- P. Upon loss of the analog speed reference signal the following shall be selectable:
1. The VFD follows the programmed deceleration ramp to a controlled stop.
 2. The VFD holds the speed based upon the last good value and trigger a warning alarm.
- Q. The VFD operates at a pre-determined frequency (user programmable).
- R. STOP key on the keypad shall be functional at all time, drive mode insensitive.
- S. The VFD shall be insensitive to input power phase sequence. Input phase loss detection shall be available.
- T. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded (stall prevention).
- U. For pump applications, the VFD shall incorporate a forward/reverse pump start sub-routine to assist with clogging.
- V. An optional real time clock feature shall be available, which must facilitate the time stamping of any drive trip messages.
- W. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.

- X. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.
- Y. The VFD shall include parameter selectable input and output phase loss protection.
- Z. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.
- AA. The VFD shall be rated as a safety VFD (STO) EN ISO 13849-1 PLd/Cat.3, EN61508, and EN61800-5-2 SIL 1 without additional options.
- BB. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- CC. Minimum Efficiency at Full Load: 96 percent.
- DD. Overload Capability: 1.1 times the base load current for 60 seconds every 10 minutes; 1.3 times the base load current for 2 seconds every minute.
- EE. Starting Torque: 100 percent of rated torque or as indicated.
- FF. Speed Regulation: Plus or minus 1 percent with no motor derating.
- GG. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.
- HH. The drive shall provide self-protection when the load is lost or disconnected without damage to the drive.
- II. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- JJ. Deceleration Rate Adjustment: 1 - 30 seconds.
- KK. Minimum Adjustment Range for the Output Frequency shall be: 0 to 90 Hertz.
- LL. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- MM. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.
- NN. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- OO. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
- PP. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- QQ. Automatic Reset/Restart: Attempts up to 10 restarts after controller fault, on return of power after an interruption, or on undervoltage fault, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load (coasting motor re-start).
- RR. Excitation Control will regulate motor output voltage based on torque requirement. Must be able to provide full motor torque when necessary across the operating speed range.

- SS. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- TT. Control Transformer: Provide control power transformer for control, 120 volt secondary, fused.
- UU. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Ethernet.
 - g. Keypad display for local hand operation.
 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
 4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
 5. The control power for the VFD digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
 6. The drive control board shall be capable of operating from an independent 24V dc power supply.
 7. All logic connections shall be furnished on a removable terminal strip.
 8. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
 9. Speed command input shall be by means of:
 - a. Keypad.
 - b. Analog input.
 - c. Serial communications.
 - d. Ethernet communications.

- VV. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 230900. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
- WW. Control:
1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door or keypad.
 2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
 3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
 4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
 5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass to direct-on-line operation. In this mode the thermal overload relay for the motor must be disabled.
- XX. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.
- YY. Convertible Auxiliary Contacts (additional): Provide two additional convertible normally open / normally closed contacts.
- ZZ. Electronic Thermal Overloads: Provide adjustable electronic type thermal overloads. Size protection per motor nameplate data.

2.4 OPTIONS AND ACCESSORIES - DESCRIPTIONS

- A. Passive Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating.
1. When required:
 - a. As required to satisfy, the Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- B. Active Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating. Provide all VFDs coupled with an Active Harmonic Filter with a minimum three percent (3%) input line reactor; or larger per manufacturer requirements.
1. When required:
 - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- C. Active Bridge Rectifier Stage: Capable of limiting current harmonic distortion at the drive input terminals.

1. When required:
 - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
 - b. Per VFD schedule.
- D. Dynamic Braking: The VFD shall incorporate terminals for adding an external braking unit to allow for dissipation of excessive electrical energy from the motor. Provide dynamic braking with load resistor or DC injection braking to provide a means of rapid deceleration of the AC motor within one (1) minute. Adjust the controls to stop the motor within 30 seconds.
1. When required:
 - a. 100HP or larger applications.
 - b. VFD served by package engine generator.
 - c. Per VFD schedule or other portions of this specification.
 - d. All VFDs supplied for fan applications when VFD is not capable of capturing a free spinning load without damage to the VFD or motor.
 2. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds. The following options shall be available:
 - a. Adjustable operation frequency, time, and voltage.
 - b. External line regeneration.
 - c. Shared DC bus capability systems for multiple drive regeneration.
- E. Three- Contactor Manual Bypass:
1. When required: Per VFD schedule.
 2. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch or third contactor to allow maintenance of inverter during bypass operation.
 3. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.
 4. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.
 5. Provide a Drive-Bypass Selector Switch.
 6. When operating in bypass mode, the main power supply to the VFD shall be disconnected and isolated for service.
 7. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.
- F. Shielded VFD Motor Cable:
1. When required:
 - a. Per VFD schedule.
 - b. Required by other portions of this specification.
 - c. Recommended by the manufacturer.
 2. Multi-conductor single overall jacket cable, AC motor application controlled by PWM pulse-width modulation VFD applications, minimum 2000 volt rated, copper phase conductor(s) to match motor application and ratings, three copper conductor ground in direct contact with shield, copper tape or braided shield, provide with wire termination kits at VFD and motor, install per manufacturer recommendations.

3. Conduit Raceway: Contractor to size raceway per code and cable cross sectional area provided by manufacturer.
 4. Installation: Contractor shall install without cable splices between VFD and motor unless approved by engineer prior to installation.
- G. Forced Cooling / Heating Cabinet Enclosure:
1. When required:
 - a. Per VFD schedule.
 - b. When VFD is located exterior to the building or specified with a NEMA 3R, 4, 4X, or 12 enclosure.
 2. Provide custom VFD enclosure with DX based cooling system, strip heaters, and thermostat temp controller.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Refer to startup and commissioning requirements.
- B. The VFD and all associated controller components shall be covered by a supplier parts warranty of 2 years from the time of installation. There shall be an option to extend the warranty to 5 years if initial installation is carried out by a supplier-approved contractor.

3.2 INSTALLATION

- A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.
- B. Install harmonic filter components in accordance with manufacturer's instructions. Locate filters above or below VFD to minimize use of available horizontal wall space pending field conditions.
- C. Adjust VFD settings per recommendations of the harmonic filter manufacturer's instructions; example: switching frequency.
- D. VFD Output Feeder and Raceway: The contractor shall provide VFD shielded cable for the VFD output feeder when the distance to the motor exceeds manufacturer recommendations or the requirements of this specifications. Contractor to size raceway per code and cable cross sectional area provided by manufacturer.
- E. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.
- F. Provide engraved phenolic nameplates under the provisions of Section 230553.
- G. Connections: All conduit connections to the VFD shall be by flexible conduit.
- H. Input, output, and control wiring shall each be run in separate conduits.
- I. All interlocking required by the drive manufacturer shall be the responsibility of the Mechanical Contractor.

- J. Forced Cooling / Heating Cabinet Enclosure: Coordinate installation with field conditions and manufacturer instructions. Provide additional branch circuit(s) for cooling and heating system per manufacturer requirements.

3.3 STARTUP AND COMMISSIONING

- A. The Mechanical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.
- B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.
- C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.
- D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.
- E. Document settings in the Operations and Maintenance manual.

END OF SECTION 230515

SECTION 230516 - HVAC EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Expansion Joints and Compensators.
- B. Pipe Loops, Offsets, and Swing Joints.

1.2 REFERENCES

- A. Conform to Standards of Expansion Joint Manufacturer's Association.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Expansion joint shop drawings shall include maximum motion.

1.4 DESIGN CRITERIA

- A. Unless noted otherwise, base expansion calculations on 50°F installation temperature to 210°F for heating water and steam condensate, plus 30% safety factor. Contact Engineer for steam temperatures.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

- A. Type EJ-5:
 1. Universal tied expansion joint with two independent bellows.
 2. Multiple plies of 300 series stainless steel bellows.
 3. Tie/Limit rods are required to absorb pressure thrust force in case of anchor failure and provide safety limits for design motions.
 4. Rated for 150 psi working pressure at 250°F and 100 psi at 400°F.
 5. Cycle life shall be at least 1,000 full range (compression and extension) cycles at rated stroke and 6,000 cycles at 1/2 rated stroke.
 6. Lateral motion shall be as scheduled on the drawings, but not less than 2" (compression and extension).
 7. Joints shall have 300 lb. flanges on each end.
 8. Provide stainless steel inner liner.
 9. Provide removable metal insulation shroud around the bellows.
 - a. Manufacturers:
 - 1) American BOA Type FS3300
 - 2) Flexonics
 - 3) RM Model X-Flex-300 Multiply
 - 4) Hyspan Model 1501

B. Type EJ-6:

1. Externally pressurized expansion joint with bellows completely enclosed with rigid pipe exterior.
2. Multiple plies of 300 series stainless steel bellows.
3. Rated for 150 psi (1035 kPa) working pressure at 250°F (121°C) and 100 psi (690 kPa) at 400°F (204°C).
4. Cycle life shall be at least 1,000 full range (compression and extension) cycles at rated stroke and 6,000 cycles at 1/2 rated stroke.
5. Axial motion shall be as scheduled on the drawings, but not less than 2" (50 mm) (compression plus extension).
6. Provide stainless steel inner liner for all steam expansion joints.
7. Provide removable metal insulation shroud around the bellows.
8. Joints 2" (50 mm) or smaller in copper piping systems shall have all copper, brass or bronze construction with stainless steel bellows and union ends or sweat ends with unions added.
 - a. Manufacturers:
 - 1) American BOA Type KH
 - 2) Hyspan Type 8509
 - 3) Flexonics Model HB
 - 4) Metraflex Model HPMF
 - 5) Keflex Series 7QT

C. Alignment Guides:

1. Bolted semi-steel spider.
2. Bolted guiding cylinder with supporting legs welded to pipe support.
3. Sized to allow insulation to pass through the outer cylinder.
 - a. Manufacturers:
 - 1) American BOA
 - 2) Hyspan
 - 3) Flexonics
 - 4) Keflex
 - 5) Metraflex

D. Concrete Thrust Blocks - Rods and Clamps:

1. Bends, offsets, tees, crosses, and dead ends, including flange and spigot pieces, shall be suitably rodded or clamped and blocked with concrete thrust blocks.
2. Rods shall be all thread type, galvanized steel conforming to ANSI B1.1, Class 2A FIT, USS National Coarse Thread, tensile strength 55/77 ksi, yield strength 36 ksi minimum.
3. Rods and clamps shall receive one field coat of asphaltum after installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Accomplish structural work and provide equipment required to control expansion and contraction of piping; including loops, offsets, swing joints, and expansion joints where required.

- B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so all movement occurs along axis of pipe only.
- C. Each mechanical expansion joint shall have one anchor on each side and two alignment guides on each side of it. Guides shall be located within 4 and 14 pipe diameters of the mechanical expansion joint or as recommended by the joint manufacturer.
- D. Preset all expansion joints to allow for expected expansion from installation temperature to operating temperature.

END OF SECTION 230516

SECTION 230529 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Cutting of Openings.
- E. Escutcheon Plates and Trim.

1.2 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping.
- B. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- C. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- D. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- E. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230500.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"
8" through 12"	7/8"	3/4"
14"	1"	7/8"
16" and 18"	1"	N/A
20" and 24"	1-1/4"	N/A

Column #1: Steel pipe.
 Column #2: Copper pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

- 1. Shower rooms.

2.2 PIPE AND STRUCTURAL SUPPORTS

A. General:

- 1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
- 2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Vertical Supports:

- 1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

- 1) Eaton Fig B3373 Series
- 2) nVent 510 Series
- 3) Anvil Fig. 90

- 2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

- 1) Mason RBA, RCA or RDA
- 2) Mason BR

- 3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellent calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

a. Products:

- 1) Pipeshields E100

- 4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.

5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

a. Products:

- 1) Anvil Fig. 160, 161, 162, 163, 164, 165
- 2) Eaton Fig. 3160, 3161, 3162, 3163, 3164, 3165
- 3) nVent Model 630, 631, 632, 633, 634, 635

5. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

1) Products: Bare Steel or Insulated Pipe:

- a) Anvil Fig. 260
- b) Eaton Fig. 3100
- c) nVent Model 400

2) Products: Bare Copper Pipe:

- a) Eaton Fig. B3104F or B3100CTC
- b) Anvil Fig. CT65
- c) nVent Fig. 402

b. Roller Type: Service: Insulated Hot Pipe - 4 inches and Larger:

1) Products: 4" through 6":

- a) Anvil Fig. 181, 271
- b) Eaton Fig. 3110
- c) nVent Model 610

c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:

1) Products: Bare Steel Pipe:

- a) Anvil Fig. 69
- b) Eaton Fig. B3170NF
- c) nVent Model FCN

- 2) Products: Bare Copper Pipe:
 - a) Eaton Fig. B3170CTC
 - b) nVent 102A0 Series
 - c) Anvil Fig. CT-69

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
 - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
 - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
 - a. Clamp Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
 - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, nVent Cushion Clamp or Eaton Vibra-Clamp.
 - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
 - 3) Products: Bare Steel or Insulated Pipe:
 - a) Unistrut Fig. P1100 or P2500
 - b) Eaton Fig. B2000 or B2400
 - c) Anvil Fig. AS1200
 - d) nVent USC
 - 4) Products: Bare Copper Pipe:
 - a) Eaton Fig. BVT
 - b) nVent CADDY Cushion Clamp
 - b. Roller Type: Service: Insulated Hot Pipe - 4 inches and larger:
 - 1) Products: 4" through 6":
 - a) Unistrut Fig. P2474
 - b) Eaton Fig. B218
 - c) Anvil Fig. ROL-12
 - d) nVent ROL12

- D. Upper (Structural) Attachments:
 1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
 - a. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

- b. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength).
4. Equipment requiring bases is as follows:
 - a. Boilers
 - b. Chemical Feed Equipment
 - c. Chiller
 - d. Expansion Tanks
 - e. Fuel Oil Transfer Pump Set
 - f. Base-mounte Pumps

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.

- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Engineer.

2.5 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Engineer. Sleeves shall then comply with the Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	High/Low Temperature (Steam)	Silicone	-67°F to 400°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
 1. Install all items per manufacturer's instructions.
 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
 3. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.
- B. Supports Requirements:
 1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
 2. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
 3. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
 4. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

E. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

F. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel (Std. Weight or Heavier - Liquid Service):

- a. Maximum Spacing:

- 1) 1-1/4" & under: 7'-0"
- 2) 1-1/2": 9'-0"
- 3) 2": 10'-0"
- 4) 2-1/2": 11'-0"
- 5) 3": 12'-0"
- 6) 4" & larger: 12'-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

- a. Maximum Spacing:

- 1) 1-1/4" and under: 9'-0"
- 2) 1-1/2": 12'-0"
- 3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):

- a. Maximum Spacing:

- 1) 3/4" and under: 5'-0"
- 2) 1": 6'-0"
- 3) 1-1/4": 7'-0"
- 4) 1-1/2" 8'-0"
- 5) 2": 8'-0"

- 6) 2-1/2": 9'-0"
- 7) 3": 10'-0"
- 8) 4": 12'-0"
- 9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

a. Maximum Spacing:

- 1) 3/4" & under: 7'-0"
- 2) 1": 8'-0"
- 3) 1-1/4": 9'-0"
- 4) 1-1/2": 10'-0"
- 5) 2": 11'-0"
- 6) 2-1/2" & larger: 12'-0"

G. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION 230529

SECTION 230548 - HVAC VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Bases.
- B. Vibration Isolation.
- C. Flexible Connectors.

1.2 SUBMITTALS

- A. Submit shop drawings per Section 230500 and the Vibration Isolation Submittal Form at the end of this section.
- B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
- C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.
- D. Isolator submittals shall include:
 - 1. Equipment served
 - 2. Type of Isolator
 - 3. Load in Pounds per Isolator
 - 4. Recommended Maximum Load for Isolator
 - 5. Spring Constants of Isolators (for Spring Isolators)
 - 6. Load vs. Deflection Curves (for Neoprene Isolators)
 - 7. Specified Deflection
 - 8. Deflection to Solid (at least 150% of calculated deflection)
 - 9. Loaded (Operating) Deflection
 - 10. Free Height
 - 11. Loaded Height
 - 12. K_x/K_y (horizontal to vertical stiffness ratio - for spring isolators)
 - 13. Materials and Coatings
 - 14. Spring Diameters
- E. Make separate calculations for each isolator on equipment where the load is not equally distributed.
- F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENT

- A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

- B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.
- C. The lateral to vertical stiffness ratio (K_x/K_y) of spring isolators shall be between 0.8 and 2.0.
- D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.
- E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.
- F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.
- G. Provide motor slide rails for belt-driven equipment per Section 230513.
- H. All isolators, except M1, shall have provision for leveling.

2.2 MOUNTINGS

- A. Type M1:
 1. 0.75" thick waffled neoprene pad with minimum static deflection of 0.07" at calculated load and 0.11" at maximum load. For loads less than 15 pounds, the deflection at calculated load requirement is waived, but the isolator must have a maximum stiffness of the ratio of 45#/0.35".
 2. Units need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators.
 3. Manufacturers:
 - a. Mason "Super W"
 - b. Kinetics "NGS"
 - c. VMC/Amber-Booth "SPNR"
 - d. Vibration Eliminator Co. "400N"
- B. Type M2:
 1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
 - a. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
 2. All units shall have bolt holes and be bolted down.
 3. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
 4. Manufacturers:
 - a. Mason Industries "ND" or "DNR"
 - b. VMC/Amber-Booth "RVD"
 - c. Kinetics "RD"

- d. Vibration Mountings and Controls "RD"
- e. Vibration Eliminator Co. "T22" or "T44"

C. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.
3. All mountings shall have leveling bolts.
4. Manufacturers:
 - a. Mason "SLFH"
 - b. Kinetics "FDS"
 - c. VMC/Amber-Booth SW-3 [4"][, 5"][, or][6"]
 - d. Vibration Eliminator Co. "OST"

2.3 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
4. Manufacturers:
 - a. Mason "HD"
 - b. Kinetics "RH"
 - c. Aeroflex "RHD"
 - d. Vibration Eliminator Co. "IC/3C/3CTD"
 - e. Vibro Acoustics "RH"

B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Manufacturers:
 - a. Mason "30"
 - b. Kinetics "SRH"
 - c. VMC/Amber-Booth "BSRA"
 - d. Aeroflex "RSH"
 - e. Vibration Eliminator Co. "SNC"
 - f. Vibro Acoustics "SH/SHC"

2.4 BASES

A. Type B1:

1. Rectangular structural steel bases.
2. All perimeter members shall be beams or channels with minimum depth of 10% of the longest base dimension or 14" maximum if rigidity is acceptable to the equipment manufacturer.
3. Use height saving brackets, unless noted otherwise.
4. Manufacturers:
 - a. Mason "WF"
 - b. Kinetics "SBB"
 - c. Aeroflex
 - d. Vibration Eliminator Co. "AF"

B. Type B2:

1. Steel members welded to height-saving brackets to cradle machines having legs or bases that do not require complete supplementary bases.
2. Members shall be sufficiently rigid to prevent strains in the equipment.
3. Manufacturers:
 - a. Mason "ICS"
 - b. Kinetics "SFB"
 - c. Aeroflex

C. Type B3:

1. Rectangular structural channel concrete forms for floating foundations.
2. Where applicable, bases shall be large enough to support suction elbows, discharge elbows, and suction diffusers.
3. Channel depth shall be at least 1/12 the longest dimension of the base but not less than 6". Depth need not exceed 12" if rigidity is acceptable to equipment manufacturer.
4. Forms shall include 1/2" rebars welded on 6" centers running both ways in a layer 1-1/2" above the bottom, and drilled steel members with sleeves welded below the holes to receive the equipment anchor bolts.
5. Contractor shall pour 3,300 PSI concrete inside entire base. Concrete to be same thickness as sides of base. Trowel concrete smooth on top of base.
6. Use height saving brackets, unless noted otherwise.
7. Manufacturers:
 - a. Mason "K"
 - b. Kinetics "CIB-H"
 - c. Aeroflex "MPF"
 - d. VMC/Amber-Booth "CPF"
 - e. Bulldog, Inc.
 - f. Vibration Eliminator Co. "SN".

2.5 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.

3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
4. Connectors up to 2" size may have threaded ends.
5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
7. Manufacturer:
 - a. Metraflex "Double Cable-Sphere"
 - b. Minnesota Flex Corp.
 - c. Mercer "200 Series"
 - d. Twin City Hose "MS2".

B. Type FC2:

1. Stainless steel flexible connectors with corrugated stainless steel hose body and stainless steel braided casing.
2. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
3. Sizes 2" and under shall have steel threaded connections.
4. Sizes 2-1/2" and over shall have 150 lb. steel flanges.
5. Suitable for 1/2" permanent misalignment.
6. Manufacturers:
 - a. Mason or Mercer "BSS-GU"
 - b. Metraflex "ML"
 - c. Twin City Hose "TCHS"
 - d. American "BOA B4-1"
 - e. Flexible Metal Hose Company "FM-21"
 - f. or Wheatley.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Provide vibration isolation as indicated on the drawings and as described herein.
- C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.
- D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.
- E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.
- F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.2 PIPE ISOLATION

- A. The first three hangers from vibration-isolated equipment shall be type H1.
- B. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.
- C. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220°F, and the fluid handled is compatible with neoprene and EPDM.
- D. Use Type FC2 for all other services. FC2 shall be installed parallel with equipment shafts.
- E. Provide sufficient piping flexibility for vibrating refrigerant equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.
- F. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.
- G. Support piping to prevent extension of flexible connectors.

3.3 VIBRATION ISOLATION OF DUCTWORK

- A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.
- B. Provide flexible duct connections as described in Section 233300.

3.4 VIBRATION ISOLATION SCHEDULE

- A. Inline Pumps:
 1. Base Type: NA
 2. Isolator Type: M3 or H2 or H3
 3. Static Deflection :0.75"
 4. Flexible Connections: NA
- B. Base-Mounted Pumps (less than 15 HP):
 1. Base Type: NA
 2. Isolator Type: NA
 3. Static Deflection: NA
 4. Flexible Connections: FC-1
- C. Base-Mounted Pumps (15 HP and above):
 1. Base Type: B3
 2. Isolator Type: M3
 3. Static Deflection: 0.75"
 4. Flexible Connections: FC-1

D. Air Cooled Chillers (mounted on grade):

1. Base Type: NA
2. Isolator Type: M1
3. Static Deflection: 0.25"
4. Flexible Connections: FC-1

E. Boilers:

1. Base Type: NA
2. Isolator Type: NA
3. Static Deflection: NA
4. Flexible Connections: FC-1

F. Fan Coil Units (600 cfm and below):

1. Base Type: NA
2. Isolator Type: H1
3. Flexible Connections: NA

G. Fan Coil Units (above 600 cfm):

1. Base Type: NA
2. Isolator Type: H2
3. Static Deflection: 0.75"
4. Flexible Connections: NA

END OF SECTION 230548

VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12		
ITEM SERVED		MIN DEFL ("mm)	TAG	PROPOSED ISOLATOR								CALCULATIONS	
				MODEL	MAX LOAD (#kg)	DEFL @ MAX LOAD ("mm)	DEFL TO SOLID ("mm)	FREE HT ("mm)	Kx/Ky	LOAD (#kg)	DEFL ("mm)	DEFL RATIO	

- COLUMN NOTES:** Note numbers correspond to the column numbers above.
- 1. Item served should match designation on the design drawings.
 - 2. List the deflection scheduled or specified in the design documents.
 - 3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
 - 4. List the manufacturer's complete model designation for the isolator.
 - 5. List the manufacturer's maximum rated load for the isolator.
 - 6. List the isolator deflection at the maximum rated load in column 5.
 - 7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
 - 8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
 - 9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
 - 10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
 - 11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
 - 12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

- 1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

SECTION 230553 - HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM B-1, B-3, and B-8 for copper conductors.
- C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 - 2kV Cables.
- D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500. Include list of items identified, wording, letter sizes, and color coding.
- B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
1. All valves (except shutoff valves at equipment) shall have numbered tags.
 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
 6. Number all tags and show the service of the pipe.
 7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Apply markers and arrows in the following locations where clearly visible:
 - a. At each valve.
 - b. On both sides of walls that pipes penetrate.
 - c. At least every 20 feet along all pipes.
 - d. On each riser and each leg of each "T" joint.
 - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment in Boiler/Laundry Bldg. shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed fan-coil units in public/staff/offender areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

F. Miscellaneous:

1. Provide engraved plastic tags at all hydronic system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CHILLED/HEATING WATER SUPPLY: White lettering; green background
2. CHILLED/HEATING WATER RETURN: White lettering; green background
3. HEATING WATER SUPPLY: White lettering; green background
4. HEATING WATER RETURN: White lettering; green background
5. SAFETY RELIEF VENT PIPING: Black lettering; yellow background
6. CHILLED WATER SUPPLY: White lettering; green background
7. CHILLED WATER RETURN: White lettering; green background
8. CONDENSATE DRAIN: White lettering; green background
9. COMPRESSED AIR: White lettering; green background
10. NATURAL GAS: Black lettering; yellow background
11. GAS REGULATOR VENT: Black lettering; yellow background
12. REFRIGERANT LIQUID: White lettering; purple background
13. REFRIGERANT SUCTION: White lettering; purple background
14. REFRIGERANT HOT GAS: White lettering; purple background
15. FUEL OIL SUPPLY: Black lettering; yellow background
16. FUEL OIL RETURN: Black lettering; yellow background

B. The primary/secondary heating water system's neutral bridge/decoupler piping shall be labeled as "HEATING WATER NEUTRAL BRIDGE" (White lettering; green background)..

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of cooling systems.
- D. Testing, adjusting, and balancing of plumbing systems.
- E. Measurement of final operating condition of HVAC systems.

1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, Seventh Edition.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing (latest edition).
- H. TABB - International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
3. All text shall be searchable.
4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 8 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Engineer prior to performing each test.
- B. Project will be constructed in phases. Provide balancing report after each phase is complete.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 - 1. General Equipment Requirements:
 - a. Equipment is safe to operate and in normal condition.
 - b. Equipment with moving parts is properly lubricated.
 - c. Temperature control systems are complete and operable.
 - d. Proper thermal overload protection is in place for electrical equipment.
 - e. Direction of rotation of all fans and pumps is correct.
 - f. Access doors are closed and end caps are in place.
 - 2. Duct System Requirements:
 - a. All filters are clean and in place. If required, install temporary media.
 - b. Duct systems are clean and free of debris.
 - c. Fire/smoke and manual volume dampers are in place, functional and open.
 - d. Air outlets are installed and connected.
 - e. Duct system leakage has been minimized.
 - 3. Pipe System Requirements:
 - a. Coil fins have been cleaned and combed.
 - b. Hydronic systems have been cleaned, filled, and vented.
 - c. Strainer screens are clean and in place.
 - d. Shutoff, throttling and balancing valves are open.
- B. Report any defects or deficiencies to Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A. $\pm 10\%$ of scheduled values:
 1. Adjust air inlets and outlets to $\pm 10\%$ of scheduled values.
 2. Adjust piping systems to $\pm 10\%$ of design values.
- B. $+ 5\%$ of scheduled values
 1. Adjust outdoor air intakes to within $+ 5\%$ of scheduled values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.1 GENERAL REQUIREMENTS

- A. Title Page:
 1. Project name.
 2. Project location.
 3. Project Engineer.
 4. Project Engineer (IMEG Corp.).
 5. Project General Contractor.
 6. TAB Company name, address, phone number.
 7. TAB Supervisor's name and certification number.
 8. TAB Supervisor's signature and date.
 9. Report date.

- B. Report Index
- C. General Information:
 1. Test conditions.
 2. Nomenclature used throughout report.
 3. Notable system characteristics/discrepancies from design.
 4. Test standards followed.
 5. Any deficiencies noted.
 6. Quality assurance statement.

- D. Instrument List:
 1. Instrument.
 2. Manufacturer, model, and serial number.
 3. Range.
 4. Calibration date.

4.2 AIR SYSTEMS

- A. Ducted Fan Coil Units:
 1. General Requirements:
 - a. Drawing symbol.
 - b. Location.
 - c. Manufacturer, model, arrangement, class, discharge.
 - d. Fan RPM.
 - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
 - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
 2. Flow Rate:
 - a. Supply flow rate (cfm): specified and actual.
 - b. Return flow rate (cfm): specified and actual.
 - c. Outside flow rate (cfm): specified and actual.
 3. Pressure Drop and Pressure:
 - a. Filter pressure drop: specified and actual.
 - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
 - c. Inlet pressure.
 - d. Discharge pressure.
- B. Electric Motors:
 1. Drawing symbol of equipment served.
 2. Manufacturer, Model, Frame.
 3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
 4. Measured: Amps in each phase.
- C. Air Terminal (Inlet or Outlet):
 1. Drawing symbol.
 2. Room number/location.

3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

4.3 HEATING SYSTEMS

- A. Pump Data (Primary and Secondary Heating Water Loop Pumps):
 1. Existing drawing symbol or equipment TAG
 2. Service.
 3. Manufacturer, size, and model.
 4. Impeller size: specified, actual, and final (if trimmed).
 5. Flow Rate (gpm): specified and actual.
 6. Pump Head: specified, operating and shutoff.
 7. Suction Pressure: Operating and shutoff.
 8. Discharge Pressure: Operating and shutoff.
 9. Final frequency of motor at maximum flow rate (on pumps driven by VFD).
- B. Electric Motors (Associated Heating Water Loop Pump Motors):
 1. Drawing symbol of equipment served.
 2. Manufacturer, Model, Frame.
 3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
 4. Measured: Amps in each phase.

4.4 COOLING SYSTEMS

- A. Pump Data: Since this project has a 2-pipe hydronic heating/cooling system, the cooling system primary pumps are the same pumps that are used as system/secondary pumps with the heating system. Under base bid, contractor shall test, adjust, and balance the pumps while the system is in heating mode. Under Alternate Bid 1, contractor shall also test, adjust, and balance the pumps while the system is in cooling mode.
- B. General Requirements:
 - a. Drawing symbol.
 - b. Service.
 - c. Manufacturer, size, and model.
 - d. Impeller size: specified, actual, and final (if trimmed).
 - e. Final frequency of motor at maximum flow rate. (On pumps driven by VFD.)
 2. Flow Rate:
 - a. Flow Rate (gpm): specified and actual.
 3. Pressure Drop and Pressure:
 - a. Pump Head: specified, operating and shutoff.
 - b. Suction Pressure: Operating and shutoff.
 - c. Discharge Pressure: Operating and shutoff.
- C. Electric Motors:
 1. Drawing symbol of equipment served.

2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

D. Air Cooled Chillers:

1. General Requirements:
 - a. Drawing symbol.
 - b. Manufacturer and model.
 - c. Refrigerant type and capacity.
 - d. Starter type, size, and thermal protection.
 - e. Capacity: specified and actual.
2. Temperature:
 - a. Evaporator entering water temperature: specified and actual.
 - b. Evaporator leaving water temperature: specified and actual.
 - c. Condenser entering air temperature.
 - d. Condenser leaving air temperature.
3. Pressure Drop and Pressure:
 - a. Evaporator pressure drop: specified and actual.
4. Flow Rate:
 - a. Evaporator water flow rate: specified and actual.

4.5 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

END OF SECTION 230593

SECTION 230713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials:
 - 1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
 - 2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
 - 3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.
 - 4. UL listed in Category HNKT.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E136 - Standard Test Method for the Behavior of Materials in a Vertical Tube Furnace at 750°C.
- F. ASTM E814 - Fire Tests of Through Penetrations Firestops.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- H. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.
- I. NFPA 255 - Surface Burning Characteristics of Building Materials.
- J. UL - XHEZ - Through Penetration Firestop Systems.
- K. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- L. UL 723 - Surface Burning Characteristics of Building Materials.

- M. UL 1479 - Fire Tests of Through Penetrations Firestops.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and location.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.
- B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75°F; foil scrim Kraft facing, 3 lb./cu. ft. density.

2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
 1. Apply with edges tightly butted.
 2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
 3. Seal joints with adhesive backed tape.
 4. Apply so insulation conforms uniformly and firmly to duct.
 5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
 6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
 7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Engineer.
 8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.

9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Continue insulation with vapor barrier through penetrations unless code prohibits.

H. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.2 SCHEDULE

- A. Refer to Section 233100 for scheduling of insulation.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment Insulation.
- B. Equipment Insulation Finishes.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate
- C. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- D. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- E. ANSI/ASTM C534 - Elastomeric Foam Insulation
- F. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- G. ANSI/ASTM C553 - Mineral Fiber Blanket Thermal Insulation.
- H. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- I. ANSI/ASTM C921 - Properties of Jacketing Materials for Thermal Insulation
- J. ANSI/ASTM D1668 - Glass Fabric for Waterproofing
- K. ASTM E84 - Surface Burning Characteristics of Building Materials.
- L. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.
- M. NFPA 255 - Surface Burning Characteristics of Building Materials.
- N. UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for equipment scheduled.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Rigid Mineral Fiber Blocks; ANSI/ASTM C612; 0.625 maximum 'K' value 800°F. Suitable to 1900°F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).
- B. Type B: Cellular Glass Board; ANSI/ASTM C552; 0.35 maximum 'K' value at 200°F; 8.0 lb/cu ft.); suitable to 900°F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).
- C. Type C: Glass Fiber Blanket; ANSI/ASTM C612; 0.40 maximum 'K' value at 300°F; 2.5 lb/cu ft.; suitable to 850°F, with all service jacket (ASJ) vapor retarder jacket having 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- D. Type D: Glass Fiber Board; ANSI/ASTM C612; 0.28 maximum 'K' value at 200°F; 6.0 lb/cu ft; suitable to 850°F, 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).
- E. Type E: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
- F. Type F: Semi-Rigid Mineral Wool Fiberboard; ANSI/ASTM C612; 0.30 maximum 'K' value at 200°F; suitable to 1200°F.
- G. Type G: Hydrous Calcium Silicate Blocks; ANSI/ASTM C533; 0.40 maximum 'K' value at 300°F; suitable to 1200°F.

2.2 INSULATION FINISHES

- A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures less than 70°F and having maximum 0.013 perms/inch) rating at 0.043 inch dry-film thickness when tested in accordance with ASTM E-96 Procedure B (Foster 30-80 or approved equivalent). Use breather mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures 70°F or greater (Foster 35-00 or approved equivalent).
- B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.
- C. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.
- D. Type 4: Aluminum Jacket; ASTM B209; 0.016" thick stucco embossed finish; install with 3/4" aluminum bands 12" on center.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all materials per manufacturer's instructions, codes and industry standards.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- C. Do not insulate factory insulated equipment.
- D. Apply insulation as close as possible to equipment by grooving, scoring, and bevelling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.
- F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.
- G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.
- H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.
- I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60°F (whether it will do so under this project or in the future) and/or above 100°F . Verify insulation type and thickness with equipment manufacturer and Engineer.
- J. Insulate all supports on equipment that is designed to operate below ambient temperature (whether it will do so under this project or in the future).

3.2 INSULATION

- A. Type A and G:
 - 1. Apply with edges tightly butted and joints staggered.
 - 2. Secure with 1/2" x 0.015" galvanized steel bands, 12" on center.
- B. Type B:
 - 1. Apply with edges tightly butted and joints staggered.
 - 2. Seal all joints with manufacturer approved adhesive.
 - 3. Secure with 1/2" x 0.015 galvanized steel bands, 12" on center.
- C. Type C, D and F:
 - 1. Apply with edges tightly butted and joints staggered.
 - 2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

D. Type E:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Do not wrap sheet insulation around square corners, but cut and overlap insulation at corners to provide full insulation thickness on all sides. Seal all overlapping insulation surfaces with manufacturer approved adhesive.
3. Secure with manufacturer approved adhesive in accordance with installation instructions. Where applied to underside surfaces or on surfaces with temperatures 140°F and above, cover all surfaces with full application of adhesive. Seal all joints and seams with manufacturer approved adhesive.

3.3 SCHEDULE

- A. Heating Water-to-Domestic Water Plate & Frame Heat Exchanger (up to 200°F): 1" thick Type E; Finish 3.
- B. Air Separator/Coalescing Filter: 2" thick Type C, Finish 1 or 2.
- C. Heating Water Pumps: No insulation is required on pumps that will only handle heating water.
- D. Heating/Chilled Water Pumps: 1" (25 mm) thick Type E, Finish 3 (insulation is not required under base bid; it is only required under Alternate Bid 1, on pumps that will handle chilled water in cooling mode)
- E. Heating/Chilled Water Flexible Connections & Expansion Joints: 3/4" thick Type E, Finish 3 (insulation is not required under base bid; it is only required under Alternate Bid 1, on items that will handle chilled water in cooling mode).
- F. Chiller Cold Surfaces (not factory insulated): 1" thick Type E, Finish 3.
- G. Boiler Breechings & Flues:
 1. 4" thick Type F, Finish 4.
 2. 4" thick Type G, Finish 4.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- C. ANSI/ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- D. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- E. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation.
- F. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- G. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- H. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation.
- I. ASTM C578 - Preformed Cellular Polystyrene Thermal Insulation.
- J. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- K. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.
- L. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation.

- M. ASTM E84 - Surface Burning Characteristics of Building Materials.
- N. NFPA 255 - Surface Burning Characteristics of Building Materials.
- O. UL 723 - Surface Burning Characteristics of Building Materials.
- P. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F; rated for maximum continuous service temperature not less than 200°F; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Engineer.
- B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

2.4 REMOVABLE INSULATION JACKETS

- A. Removable insulation jackets shall consist of outer covering, interstitial insulation material, and inner covering.
- B. Inner and outer covering shall be constructed from a minimum 16.5 oz./yd² PTFE fiberglass composite and suitable for insulating surface temperatures up to 550°F.

- C. Interstitial insulation blanket shall be minimum 1-1/2" thick and shall consist of either:
 - 1. Silica and glass-fiber insulation felts and blankets - minimum 6 lb./ft³ density.
 - 2. E-type glass-fiber felts and blankets - minimum 6 lb./ft³ density.
- D. Construction: Inner and outer covering with interstitial insulation material shall be joined into a single assembly using a double sewn lock stitch with 4-6 stitches/inch. The thread used shall be able to withstand minimum 550°F surface temperatures without degradation. The use of hog rings, staples, and wires for closure of assembly are not acceptable. The interstitial insulation shall be sewn as an integral part of the inner and outer coverings to prevent shifting of the insulation. Insulation pins are not an allowable method of preventing the insulation from shifting and shall not be used.
- E. No raw cut jacket edges shall be exposed.
- F. Jackets shall be fastened to equipment and piping components using hook and loop (Velcro) straps and minimum 1" slide buckles.
- G. Jacket coverings shall have an inner covering edge with a continuous strip of hook & loop closure (Velcro) that is parallel to the seam and overlaps the outer covering by a minimum of 2 inches.
- H. Manufacturers:
 - 1. Firwin Corp
 - 2. Lewco Specialty Products
 - 3. ThermaXX Jackets LLC
 - 4. Approved equivalent

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.
- B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

3.2 INSTALLATION

- A. General Installation Requirements:
 - 1. Install materials per manufacturer's instructions, building codes and industry standards.
 - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
 - 3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
 - 4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.

- B. Insulated Piping That Could Operate Below 60°F (whether under this project or in the future):
1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
 2. On piping that could operate below 60°F (whether under this project or in the future) in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases, etc.), Type B insulation shall be used.
 3. All balance valves and strainers with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.
- C. Insulated Piping That Will Only Operate Above 140°F:
1. Insulate fittings, valves, flanges, and strainers.
 2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
 3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, strainers, line sets, and the like).
- D. Exposed Piping:
1. Locate and cover seams in least visible locations.
 2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

3.3 SUPPORT PROTECTION

- A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.
- B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
 - a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
 - b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield. Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
 - c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14, provide rolled steel plate in addition to the shield.

- d. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
 - 1) Products:
 - a) Buckaroo CoolDry
 - b) Cooper/B-Line Fig. B3380 through B3384
 - c) Pipe Shields A1000, A2000
- e. Insulation Couplings:
 - 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
 - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
 - a) Klo-Shure or equal
 - 3) Vertical Manufacturers:
 - a) Manufacturers: Klo-Shure Titan or equal
- f. Rectangular blocks, plugs, or wood material are not acceptable.
- g. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge
8" to 14"	24" long x 14 gauge
16" to 24"	24" long x 12 gauge

F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 230529 "HVAC Supports and Anchors".

G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.4 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
 - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.5 JACKET COVER INSTALLATION

A. Metal Covering:

1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.
4. Use metal covering on the following pipes:
 - a. All exterior piping.
 - b. All exposed piping in areas noted on drawings.

B. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on the following pipes:
 - a. All exposed piping in areas noted on drawings.
 - b. All exposed piping below 8'-0" above floor.
 - c. All piping in boiler room and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)

3.6 SCHEDULE

- A. Refer to drawings for insulation schedule.

END OF SECTION 230719

SECTION 230900 - CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.3 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/ASHRAE Standard 135-2001: BACnet® - A Data Communication Protocol for Building Automation and Control Networks, including all amendments.
- D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).
- E. ANSI/NFPA 70 - National Electrical Code.
- F. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- G. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- H. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
- I. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- J. ANSI/ASTM B32 - Solder Metal.
- K. ASTM B280 - Seamless Copper Tube for Air Conditioning & Refrigeration Field Service.

L. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

1.4 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
2. Control valve selections shall be based on flow rates shown in approved shop drawings.
3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 230500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
 - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
 - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - c. Identification of all control components connected to emergency power.
 - d. Schematic diagrams for all field sensors and controllers.
 - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
 - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
 - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - h. All installation details and any other details required to demonstrate that the system will function properly.
 - i. All interface requirements with other systems.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Engineer. Clearly highlight any deviations from the specified sequences on the submittals.
8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
 - a. Damper Identification Tag.
 - b. Location.
 - c. Damper Type.
 - d. Damper Size.
 - e. Duct Size.
 - f. Arrangement.
 - g. Blade Type.
 - h. Velocity.
 - i. Pressure Drop.
 - j. Fail Position.
 - k. Actuator Identification Tag.
 - l. Actuator Type.
 - m. Mounting.
10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
 - a. Valve Identification Tag.
 - b. Location.
 - c. Valve Type.
 - d. Valve Size.
 - e. Pipe Size.
 - f. Configuration.
 - g. Flow Characteristics.
 - h. Capacity.
 - i. Valve C_v .
 - j. Design Pressure Drop.
 - k. Pressure Drop at Design Flow.
 - l. Fail Position.
 - m. Close-off Pressure.
 - n. Valve and Actuator Model Number and Type.
11. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

12. Provide PICS files indicating the BACnet functionality and configuration of each device.
13. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.
14. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
15. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
16. Clearly identify work by others in the submittal.
17. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 230500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
 - a. Table of contents with indexed tabs dividing information as outlined below.
 - b. Definitions: List of all abbreviations and technical terms with definitions.
 - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
 - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
 - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
 - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
 - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
 - i. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
 - j. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

D. Training Manual:

1. Provide a course outline and training manuals for each training class.

E. Record Documents:

1. Submit record documentation per Section 230500.
2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the Engineer verifying completion and proper operation of all points.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.
- D. Gauge Taps.
- E. Automatic Dampers.
- F. Flow Meters.

1.7 AGENCY AND CODE APPROVALS

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
 1. UL-916; Energy Management Systems.
 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
 3. EMC Directive 89/336/EEC (European CE Mark).
 4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.8 ACRONYMS

- A. Acronyms used in this specification are as follows:
 1. B-AAC BACnet Advanced Application Controller

2. B-ASC BACnet Application Specific Controller
3. BTL BACnet Testing Laboratories
4. DDC Direct Digital Controls
5. FMCS Facility Management and Control System
6. GUI Graphic User Interface
7. IBC Interoperable BACnet Controller
8. IDC Interoperable Digital Controller
9. LAN Local Area Network
10. NAC Network Area Controller
11. ODBC Open DataBase Connectivity
12. OOT Object Oriented Technology
13. OPC Open Connectivity via Open Standards
14. PICS Product Interoperability Compliance Statement
15. PMI Power Measurement Interface
16. POT Portable Operator's Terminal
17. TCC Temperature Control Contractor
18. TCS Temperature Control System
19. WAN Wide Area Network
20. WBI Web Browser Interface

1.9 SUMMARY

- A. Extend Existing System:
 1. Extend the State of Missouri's existing FMCS under this project to serve Bldg. 3 and the associated Boiler/Laundry Bldg. on the Maryville Treatment Center campus in Maryville, MO.
 2. All controllers and accessories shall interface with the existing FMCS.
- B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.
- D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.10 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.
- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.
- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.

- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.

1.11 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.

1.12 JOB CONDITIONS

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

1.13 WARRANTY

- A. Refer to Section 230500 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.14 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. BACnet Protocol:
 - 1. Schneider Electric - EcoStruxure Building Operation

2.2 SYSTEM ARCHITECTURE

- A. General:
 - 1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
 - 2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.
- B. Open, Interoperable, Integrated Architectures:
 - 1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
 - 2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.
 - 3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.
 - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 NETWORKS

- A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.
- B. Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE Standard 802.3.
 - 2. Cable; 100 Base-T, UTP-8 wire, Category 6.
 - 3. Minimum throughput; 100 Mbps.

- C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.
- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.4 NETWORK AREA CONTROLLER (NAC)

- A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.
- B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:
 1. Calendar functions.
 2. Scheduling.
 3. Trending.
 4. Alarm monitoring and routing.
 5. Time synchronization.
 6. Integration of all controller data.
 7. Network Management functions.
- C. The Network Area Controller shall provide the following hardware features as a minimum:
 1. One Ethernet Port - 10/100 Mbps.
 2. One RS-232 port.
 3. One RS-485 port.
 4. Battery backup.
 5. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
 6. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
 7. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
 8. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.
- D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.

- F. Event Alarm Notification and Actions:
1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - a. Alarm
 - b. Normal
 4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.
 5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Treat control equipment and network failures as alarms and annunciated.
- H. Annunciate alarms in any of the following manners as defined by the user:
1. Screen message text.
 2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
 - a. Day of week.
 - b. Time of day.
 - c. Recipient.
 3. Pagers via paging services that initiate a page on receipt of e-mail message.
 4. Graphic with flashing alarm object(s).
 5. Printed message, routed directly to a dedicated alarm printer.
- I. The FMCS shall record the following for each alarm:
1. Time and date.
 2. Location (building, floor, zone, office number, etc.).
 3. Equipment tag.
 4. Acknowledge time, date, and user who issued acknowledgement.
 5. Number of occurrences since last acknowledgement.
- J. Give defined users proper access to acknowledge any alarm.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.5 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).
- C. Interoperable BACnet Controller (IBC):
 - 1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
 - 2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
 - a. BACnet Building Controller(s) (B-BC).
 - b. BACnet Advanced Application Controller(s) (B-ACC).
 - c. BACnet Application Specific Controller(s) (B-ASC).
 - 3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
 - 4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
 - 5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
 - 6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
 - a. BACnet Device; MAC address, name, type and instance number.
 - b. BACnet Objects; name, type and instance number.
 - 7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.
- D. Object Libraries:
 - 1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
 - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
 - b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
 - d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
 - e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
 - a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
 - c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

- d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
 - e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.
 - f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 - g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 - h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.
 - i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
 - j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.
 - k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:
- a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.

- b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.
- c. For BACnet devices, provide the following objects:
 - 1) Analog In.
 - 2) Analog Out.
 - 3) Analog Value.
 - 4) Binary.
 - 5) Binary In.
 - 6) Binary Out.
 - 7) Binary Value.
 - 8) Multi-State In.
 - 9) Multi-State Out.
 - 10) Multi-State Value.
 - 11) Schedule Export.
 - 12) Calendar Export.
 - 13) Trend Export.
 - 14) Device.
- d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
- e. For BACnet devices, provide the following support at a minimum:
 - 1) Segmentation.
 - 2) Segmented Request.
 - 3) Segmented Response.
 - 4) Application Services.
 - 5) Read Property.
 - 6) Read Property Multiple.
 - 7) Write Property.
 - 8) Write Property Multiple.
 - 9) Confirmed Event Notification.
 - 10) Unconfirmed Event Notification.
 - 11) Acknowledge Alarm.
 - 12) Get Alarm Summary.
 - 13) Who-has.
 - 14) I-have.
 - 15) Who-is.
 - 16) I-am.
 - 17) Subscribe COV.
 - 18) Confirmed COV notification.
 - 19) Unconfirmed COV notification.
 - 20) Media Types.
 - 21) Ethernet.
 - 22) BACnet IP Annex J.
 - 23) MSTP.
 - 24) BACnet Broadcast Management Device (BBMD) function.
 - 25) Routing.

2.6 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
 - 3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
 - 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.
- C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- D. All log data shall be available to the user in ALL the following data formats:
 - 1. HTML.
 - 2. XML.
 - 3. Plain text.
 - 4. Comma or tab separated values.
- E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:
 - 1. Archive on time of day.
 - 2. Archive on user-defined number of data stores in the log (buffer size).
 - 3. Archive when log has reached its user-defined capacity of data stores.
 - 4. Provide ability to clear logs once archived.

2.7 AUDIT LOG

- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
 - 1. Time and date.
 - 2. User ID.
 - 3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

2.8 DATABASE BACKUP AND STORAGE

- A. The NAC shall automatically backup its database on a user-defined time interval.
- B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.

- C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. A UPS shall be provided for each of the following:
 1. Network area controllers.
 2. Boiler plant manager.
- B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for two (2) minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.

2.10 SYSTEM PROGRAMMING

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.
- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods:
 1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
 2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
 3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
 4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
 5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.11 DDE DEVICE INTEGRATION

- A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
 - 1. DDE Generic AI Object.
 - 2. DDE Generic AO Object.
 - 3. DDE Generic BO Object.
 - 4. DDE Generic BI Object.

2.12 CONTROL DAMPERS

- A. Rectangular Control Dampers - Standard Construction:
 - 1. Shall be licensed to bear the AMCA Certified Rating Seal.
 - 2. Test leakage and pressure drop per AMCA 500.
 - 3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
 - 4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
 - 5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
 - 6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
 - 7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
 - 8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
 - 9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
 - 10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
 - 11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
 - 12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24" x 24" damper (2000 fpm).
 - 13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

2.13 DAMPER ACTUATORS

A. Damper Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Dampers: Where shown on the drawings or sequences, fail-safe mechanism shall operate the damper to the fail position following power interruption.
 - a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
 - b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.
6. Damper End Switches: Where shown on the drawings or sequences, provide end switches to prove damper reaches open/closed position.

2.14 HYDRONIC CONTROL VALVES

A. General:

1. Two-position valves shall be a minimum of line size with a maximum allowable pressure drop of 1 psi.
2. Size two-way and three-way modulating valves to provide a pressure drop at full flow of 4 to 5 psi, except boiler three-way valves shall not have a pressure drop over 4 psi.
3. Modulating two-way valves shall have equal percentage flow characteristics.
4. Modulating three-way valves shall have linear flow characteristics.
5. Piping geometry correction factors for C_v ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

B. Two-position:

1. Butterfly 2-1/2" to 12":
 - a. Design Pressure: 125 psi
 - 1) Design Temperature: -20 to 212°F
 - 2) Design Flow Differential Pressure Rating: 50 psi
 - b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.

C. Modulating:

1. Globe 2-1/2" to 6":
 - a. Design Pressure: 125 psi
 - 1) Design Temperature: 250°F
 - 2) Design Flow Differential Pressure Rating: 25 psi
 - 3) Leakage: ANSI Class III
 - b. Cast iron body, bronze or brass trim and plug; stainless steel stem; bronze seat; EPDM, PTFE or RTFE packing; flanged ends.
2. Pressure Independent Control Valves (PIC Valves or PICV) 3/4" and Smaller:
 - a. Design Pressure: 360 psi
 - b. Close-off Pressure: 75 psig
 - c. Design Temperature: Between 36°F to 212°F
 - d. Pressure independent operation up to system delta-p of 50 psid minimum; maximum pressure drop of 5.0 psid at design flow; 0% leakage; forged brass body; NPT female ends; stainless steel ball and stem, PTFE seats and dual EPDM seals.
3. Pressure Independent Control Valves (PIC Valves or PICV) NPS 6 (DN 150) and Smaller:
 - a. Design Pressure for NPS 2 (DN 50) and Smaller: 360 psi
 - b. Design Pressure for NPS 2-1/2 (DN 65) through NPS 6 (DN 150): ANSI 125, Class B
 - c. Close-off Pressure for NPS 2 (DN 50) and Smaller: 200 psi
 - d. Close-off Pressure for NPS 2-1/2 (DN 65) through NPS 6 (DN 150): 100 psi
 - e. Design Temperature: Between 14°F to 250°F
 - f. Pressure independent operation up to system delta-p of 50 psid minimum; maximum pressure drop of 5.0 psid at design flow.
 - g. A characterized control valve shall be integrated with an ultrasonic flow meter providing analog flow feedback. The valve shall reposition to maintain the required flow with +/- 5% accuracy. The flow meter shall incorporate an algorithm to automatically calculate the glycol concentration and be readable by a local device, BACnet or MODBUS.
 - h. Leakage 0%; equal percentage flow characteristic.
 - i. Body; NPS 2 (DN 50) and Smaller: Forged brass, nickel plated with NPT female ends; stainless steel ball and stem, PTFE seats, Teflon characterizing disc.
 - j. Body; NPS 2-1/2 (DN 65) through NPS 6 (DN 150): Cast iron with pattern to mate with ANSI 125 flange, stainless steel ball and stem, PTFE seats, stainless steel characterizing disc.

2.15 VALVE ACTUATORS

A. General:

1. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.
2. Provide visual position indication.
3. Mount actuator directly on valve or provide linear motion assembly as required for valve type.

B. Valve Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Valves: Where shown on the drawings or sequences, fail-safe mechanism shall operate the valve to the fail position following power interruption.
 - a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
 - b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.

2.16 CONTROL INSTRUMENTATION

A. Temperature Sensors:

1. Room Temperature Sensor:
 - a. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, $\pm 0.50^\circ\text{F}$ accuracy, no setpoint adjustment or override button.
 - b. Sensor with Setpoint Adjustment: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, $\pm 0.50^\circ\text{F}$ accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a single warmer/cooler or red/blue visual scale), no override button.
 - c. Sensor with Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, $\pm 0.50^\circ\text{F}$ accuracy, occupied/unoccupied override button with LED, no setpoint adjustment.
 - d. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, $\pm 0.50^\circ\text{F}$ accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.
2. Duct Temperature Sensor:
 - a. RTD type averaging sensor. 1000 ohm platinum RTD; accuracy: minimum $\pm 1.2^\circ\text{F}$; range -40°F - 220°F .

- b. Sensing element shall have a minimum of 1 foot of sensor length for each 2 square feet of duct or coil area. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 1 foot away from the sensor.
 - c. Probe type thermistors are acceptable in VAV box duct applications downstream of reheat coils.
3. Water Temperature Sensor:
- a. RTD type. 1000 ohm platinum RTD; accuracy: minimum +/- 0.65°F; range -40°F-220°F.
 - b. Thermowell: RTD must be installed within a 316 stainless steel thermowell using a non-hardening heat conducting paste. Thermowell shall be rated for a minimum static pressure of 500 psig at the maximum operating temperature and be capable of withstanding water velocities of up to 27 fps. The sensor shall be mounted so that it extends into the flow stream to a minimum of 1/3 of the diameter of the pipe. For pipes greater than 10 inch diameter, thermowell shall be installed in a position 45 degrees from the bottom of the pipe. Separate thermometers, as specified elsewhere, shall be installed within 2 feet of each temperature sensor.
- B. Pressure Measuring Devices
1. Pressure Transmitters/Transducer:
- a. Wet-to-Wet (uses include measuring hydronic system differential pressure for VFD control):
 - 1) Unidirectional pressure range selected for appropriate range based on the application.
 - 2) Provide transducer with minimum 250 psi high side proof pressure and minimum 60 psi low side proof pressure.
 - 3) Case shall be constructed of stainless steel/aluminum and shall be equipped with 1/4" threaded connections. Wetted parts shall be constructed of 300 series stainless steel. Provide transducer with Viton and silicone O-rings for solutions containing water and/or glycol. Provide transducer with Buna-N O-rings for hydrocarbon solutions.
 - 4) Provide transducer with factory assembled 3-valve manifold assembly to allow for field calibration of transducer.
 - 5) Performance shall be as follows:
 - a) Accuracy: $\pm 0.25\%$ F.S.
 - b) Non-Linearity: $\pm 0.20\%$ F.S.
 - c) Hysteresis: 0.10%F.S.
 - d) Non-Repeatability: 0.05% F.S.
 - e) Compensated Temp Range: +30°F to +150°F
 - f) Long Term Stability: 0.5% F.S./year
- C. Flow Measuring Devices:
- a. Insertion Type Turbine Flow Meters: General:
 - 1) Each flow meter shall be an insertion type dual turbine flow meter.
 - b. Service:
 - 1) Chilled Water: Rated for 32°F through 140°F service.
 - 2) Heating Water: Rated for minimum of 240°F service.

c. Turbine Flow Meter:

- 1) Each meter shall be rated for system pressure and shall have adequate structural integrity for a flow rate equal to 150% of the scheduled maximum initial or future flow rate, whichever is greater.
- 2) Each turbine flow meter shall be complete with all insertion hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand insertable up to 400 PSI.
- 3) Each flow meter shall have two contra-rotating axial turbines with electronic impedance based sensing (non-magnetic).
- 4) Dual turbine flow meters shall have an averaging circuit to reduce measurement error due to swirl and flow profile distortion.
- 5) Constructed of nickel plated brass with NEMA 4 powder coated cast aluminum enclosure.
- 6) Each meter shall be wet calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST.

d. Output:

- 1) Each transmitter shall produce an analog output signal, 4-20 mA, 0-10 V, or 0-5 V that is directly proportional to volumetric flow rate.
- 2) All wire shall be carried into 1/2" NPTM conduit connection. The meter shall include 25 feet of cable.
- 3) Unless scheduled or indicated otherwise, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.

e. Accuracy:

- 1) The accuracy of each meter/transmitter assembly shall be $\pm 1.0\%$ of flow rate reading over a range of 3-15 feet/second fluid velocity, with a repeatability of 0.1%. Accuracy at 1 foot/second shall be $\pm 2.0\%$.

f. Calibration:

- 1) Each meter shall be calibrated on an NIST traceable flow stand at 1, 8, and 15 feet/second. Provide written documentation of calibration.

g. Installation Hardware:

- 1) The flow meter shall be supplied with standard installation hardware, which shall include, but not be limited to, full port bronze ball valve, brass close nipple, and weld-on carbon steel branch outlet.

h. Warranty:

- 1) Provide performance warranty of at least two years from the date of installation and startup. Warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.

D. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

- a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

- a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

E. Miscellaneous Devices:

1. Control Relays:

- a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
- b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.

2. Thermostat and Sensor Enclosures:

- a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards over all sensors, except where heavy-duty enclosures are indicated on the drawings.
- b. Heavy Duty Enclosure:
 - 1) Perforated steel, tamperproof locking thermostat and control device enclosure.
 - 2) Box shall be nominally 8"x6"x2" deep or sized as required to fit devices to be enclosed.
 - 3) Perforated cover shall be 16 gauge steel with maximum 3/16" perforations on maximum 1/4" staggered centers for a 55% free area.
 - 4) Secure to wall from inside of box. Cover shall be secured by tamperproof screws to frame.
 - 5) Color shall match electrical devices. Verify color with the Electrical Contractor.

F. Outdoor Weather Station:

- 1. Outdoor rated ventilated plastic enclosure, off-white color, radiation shield including the following parameters.
- 2. Measured Parameters:
 - a. Temperature Sensor: Thermistor sensing element or resistance temperature device (RTD).
 - 1) Operating Range: -40°F to 140°F
 - 2) Accuracy: $\pm 0.54^\circ\text{F}$ at 68°F

- b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service.
 - 1) Measurement Range: 0-100% RH
 - 2) Accuracy:
 - a) $\pm 3\%$ of reading from 0%-90% RH at 50°F to 86°F
 - b) $\pm 5\%$ of reading from 0%-90% RH at -4°F to 50°F and 86°F to 140°F.
- 3. Calculated Parameters:
 - a. Dew Point Temperature in °F
 - b. Wet Bulb Temperature in °F
 - c. Enthalpy. Enthalpy sensor shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

2.17 CONDUIT AND BOXES

- A. Conduit and Boxes: Refer to Electrical Section 260533 for materials, sizing, and other requirements.
- B. Conduit and Box Identification (Color and Labeling):
 - 1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
 - 2. Refer to Electrical Section 260553 for raceway and box labeling requirements.

2.18 WIRE AND CABLE

- A. Wire and Cable: Refer to Electrical Section 260513 for wire and cable materials.
 - 1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.

- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.
- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the equipment branch. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Labels For Control Devices:
- Provide labels indicating service of all control devices in panels and other locations.
 - Labels may be made with permanent marking pen in the control panels if clearly legible.
 - Use engraved labels for items outside panel such as outside air thermostats.
 - Labels are not required for room thermostats, damper actuators and other items where their function is obvious.
- N. VFDs:
- This project includes several variable frequency drives to control the flow of pumps based on a control variable.
 - Verify output signal required, 4-20 mA or 0-10V dc.
 - If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
 - If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.
 - Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
 - 1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
 - 2. Where there are multiple floors, provide color codes/designations for the areas served by each FCU by floor.
 - 3. Where multiple FCUs serve one floor, color code the areas served by each FCU. The area shall be linked to the graphic for that area's FCU.
 - 4. Provide an overall floor plan of each floor of the building color coded by zone linked to the FCU for that zone. The zone shall be linked to the graphic for that zone's FCU graphic.
 - 5. Show the location of each thermostat on the floor plan.
 - 6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
 - 1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Boiler Primary Loop and Building Loop Supply and Return Temperatures, etc.
 - 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 - 3. Detailed graphics for each mechanical system including FCUs, chillers, and boilers, as a minimum.
 - 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
 - 1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
 - 2. TCS Bill of Material for each system, e.g. FCU, boiler, etc.
 - 3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.3 CONDUIT AND BOXES INSTALLATION

- A. Conduit and Box Installation: Refer to Electrical Section 260533 for execution and installation.
- B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 260553 for raceway and box identification installation.
- C. Outlet Box Schedule: Thermostat/temperature sensor:
 - 1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
 - 2. Other Conditions: Refer to Electrical Section 260533 for requirements.

3.4 WIRE AND CABLE INSTALLATION

- A. Wire and Cable Installation: Refer to Electrical Section 260513 for execution and installation.
- B. Field Quality Control:
 - 1. Inspect wire and cable for physical damage and proper connection.
 - 2. Torque test conductor connections and terminations to manufacturer's recommended values.
 - 3. Perform continuity test on all conductors.
 - 4. Protection of cable from foreign materials:
 - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
 - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.
- C. Installation Schedule:
 - 1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.6 COMMISSIONING

- A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

- B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.
- C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.
- D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at FCUs until the unit is at the minimum cfm.
- E. Verify the operation of all interlock systems.

3.8 TEST AND BALANCE COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.9 DEMONSTRATION AND ACCEPTANCE

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.10 TRAINING

A. On-Site:

1. After completion of commissioning, the manufacturer shall provide 8 hours of training on consecutive days for 12 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

B. Day-to-Day Operations - Training Description:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand FMCS systems components.
4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
5. Operate the workstation and peripherals.
6. Log-on and off the system.
7. Access graphics, point reports, and logs.
8. Adjust and change system setpoints, time schedules, and holiday schedules.
9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
10. Understand system drawings and Operation and Maintenance manual.
11. Understand the job layout and location of control components.
12. Access data from FMCS controllers and ASCs.
13. Operate portable operator's terminals.

- C. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.11 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. 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.
- E. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- F. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Engineer. TCC shall prime and paint the device enclosure. Color selection by Owner.

3.12 INSTALLATION OF FLOW METERS

- A. Provide manufacturer's recommended lengths of straight piping upstream and downstream of the flow meter. Up to 30 diameters upstream of the flow meter may be required depending on the piping arrangement and flow meter type.
- B. Maintain adequate pull/service space.

END OF SECTION 230900

SECTION 230913 - INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Positive Displacement Meters.
- B. Pressure Gauge.
- C. Pressure Gauge Accessories.
- D. Thermometers.
- E. Test Plugs.
- F. Static and Differential Airflow Pressure Gauges.

1.2 REFERENCES

- A. ANSI/AWWA C700 - Cold Water Meters - Displacement Type, Bronze Main Case.
- B. ANSI/AWWA C701 - Cold Water Meters - Turbine Type, for Customer Service.
- C. ANSI/AWWA C702 - Cold Water Meters - Compound Type.
- D. ANSI/AWWA C706 - Direct Reading, Remote Registration Systems for Cold Water Meters.
- E. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
- F. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- G. ASTM E1 - Specification for ASTM Thermometers.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. AWWA C700 positive displacement disc type suitable for fluid with hermetically sealed register.
- B. Provide water meters with bronze case with cast iron frost-proof, breakaway bottom cap.
- C. Manufacturers:
 - 1. Neptune
 - 2. Badger
 - 3. Hersey.

2.2 PRESSURE GAUGES

- A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for air, steam, water or oil application, 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.
- B. Manufacturers:
 - 1. Ashcroft
 - 2. Marsh
 - 3. Marshalltown
 - 4. Miljoco
 - 5. Trerice
 - 6. U.S. Gauge Figure 1901
 - 7. Weiss
 - 8. Weksler
 - 9. Wika.
- C. Select gauge range for normal reading near center of gauge.

2.3 PRESSURE GAUGE ACCESSORIES

- A. All pressure gauges shall have valves and pressure snubbers.
- B. Shutoff Valve: 1/2" ball valve as specified for each piping system.
- C. Pressure snubber, brass with 1/2" connections, porous metal type.
- D. All pressure gauge piping shall be minimum 1/2" 304 stainless steel pipe or copper tube.

2.4 THERMOMETERS

- A. Dial Type:
 - 1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
 - 2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
 - 3. Stem lengths as required for application with minimum insertion of 2-1/2".
 - 4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
 - 5. Manufacturer:
 - a. Ashcroft
 - b. Marsh
 - c. Marshalltown
 - d. Miljoco
 - e. Tel-Tru
 - f. Trerice
 - g. U.S. Gauge
 - h. Weiss
 - i. Weksler, Wika.

B. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.
2. Select thermometer for appropriate temperature range.
3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
5. Manufacturer:
 - a. Marsh
 - b. Miljoco
 - c. Terrice
 - d. Weiss
 - e. Weksler
 - f. Wika.

C. Select scales to cover expected range of temperatures.

2.5 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.
- C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" (3" 80 mm) diameter pressure gauge with 0-100 psi (0-690 kPa) range, one gauge adapter with 1/8" (3 mm) probes, two 1-1/2" (40 mm) dial thermometers with 0° to 220°F (-18° to 104°C) and -25°F to 125°F (-32° to 52°C) ranges and 5" (125 mm) stems.
 1. Manufacturers:
 - a. Sisco
 - b. Flow Design
 - c. Peterson Equipment
 - d. MG Piping Products Co.
 - e. Miljoco, Terrice
 - f. Watts Regulator.

2.6 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

- A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
- B. Accuracy shall be $\pm 3\%$ of full scale maximum throughout entire range at 70°F.
- C. Provide mounting brackets, probes, and shutoff valves required for proper installation.
- D. The range and service shall be as required for application or as noted on the drawings.

- E. Manufacturers:
 - 1. Dwyer Magnehelic Series 2000
 - 2. Marshalltown Instrument Series 85C.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install per manufacturer's instructions.
 - 2. Coil and conceal excess capillary on remote element instruments.
 - 3. Install gauges and thermometers in locations where they are easily read from normal operating level.
 - 4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Positive Displacement Meters:
 - 1. Install positive displacement meters with shutoff valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Pressure Gauges:
 - 1. Connect pressure gauges to suction and discharge side of all pumps.
 - 2. Provide 1/2" tubing for pressure gauge and gauge accessories.
 - 3. Provide snubber for each pressure gauge.
- D. Thermometers:
 - 1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
 - 2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION 230913

SECTION 231113 - FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aboveground Fuel Piping
- B. Valves
- C. Piping Components
- D. Transfer Pump Sets

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- B. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- C. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- D. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- E. ANSI/ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings
- F. ANSI/ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.
- G. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
- H. ASME Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- J. ASTM A105 - Carbon Steel Forgings for Piping Applications
- K. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- L. ASTM A106 - Seamless Carbon Steel Pipe for High-Temperature Service
- M. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- N. ASTM A167 - Stainless and Heat Resisting Chromium - Nickel Steel Plate.

- O. ASTM A269 Stainless and Welded Austenitic Stainless steel Tubing for General Service.
 - P. ASTM A403 Wrought Austenitic Stainless steel Piping Fittings.
 - Q. ASTM A420 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
 - R. ASTM A254 - Copper-Brazed Steel Tubing
 - S. ASTM A865 - Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
 - T. ASTM B42 - Seamless Copper Pipe, Standard Sizes
 - U. ASTM B43 - Seamless Red Brass Pipe, Standard Sizes
 - V. ASTM B75 - Seamless Copper Tube
 - W. ASTM B88 - Seamless Copper Water Tube
 - X. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
 - Y. ASTM B302 - Threadless Copper Pipe, Standard Sizes
 - Z. ASTM D2996 - Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
 - AA. AWS B2.2 - Specification for Brazing Procedure and Performance Qualification
 - BB. AWS A5.8 Specification for Filler Metals for Brazing and Braze Welding
 - CC. IMC Chapter 13: Fuel Oil Piping and Storage
 - DD. IFC Section 603: Fuel-Fired Appliances
 - EE. IFC Chapter 57: Flammable and Combustible Liquids
 - FF. NFPA 30 - Flammable and Combustible Liquids Code
 - GG. NFPA 31 - Standard for the Installation of Oil-Burning Equipment
 - HH. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
- 1.4 SUBMITTALS
- A. Submit shop drawings per Section 230500. Include manufacturer's installation instructions.
 - B. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
 - C. Submit motor data indicating compliance with Section 230513.
 - D. Provide shop drawings for the following system components:
 1. Piping, accessories, valves, and fittings.
 2. Fuel oil transfer pump set.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required mechanical systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All piping, valves, components, equipment, and materials in contact with fluid shall be chemically inert to No. 1 and No. 2 diesel fuel.

2.2 BLACK STEEL PIPE - ABOVE GROUND

- A. Steel Pipe; Threaded Joints:
 1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53 or ASTM A106.
 2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F (98°C).
 3. Joints: Screwed.
 4. Fittings: 150 psi steam - 300 psi WOG, black malleable iron, banded, ASTM A865, ANSI B16.3. Cast iron fittings are prohibited.
 5. Unions: 250 psi steam - 500 psi WOG, black malleable iron, ANSI B16.39, ground joint with brass seat. Cast iron fittings are prohibited.

2.3 VALVES

- A. Shutoff Valves:
 1. Ball Valves:
 - a. BA-31: 2" and under, 600 psi CWP, 250 psi LP gas, screwed ends, bronze body with chrome plated brass ball and trim, RPTFE seats and seals. UL 842 listed for flammable fluids, guides YRBX, YRPV, and MHKZ to 250 psi max.
- B. Check Valves:
 1. CK-31: 2" and under, 125 psi steam @ 353°F, 200 psi CWP @ 150°F, screw connections, bronze body, disc, and seat, swing check style.
- C. Back-Pressure Valve:
 1. 1/2" to 2", bronze body with screw connections rated for 200 psi CWP @ 200°F. Provide with brass body seat, 300 series stainless steel seat ring and disc, and BUNA-N diaphragm and O-ring.
 - a. Manufacturers:
 - 1) Cash Valve FR series
 - 2) Cashco Model 123 series
 - 3) Approved equivalent

2.4 PIPING COMPONENTS

A. Flexible Connectors:

1. All-steel construction with a UL listing (UL567). Connectors shall use only materials having melting points equal to or greater than 1,000°F.
2. Where used in suction piping, they shall be rated for full vacuum service at 30" Hg vacuum.
3. Flexible connectors shall have one swivel end and one female pipe thread end. Units shall be clearly marked with a lay line to minimize chances of twisting during installation.

B. Strainers:

1. ST-36: Duplex basket strainer, cast iron body, screwed ends, 1/2" to 3", bolted cover, 150 psi WOG @ 150°F with valve that directs flow through either side without interrupting flow. Stainless steel strainer elements to have 1/32" perforations.

2.5 FUEL OIL TRANSFER PUMP SET

A. Provide a complete, factory-assembled and tested system floor-mounted on a steel base pan.

B. System shall include:

1. Lead/lag transfer pump arrangement with safety valves as called for on flow diagrams. Pumps shall meet requirements of Section 231213 and shall be controlled by transfer system control panel.
2. Piping and components arranged in the order as shown on flow diagrams to include:
 - a. Isolation valves
 - b. Duplex basket strainer
 - c. Pressure gauges
 - d. Unions
 - e. Sight flow indicator
 - f. Check valves
 - g. Flow switch
3. Factory-mounted control panel with alarm contacts to send an alarm signal to a remote third-party building automation system.
4. System shall be supplied on a floor-mounted powder coated steel base pan with minimum 2" (50 mm) lip. Steel base pan shall be liquid-tight and shall come equipped with manufacturer provided leak detector that will indicate an alarm condition in the event liquid is detected within base pan. Provide 3/4" (18 mm) NPT drain with threaded plug to empty liquids from base pan.

C. Components shown on flow diagrams and listed below shall meet requirements specified under Part 2 of this section:

1. Isolation valves
2. Check valves
3. Duplex strainers

D. Control Panel Requirements:

1. UL listed, NEMA 4 rated enclosure to house all electrical components to include: transformers, fusing, wiring, relays, indicator lights, switches, and the like as required by control drawings and sequences of operation.

2. NEMA 4 rated disconnect switch that serves as a single point power connection for all pumps, controls, and associated electrical components.
 3. Controls shall be either microprocessor-based programmable controller or may use relay logic.
 4. Single point power connection with main disconnect switch for system with interlock. Provide all required transformers, wiring, fusing, terminal blocks and the like.
 5. Operator interface shall be mounted on the front panel of the control cabinet. Provide the following items as a minimum:
 - a. Individual alarm silence, manual reset, and lamp/alarm test buttons
 - b. Hand-off switch for each pump motor
 - c. "Pump On" indicator light dedicated and labeled for each pump
 - d. Alarm lamp on panel door (remains illuminated after the alarm silence switch is depressed, until the alarm condition is no longer detected)
 - e. Alarm bell on panel door
 6. Piping: Schedule 40 steel, ASTM A-53 grade "A" with malleable iron fittings having threaded connections.
 7. Flexible Connection Hoses: Furnish two flexible connection hoses (shipped loose for field installation) where field installed piping connects to fuel oil transfer pump system. Flexible hoses shall meet the following requirements:
 - a. Braid Alloy: 300 series stainless steel
 - b. Hose Material: 300 series stainless steel
 - c. UL Working/Burst Pressure: 150 psi / 600 psi
 - d. Acceptable Manufacturers:
 - 1) Hosemaster (Model FireShield)
 - 2) Approved equivalent
- E. Dedicated combination differential pressure gauge/switch shall be installed across duplex basket strainer. An alarm condition shall be indicated at control panel in the event excessive pressure drop is measured across strainer.
- F. Sequence of Operation:
1. When any hand-off switch is placed in hand position, dedicated pump motor shall run continuously.
 2. When starter is switched to hand position, the following shall indicate an alarm condition at the control panel:
 - a. Current sensing relay at pump motor detects insufficient current draw.
 - b. Flow switch detected a no-flow condition.
 - c. Excessive (4 psi - adjustable) differential pressure drop measured across basket strainer.
 3. An alarm shall be generated at the control panel when leak detector in steel base pan senses fuel oil.
- G. Acceptable Manufacturers:
1. Ace Tank & Fueling
 2. Critical Fuel Systems
 3. Earthsafe Systems Inc.
 4. Industrial Fuel Systems LLC.
 5. Power Flame Incorporated.
 6. Preferred Utilities Manufacturing Corp.

7. Phillips Fuel Systems
8. Pryco Inc.
9. Simplex Inc.

PART 3 - EXECUTION

3.1 SYSTEM, PIPING AND VALVE SCHEDULE:

- A. Fuel Oil - Liquid or Vapor Service (Aboveground):
 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
 2. Valves: BA-31
 3. Check Valves: CK-31
 4. Strainers: ST-36

3.2 ABOVEGROUND FUEL PIPING

- A. Carefully inspect all pipe, fittings, valves, equipment, and accessories before installation. Any items that are unsuitable, cracked, or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment, and accessories shall have factory-applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying, and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment, and accessories. Do not install any item that is not clean.
- D. Before assembling pipe systems, remove all loose dirt, scale, oil, and other foreign matter on internal or external surfaces by using good piping practice, subject to approval of the Engineer's representative. Blow chips and burrs from the machinery or thread cutting operation out of the pipe before assembly. Wipe cutting oil from internal and external surfaces.
- E. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges, or other items specifically designed and intended for this purpose.
- F. General Installation Requirements:
 1. Install all products per manufacturer's recommendations.
 2. Use full and double lengths of pipe wherever possible.
 3. Cut all pipe to exact measurement and install without springing or forcing.
 4. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipelines.
 5. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings or street elbows. All fittings 2-1/2" (60 mm) and larger shall be of the long radius type, unless otherwise shown on the drawings or specified.
 6. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to pumps and other equipment at line size, with reduction in size being made only at equipment connection.
 7. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
 8. Provide flanges or unions at all final connections to equipment and control valves.
 9. Provide dielectric connections between dissimilar metals.
 10. Provide clearance for access to valves and fittings.
 11. Install valve stems upright or horizontal, not inverted.

12. Group piping whenever practical at common elevations.
 13. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
 14. Slope fuel piping and arrange to drain at low points.
- G. Installation Requirements in Rooms with Electrical Equipment:
1. Do not install piping or other equipment above electrical switchboards, panelboards, or transformers. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- H. Joining of Pipe:
1. Threaded Joints:
 - a. Screw threads shall conform to ANSI B2.1 "Pipe Threads".
 - b. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
 - c. Protect plated pipe and valve bodies from wrench marks.
 - d. Apply fuel oil compatible anti-seize thread lubricant to male threads.
- I. Test piping using water, nitrogen, or air as compatible with the final service of the pipe, at 150% of normal operating pressure but no less than 100 psig. Piping shall hold this pressure for one hour with no drop in pressure. Do not use combustible fluids. Drain and clean piping after testing is complete.
- J. Flush pipe and components with No. 2 fuel oil until the discharge from each system is clean. Flow shall be in the same direction as when system is in operation. After flushing, all residual oil shall be drained or blown out of each system into separate containers. These containers of cleaning fluid shall be disposed of, complying with all federal, state, and local regulations.
- K. Corrosion Protection (painting of black steel piping):
1. Cleaning: Contractor shall thoroughly clean all steel fuel oil supply, return, and vent piping as follows:
 - a. Remove all grease, oil, salt, and chemical residue by washing exterior piping surfaces with full strength solution of cleaner/degreaser. Rinse with water and allow to thoroughly dry.
 - b. Physically clean all surfaces to be painted with thorough hand tool (SSPC-SP-2) and power tools (SSPC-SP-3). When viewed without magnification, surfaces shall be free from visible oil, grease, and dirt, and from poorly adhering mill scale, rust, paint coatings and foreign matter.
 2. Protection:
 - a. All equipment, structures, and surfaces shall be fully protected from physical and chemical damage from cleaning and painting operations to include droplets and overspray.
 - b. Provide complete protection of adjacent surfaces not being cleaned or coated by using surface protections, drop cloths, and masking.
 3. Painting: After all pipe surfaces are clean and dry, Contractor shall coat all exterior piping surfaces as follows. Color of coating shall match that of existing fuel oil piping:
 - a. Coat with two-component (1:1 mixture by volume of base & activator) Steel-Tech High-Build Epoxy Mastic as manufactured by Rust-oleum. Thorough mixing of base and activator shall be performed using power mixing tools.

- b. Provide multiple coats as required to achieve minimum dry-film thickness of 5-8 mils. A wet-film thickness of 7.0-11.5 mils is needed to achieve required dry-film thickness. Application rate shall be approximately 175 SF/gallon (3.8m²/liter).
 - c. Use appropriate activator (low temperature 40-60°F (5-16°C) or standard 50-100°F (10-38°C)) in accordance with manufacturer's instructions based on application temperature.
 - d. Do not apply coating if ambient temperatures are expected to fall below 45°F (8°C) in the first 24 hours of cure.
4. Cleanup: After painting operations are complete, completely remove and dispose of all surface protections, drop cloths and masking applied for adjacent equipment, structure, and surface protection.

3.3 FUEL OIL TRANSFER SYSTEMS

- A. Install and test fuel oil transfer systems to verify functions per manufacturer specifications.
- B. Installation of all equipment and tanks shall maintain UL listing and warranty certificates.
- C. Installation, calibration, and startup shall be performed by individuals trained by the manufacturer. Contractor shall arrange for onsite training and provide a letter from the manufacturer listing names of trained individuals and the dates of training.
- D. Unit Mounting: Provide concrete housekeeping pads for all floor-mounted transfer systems. Concrete pads shall not be less than 4" in thickness and shall extend minimum 3" beyond all sides of equipment.

END OF SECTION 231113

SECTION 231213 - FACILITY FUEL-OIL PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Positive Displacement Pumps

1.2 SUBMITTALS

- A. Submit product data per Section 230500. Include manufacturer's installation instructions.
- B. Submit certified pump performance curves with pump HP, RPM, and system operating point plotted.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- D. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 - PRODUCTS

2.1 POSITIVE DISPLACEMENT PUMPS

A. General Requirements

- 1. Provide pumps to meet requirements as called out on the drawings.
- 2. Type: Positive displacement, single stage, rotary gear.
- 3. Construction: Cast or ductile iron casing, hardened shaft with stainless steel sleeves and mechanical seals, self-lubricating bronze bearings, inlet and outlet connections, and integral bypass type adjustable relief valve.
- 4. Drive (for base mount pump applications): Flexible coupling with OSHA approved guard.
- 5. Drive (for inline pump applications): Close-coupled.

B. Manufacturers:

- 1. Haight
- 2. Oberdorfer
- 3. Viking

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

- 1. Contractor shall install pumps and piping in accordance with manufacturer's installation instructions.
- 2. Pump startup shall be performed by individuals trained by the manufacturer.
- 3. Support piping adjacent to pumps so that no weight is carried by pump casings.

4. Contractor shall provide wiring and seal-offs for all conduit.
 5. Electrical work shall conform to the National Electrical Code NFPA 70.
- B. Contractor shall arrange for onsite Owner training and provide a letter from the manufacturer listing names of trained individuals and the dates of training.

END OF SECTION 231213

SECTION 232100 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings
- B. Valves
- C. Check Valves
- D. Strainers
- E. System Piping Schedule

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

1.3 REFERENCES

- A. ANSI/AWS D1.1 - Structural Welding Code.
- B. ASME - Boiler and Pressure Vessel Code.
- C. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- D. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- E. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- F. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- G. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- H. ASME B16.12 - Cast Iron Threaded Drainage Fittings.
- I. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
- J. ASME B16.21 - Nonmetallic Flat Gaskets for Pipes Flanges.
- K. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- L. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
- M. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- N. ASME B16.51 - Copper And Copper Alloy Press-Connect Pressure Fittings.

- O. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
- P. ASME B18.2.2 - Square and Hex Nuts, Inch Series.
- Q. ASME B31.9 - Building Services Piping.
- R. ASME Section 9 - Welding and Brazing Qualifications.
- S. ASTM A126 - Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- T. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- U. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.
- V. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- W. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- X. ASTM A536 - Standard Specification for Ductile Iron Castings
- Y. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
- Z. ASTM B32 - Standard Specification for Solder Metal.
- AA. ASTM B88 - Seamless Copper Water Tube.
- BB. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
- CC. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
- DD. ASTM E413-87 - Classification for Rating Sound Insulation
- EE. ASTM F3226 - Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230500. Include data on pipe materials, fittings, valves, and accessories.
- B. Submit shop drawings per Section 230500.
- C. Test Reports: Provide results of piping system pressure tests.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 STEEL PIPE (ABOVE GRADE)

- A. Design Pressure 125 psig, Maximum Design Temperature 225°F (230°F for grooved couplings).
- B. Black Steel; Standard Weight; Threaded Joints:
 1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53; Type E, F, or S; Grade B.
 2. Joints: Screwed.
 3. Fittings: Class 125 cast iron, ASTM A126, ASME B16.4; or Class 150 malleable iron, ASTM A197, ASME B16.3.
 4. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.
- C. Black Steel; Standard Weight; Welded or Flanged Joints:
 1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.
 2. Joints: Butt-welded or flanged.
 3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.
 4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges. Flange face seal weld (backweld) is required for slip-on flanges.

2.2 COPPER PIPE (ABOVE GRADE)

- A. Design Pressure 125 psig. Maximum Design Temperature 225°F.
- B. Copper Pipe; Type L; Soldered Joints:
 1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
 2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
 3. Fittings: Wrought copper solder joint, ASME B16.22.
- C. Copper Pipe; Type L; Mechanical Press Connection:
 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
 2. Joints: Mechanical press connection.
 3. Fittings: Copper, ASME B-16.51, with embedded EPDM O-ring, NSF-61.
 4. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
 5. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
 6. Manufacturers:
 - a. Viega ProPress.
 - b. Elkhart Xpress.

- c. NIBCO Press System Fittings and Valves.
- d. Merit Brass
- e. Mueller Streamline PRS.

2.3 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Ball Valves:
 - a. BA-1 (Steel and Copper): 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.
 - 1) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
 - 2) Provide lock out trim for all valves opening to atmosphere installed in heating water piping over 120°F, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
 - b. BA-1A (Steel): 2-1/2" and 3", 125 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals.
 - 1) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
 - 2) Provide lock out trim for all valves opening to atmosphere installed in heating water piping over 120°F, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
3. Butterfly Valves:
 - a. BF-1:
 - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.

2.4 THROTTLING VALVES

A. Throttling Valves (Steel):

1. For pipe systems where mechanical press connections are allowed, throttling valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Globe Valves (Steel Pipe):
 - a. GL-1: 3" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze.
3. Globe Valves (Copper Pipe):
 - a. GL-5: 2" and under, 125 psi saturated steam, 300 psi WOG, solder, bronze.
4. Butterfly Valves:
 - a. BF-4:
 - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.

2.5 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

2.6 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: Check Valves (Steel Pipe); 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing.
 1. Manufacturers:
 - a. Crane #37
 - b. Hammond #IB904
 - c. Walworth #406
 - d. Milwaukee #509
 - e. Watts #B-5000
 - f. or NIBCO #T-413.

- C. CK-13: Check Valves (Steel Pipe); 2-1/2" thru 12", 200# WOG, double disc wafer type, non-slam silent check, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.

1. Manufacturers:

- a. Milliken 740G
- b. NIBCO W-920-W
- c. Crane Duo-Chek
- d. Victaulic V715

- D. CK-4: Check Valves (Copper Pipe); 2" and under, 200 psi WOG @ 150°F, solder, bronze, horizontal swing.

1. Manufacturers:

- a. Crane #1342
- b. Hammond #IB912
- c. Walworth #406SJ
- d. Milwaukee #1509
- e. Watts #B-5001
- f. NIBCO #S-413.

2.7 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

- B. ST-1: Bronze body, screwed ends, screwed cover, 125 psi S @ 353°F, 200 psi WOG @ 150°F

1. Manufacturers:

- a. Armstrong #F4SC
- b. Metraflex #TS
- c. Mueller Steam Specialty Co. #351
- d. Sarco #BT
- e. Watts #777
- f. NIBCO T-122-A.

- C. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F.

1. Manufacturers:

- a. Armstrong #A1FL
- b. Metraflex #TF
- c. Mueller Steam Specialty Co.#758
- d. Sarco #CI-125
- e. Watts #77F-D
- f. Victaulic #732 or #W732
- g. NIBCO F-721-A.

- D. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
 - 1. Pipe Size:
 - a. 1/4" - 2": 1/32" screen
 - b. 2-1/2" - 8": 1/16" screen
- E. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.
- F. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

PART 3 - EXECUTION

3.1 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. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

3.2 SYSTEMS, PIPING, AND VALVE SCHEDULE

- A. Heating Water (Above Grade - maximum 200°F unless noted otherwise below):
 - 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
 - 2. Copper Pipe; Type L; Soldered Joints: 2" and Under
 - 3. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
 - 4. Black Steel; Standard Weight; Welded or Flanged Joints: 2-1/2" and Over
 - 5. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1
 - 6. Throttling Valves: GL-1, GL-5, BF-4
 - 7. Check Valves: CK-1, CK-4, CK-13
 - 8. Strainers: ST-1, ST-2
- B. Chilled Water (Above Grade):
 - 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
 - 2. Copper Pipe; Type L; Soldered Joints: 2" and Under
 - 3. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
 - 4. Black Steel; Standard Weight; Welded or Flanged Joints: 2-1/2" and Over
 - 5. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1
 - 6. Throttling Valves: GL-1, GL-5, BF-4
 - 7. Check Valves: CK-1, CK-4, CK-13
 - 8. Strainers: ST-1, ST-2
- C. Combined Heating/Chilled Water (Above Grade) (Maximum 185°F):
 - 1. Black Steel; Standard Weight; Threaded Joints: 2" and Under

2. Copper Pipe; Type L; Soldered Joints: 2" and Under
3. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
4. Black Steel; Standard Weight: Welded or Flanged Joints: 2-1/2" and Over
5. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1
6. Throttling Valves: GL-1, GL-5, BF-4
7. Check Valves: CK-1, CK-4, CK-13
8. Strainers: ST-1, ST-2

D. Condensate/Equipment Drain (DPP) Piping:

1. Copper Pipe; Type L; Soldered Joints: 2" (50 mm) and Under
2. Copper Pipe; Type L; Mechanical Press Connection: 4" (200 mm) and Under

3.3 TESTING PIPING

- A. Test pipes underground or in chases and walls before piping is concealed.
- B. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.
- C. Test the pipe with water at 1.5 times the design pressure but not less than 125 psig pressure. Hold pressure for at least two hours.
- D. Test to be witnessed by the Engineer or their representative, if requested by the Engineer.

3.4 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.
2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.
3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.

4. After each system has been cleaned and thoroughly flushed of pretreatment chemicals, it shall be immediately refilled with water and treated with chemical treatment as specified in Section 232500. The system shall not be allowed to sit empty for any length of time.
5. When system water is clear, remove, clean and replace all strainers.
6. Water samples may be taken by the Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 232500, shall be repeated at the Contractor's expense.
7. Chemical cleaning applies to the following systems:
 - a. Heating Water
 - b. Chilled Water
 - c. Combined Heating/Chilled Water

3.5 INSTALLATION

A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
2. Install piping to conserve building space, and not interfere with other work.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
6. Install bell and spigot pipe with bells upstream.
7. Seal pipes passing through exterior walls with a wall seal per Section 230529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
3. Provide clearance for installation of insulation, and access to valves and fittings.
4. Prepare pipe, fittings, supports, and accessories for finish painting.
5. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
6. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
7. Provide flanges or unions at all final connections to equipment, traps and valves.
8. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

9. Horizontal swing check valves may only be installed in horizontal position. Do not install horizontal swing check valves in upward or downward flow direction. Where upward or downward flow installation is required, use spring-assisted, non-slam check valve.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. 2-1/2" and larger fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.
- H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
- B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.
- C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.
- D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.
- E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.
- F. All vent and drain piping shall be of same materials and construction as the service involved.

3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
 - 1. Must have at least same pressure rating as the main.
 - 2. Header or main must be 2-1/2" or over.
 - 3. Branch line is at least two pipe sizes under header or main size.

3.9 JOINING OF PIPE

- A. Threaded Joints (Steel Pipe):
 - 1. Ream pipe ends and remove all burrs and chips.
 - 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
 - 3. Apply Teflon tape to male threads.
- B. Flanged Joints (Steel Pipe):
 - 1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.
 - 2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.
 - 3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
 - 4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:
 - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
 - b. Maximum pressure rating of at least 250 psig.
 - c. Minimum temperature rating: -10°F.
 - d. Maximum temperature rating of at least 250°F for water systems operating above 140°F and up to 180°F.
- C. Solder Joints (Copper Pipe):
 - 1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
 - 2. Flux shall be non-acid type conforming to ASTM B813.
 - 3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove composition discs and all seals during soldering if not suitable for 470°F.

D. Welded Joints (Steel Pipe):

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

E. Mechanical Press Connection (Copper):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

END OF SECTION 232100

SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air Vents
- B. Automatic Air Vents
- C. Basket Strainers
- D. Makeup Water Accessories
- E. Safety Relief Valves
- F. Triple Duty Valves
- G. Suction Diffusers
- H. Self-Contained Control Valves
- I. Balancing Valves
- J. Venturi Flow Measurement
- K. Combination Piping Packages
- L. Expansion Tank
- M. Air Separators
- N. Drain Valves and Blowdown Valves

1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

1.3 REFERENCES

- A. ASME - Boiler and Pressure Vessel Code.
- B. ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.
- C. ASME B31.9 - Building Services Piping.
- D. ASME Section 9 - Welding and Brazing Qualifications.
- E. ASTM A536 - Standard Specification for Ductile Iron Castings

- F. ASTM B32 - Standard Specification for Solder Metal.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230500. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

1.6 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 AIR VENTS

- A. At end of main and other points where large volume of air may be trapped, use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.
- B. On branch lines and small heating units, use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

2.2 AUTOMATIC AIR VENTS

- A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet.
 - 1. Manufacturers:
 - a. B&G #87
 - b. Armstrong
 - c. Spirotherm
 - d. Taco
 - e. Watts
- B. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet.
 - 1. Manufacturers:
 - a. B&G #107
 - b. Armstrong
 - c. Spirotherm
 - d. Taco
 - e. Watts

2.3 MAKEUP WATER ACCESSORIES

A. Pressure Reducing Valve:

1. For water fill lines to hydronic systems.
2. Removable strainer, field adjustable discharge pressure, brass body, disc and seat, union with 1/2" or 3/4" NPT sweat connection, 125 psig maximum working pressure, 225°F maximum temperature.
3. Manufacturers:
 - a. Armstrong
 - b. Bell & Gossett
 - c. Conbraco
 - d. Thrush
 - e. Watts

B. Relief Valve:

1. For water fill lines to hydronic systems.
2. Cast iron or bronze body, 1/2" or 3/4" screwed connections, 125 psig working pressure, 225°F maximum temperature. Minimum 500,000 Btuh capacity at 30 psig. Manual test lever.
3. Manufacturers:
 - a. Armstrong
 - b. Bell & Gossett
 - c. Conbraco
 - d. Taco
 - e. Watts

C. Backflow Preventer:

1. Reduced pressure type as scheduled on the drawings.
2. Provide an air gap fitting and piping to drain.
3. If not indicated on the drawings, unit shall be same size as pipe.
4. Field test and tag units per manufacturer's instructions by a certified tester before initial operation.

2.4 SAFETY RELIEF VALVES

A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250°F. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled.

B. Manufacturers:

1. Kunkle # 537
2. B&G
3. Conbraco
4. McDonnell & Miller
5. Watts

2.5 TRIPLE DUTY VALVE

- A. Type TD-1: 2" and above, 175 psi working pressure, flanged, cast iron, non-slam check valve, calibrated throttling, shutoff capabilities, angle or straight pattern. Pressure drop with design flow at 100% open shall not exceed 10 feet. Size to match pipe (not pump outlet) size, but reduce size by not more than one (1) if needed to provide at least 3 feet of differential pressure across the flow measuring taps at scheduled flow rate.
- B. Manufacturers:
 - 1. Armstrong
 - 2. Bell & Gossett
 - 3. Taco
 - 4. Wheatley
 - 5. Victaulic

2.6 Triple duty valves may replace the combination of shutoff valve, balancing valve, and check valve on constant volume systems. Triple duty valves are not permitted on variable volume systems. SUCTION DIFFUSER

- A. Furnish and install on base-mounted pumps with inlet size same as pipe size shown on the drawing.
- B. In no case shall pressure drop exceed 3.0 psi.
- C. Suction diffuser shall consist of angle body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection, gauge tappings, and blowdown connection. Orifice cylinder, with bronze or stainless steel strainer with free area at least 5 times cross section area of pump suction opening. Furnish adjustable foot to support weight of suction piping. Connect drain valve to blowdown connection. Provide 16 mesh bronze startup strainer. The startup strainer shall be removed after the system has been started, cleaned, and is operating under normal conditions, but before the system is turned over to the Owner. Hang the startup strainer on the piping near the pump after it is removed.
- D. Manufacturers:
 - 1. Amtrol
 - 2. Armstrong
 - 3. Bell & Gossett
 - 4. Patterson
 - 5. Taco
 - 6. Wheatley
 - 7. Victaulic

2.7 SELF-CONTAINED CONTROL VALVES

- A. Thermostatic hot water control valves, self-contained bellows, nickel-plated body with EPDM disc, stainless steel spindle, and lifetime lubricated packing gland. Gland shall be replaceable with valve in operation.
- B. Size for maximum pressure drop of 1 psi.
- C. Configuration SCCV-2: Mount operator on valve body with remote sensor and capillary connection. Provide tamperproof cover.

- D. Manufacturers:
1. Danfoss
 2. Type RA
 3. Bell & Gossett
 4. Honeywell Braukmann
 5. Sterling
 6. Rittling

2.8 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units that sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit meeting the following requirements:
1. Carrying case with handle.
 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
- D. Valves in copper piping shall be brass or bronze.
1. Quarter-Turn Venturi Style (Brass or Bronze):
 - a. Manufacturers:
 - 1) Presso "B+"
 - 2) Griswold "Quickset"
 - 3) Gerand "BALVALVE Venturi"
 - 4) HCI "Terminator B"
 - 5) Nexus Valve "UltraXB Orturi"
 - 6) IMI Hydronic Engineering "Accusetter"
- E. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Option to balancing valves noted above are flow sensors specified in Section 230900 with a specified throttling valve.
1. Quarter-Turn Venturi Style (Ferrous Piping ä? 2"):
 - a. Manufacturers:
 - 1) Presso "B+"
 - 2) Gerand "BALVALVE Venturi"
 - 3) HCI "Terminator B"
 - 4) Nexus Valve "UltraXB Orturi"
 - 5) IMI Hydronic Engineering "Accusetter"

- F. Balancing valves in ferrous piping over 2 size shall have flanged or grooved ends and steel or cast iron construction. Option to balancing valves noted above are flow sensor specified in Section 230900 with a specified throttling valve.

1. Quarter-Turn Venturi Style (Ferrous Piping Greater Than 2"):

a. Manufacturers:

- 1) Presso "B+"
- 2) Taco "Accu-flo"
- 3) HCI "Terminator G"
- 4) Nexus Valve "Nextrol NXFB"
- 5) IMI Hydronic Engineering "Accusetter"

- G. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.9 VENTURI FLOW MEASUREMENT

- A. Static Low loss Venturi: Flanged or grooved end, 400 psig at 250 deg F working pressure; ANSI 150 pressure class; carbon steel body and insert; P/T ports for external gauge connection; $\pm 3\%$ accuracy. Size venturi to match pipe (not pump outlet) size, but reduce size by not more than one (1) if needed to provide a minimum of 20" w.c. differential pressure across the flow measuring taps at scheduled design flow rate. In no instance shall pressure drop exceed 60" w.c. at scheduled design flow rate.

B. Manufacturers:

1. IMI Flow Design
2. Hayes Fluid Controls
3. Tunstall/Macon
4. Bell and Gossett

2.10 COMBINATION PIPING PACKAGES

- A. Combination piping packages are allowed at unitary equipment only (1" pipe size and smaller) in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined. Coil connections shall be rigid. Combination piping packages shall include:

1. Shutoff valves
2. Wye strainers, with 1/4 turn strainer blowdown valves with hose thread and cap
3. Test plugs
4. Manual air vents
5. Unions

B. Manufacturers:

1. FDI Flowset
2. Griswold
3. Hays Fluid Controls
4. HCI Terminator
5. Nexus Coil Pak
6. NIBCO, Victaulic

2.11 EXPANSION TANK

A. Bladder Type:

1. Tank shall be welded steel, ASME construction and stamped.
2. Tank shall be complete with heavy-duty replaceable butyl bladder, charging valve, lifting ring, drain tapping, and system connection.
3. 125 psig working pressure and 240°F maximum operating temperature.
4. Manufacturers:
 - a. Thrush
 - b. Taco
 - c. Bell & Gossett
 - d. Armstrong
 - e. Watts
 - f. Wessels
 - g. Wheatley
 - h. Amtrol
 - i. Patterson
 - j. Grundfos

2.12 TANGENTIAL AIR SEPARATORS

- A. Separators shall be ASME constructed and stamped for 125 psi working pressure and 350°F operating temperature.
- B. Provide openings for inlet, outlet, blowdown, and expansion tank.
- C. Separators shall be line size or larger, with maximum pressure drop of 1 psi. Refer to drawing for separator sizing.
- D. Separators shall not include strainers, unless noted on the drawings. When furnished, strainers shall be removable and the blowdown fittings shall have drain valves.
- E. Manufacturers:
 1. Amtrol
 2. Armstrong
 3. Bell & Gossett
 4. Taco
 5. Wheatley
 6. Patterson
 7. Wessels
 8. Grundfos

2.13 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

2.14 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel, and stainless steel are commonly used and require isolation from each other with the following exceptions:
 - 1. Iron and steel connected to each other.
 - 2. Brass, copper, and bronze connected to each other.
 - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
 - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
 - 2. Manufacturers:
 - a. Elster Group ClearFlow fittings
 - b. Victaulic Series 647
 - c. Grinnell Series 407
 - d. Matco-Norca
- F. Flanged Joints (any size):
 - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
 - 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
 - 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
 - 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
 - 5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
 - 6. Manufacturers:
 - a. EPCO
 - b. Central Plastics
 - c. Pipeline Seal and Insulator
 - d. F.H. Maloney
 - e. Calpico

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valves/Fittings and Accessories:
 - 1. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.
 - 2. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.
 - 3. Prepare accessories for finish painting.

4. Install accessories with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
5. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
6. Provide flanges or unions at all final connections to equipment, traps and valves.
7. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

END OF SECTION 232116

SECTION 232123 - HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All pumps except where integral with a manufactured piece of equipment.
- B. Pump controls where self-contained.

1.2 SUBMITTALS

- A. Submit product data under provisions of Section 230500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Submit motor data indicating compliance with Section 230513.
- D. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 - PRODUCTS

2.1 PUMPS - GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Heating pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 230513.
- G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.
- H. Pumps specified in this section operating in clean water with a flow greater than 25 GPM and less than 459 feet head shall have a Pump Energy Index (PEI) less than 1.0.

2.2 BASE MOUNTED END SUCTION PUMPS

- A. Type: Centrifugal, single stage.
- B. Casing: Cast iron, single suction, rated for greater of 150 psi or 1.25 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.

- D. Shaft: High grade alloy steel with copper, bronze or stainless steel shaft sleeves.
- E. Bearings: Grease lubricated roller or ball bearings with grease fittings. If pump will be insulated, grease fittings shall be extended 3" with rigid pipe to clear the insulation.
- F. Drive: Flexible coupling with OSHA-approved guard.
- G. Seals: Mechanical type with internal flushing rated for -20 to 225°F with Buna elastomer, carbon primary ring, and ceramic stationary ring.
- H. Baseplate: Heat treated cast iron or reinforced heavy steel.
- I. Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 3. Armstrong
 - 4. Grundfos/Peerless/PACO
 - 5. Patterson

2.3 IN-LINE PUMP

- A. Type: Centrifugal, single stage, wet rotor in-line, suitable for horizontal or vertical operation. Pump internals shall be capable of being serviced without disturbing the piping connections.
- B. Casing: Cast iron, rated for greater of 125 psi or 1.5 times actual working discharge pressure, flanged suction and discharge.
- C. Impeller: Polyphenylene sulfide or stainless steel, fully enclosed, dynamically balanced.
- D. Shaft: Stainless steel.
- E. Rotor: Permanent magnet
- F. Bearing: Carbon sleeve.
- G. Gasket/O-ring: EPDM.
- H. Motor: Electronically Commutated (EC) permanent magnet, with integral control pushbuttons or dial to allow adjustment of motor speed.
- I. SPE Manufacturers:
 - 1. Bell & Gossett
 - 2. Taco
 - 3. Armstrong
 - 4. Grundfos/Peerless/PACO
 - 5. Patterson

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install all products per manufacturer's recommendations.
2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18" clearance for removal of suction diffuser.
3. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
4. Install on vibration isolators as scheduled on drawings and/or as specified in section 230548.

B. In-Line Pumps:

1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
2. Pump orientation shall be in accordance with the manufacturer's recommendations.

C. Base-Mounted Pumps:

1. Base-mounted pump alignment shall be inspected and approved by a factory-trained representative. If alignment is not satisfactory, the representative shall field laser align the shaft. If the pump is aligned in the field, an alignment report shall be provided as part of the closeout documents.
2. Unless otherwise shown on the drawings, mount all base mounted pumps on 4" high concrete pads and anchor frames to pads with cast-in-place anchors.
3. All base-mounted pumps shall be grouted-in. Follow manufacturer's instructions for grouting.

END OF SECTION 232123

SECTION 232500 - CHEMICAL (WATER) TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Treatment for Closed Systems (Water).
- B. Chemical Feed Equipment.

1.2 CHEMICAL TREATMENT CONTRACTOR

- A. The Owner has an existing State contract with Walter Louis Fluid Technologies, for chemical treatment maintenance and upkeep of existing systems. Contractor shall contract with Walter Louis and pay them to furnish all chemicals necessary for this project, perform startup services, and provide one year of maintenance services, as specified in this section.

1. Walter Louis - Contact Roger Smith (217) 223-2017.

- B. Contractor shall provide and install chemical treatment equipment specified herein, as well as any additional equipment required by Chemical Treatment contractor.
- C. Contractor shall coordinate with Chemical Treatment contractor to ensure water treatment system is compatible with new mechanical equipment.

1.3 REFERENCES

- A. ASTM D 859-00: Test Method for Silica in Water
- B. ASTM D 1066-97: Practice for Sampling Steam
- C. ASTM D 1067-92: Test Methods for Acidity or Alkalinity in Water
- D. ASTM D 1068-03: Test Methods for Iron in Water
- E. ASTM D 1126-02: Test Method for Hardness in Water
- F. ASTM D 1129-03a: Terminology Relating to Water
- G. ASTM D 3370-95a: Practices for Sampling Water from Closed Conduits
- H. AWWA C700-02: Cold-Water Meters - Displacement Type

1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230500.
- B. Include system schematics, equipment locations, and controls schematics.
- C. Submit product data indicating chemicals and equipment.
- D. Submit manufacturer's installation instructions.

- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit reports indicating start-up of treatment systems is completed and operating properly. Include reports indicating analysis of system water after cleaning and after treatment.

1.5 EXTRA STOCK

- A. Provide clean cartridges or bags in all bypass (pot) feeders with filters.
- B. Provide two complete sets of replacement cartridges or filters for each bypass (pot) feeder with filters installed. Deliver to Owner at job site.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include data on pumps and other equipment including spare parts lists, procedures, and treatment programs.
- C. Include step-by-step instructions on test procedures including target concentrations and test frequencies.
- D. Include list of treatment chemicals and associated SDS.

1.7 REGULATORY REQUIREMENTS

- A. Conform to all applicable codes and regulations for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Provide only chemicals approved for use and disposal by local authorities. Contact the Engineer if any specified chemicals are prohibited.

1.8 MAINTENANCE SERVICE

- A. Provide the following services to assist the owner in setting up and maintaining chemical treatment systems for one year from Date of Substantial Completion:
 1. Provide technical service visits to perform field inspections and make water analysis on site. Visits shall be twice annually for closed systems. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit copies of the field service report after each visit to the Owner and to the Mechanical Contractor. Any problems related to the operation of the chemical treatment program shall be reported to the Engineer.
 2. Provide laboratory and technical assistance services for warranty period.
 3. Include 2-hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start-up of systems.
 4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.
 5. Provide sufficient chemicals for treatment and testing during warranty period.

- B. The Chemical Treatment contractor shall be responsible for assisting the Mechanical Contractor by adding the chemical solutions required for cleaning each piping system. During the remainder of the warranty period, the Chemical Treatment contractor will be responsible for adding chemicals and doing other work related to the operation of system. The Chemical Treatment contractor shall make periodic tests of the chemical treatment program as called for above and recommend changes to Owner when needed.

1.9 WATER ANALYSIS

- A. Sample feedwater to determine appropriate chemical treatment. Contact the Engineer if test indicates treatment required is different than that specified.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Closed System Treatment (Water):

1. Provide one bypass feeder on each system. Install inlet, outlet and drain valves, and necessary piping.
2. Provide a 1" water meter in the domestic cold water line that provides makeup water to hydronic systems.
3. Provide coupon rack around main system pumps for all systems.
4. Proprietary blend containing the following items:
 - a. Corrosion Inhibitors for Water Systems Operating Above 145°F: Sodium nitrite-borax or molybdate with added inhibitors such as mercaptobenzothiazole, sodium tolytriazole, or phenyltriazole to protect copper and brass and minimize dielectric pitting of steel. Maintain 1,000 ppm nitrite or 100 ppm molybdate. Adjust borax content to keep correct pH for type of system (mainly steel or mainly copper).

2.2 EQUIPMENT

- A. Bypass (Pot) Feeder: 5.0 gal; quick-opening cap with 3-1/2" minimum diameter opening and opening wrench, legs to raise fill cap to 30" to 36", drain valve, air cock, working pressure of 200 psig at 200°F, 20 to 25-micron cartridge or bag filter.
1. Acceptable Manufacturers:
 - a. Griswold
 - b. Vector Industries
 - c. J.L. Wingert
 - d. Neptune
- B. Water Meter: Positive displacement type meter with bronze housing. 1" meter size. Meter to handle 1/2 - 30 GPM.
- C. Coupon Test Rack: Compliant with ASTM D 2688-05. Fabricated of 1" diameter, Schedule 40 carbon steel, rated for the maximum expected system pressure and temperature and including the following minimum components: inlet and outlet shutoff valves, flow control valve to provide a constant velocity between 1.5 ft/s and 6 ft/s (5 GPM is acceptable for all pipe types), one coupon holder for each metal in the piping system (four minimum), and sample drain port. Support test rack independently from piping connected to sides of system piping with flow upward through test rack. Provide a coupon test rack for each closed loop hydronic system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install bypass (pot) feeder with top approximately 36" above the floor.
- C. Coordinate with Contractor to provide temporary metering capabilities during system fill to determine overall system volume. Notify Engineer of overall system volume so that expansion tank sizing can be confirmed.

3.2 CLOSED-LOOP HYDRONIC SYSTEM WATER QUALITY STANDARDS

- A. Review equipment manufacturer's water quality standard to ensure water quality is sufficient to meet their warranty requirements as well as to ensure peak heat transfer efficiency. Contractor shall maintain hydronic systems within the more stringent of either the equipment manufacturer's requirements or those listed below:

Measured Value	Multi-Metal Systems with Aluminum	Multi-Metal Systems with Stainless Steel	Multi-Metal Systems with Copper
pH Range	8.5	8.5	9.0
Alkalinity as CaCO ₃	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Hardness as CaCO ₃ *	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Suspended Solids	less than 10 mg/l	less than 10 mg/l	less than 10 mg/l
Dissolved Solids	less than 1,000 mg/l	less than 1,000 mg/l	less than 1,000 mg/l
Chlorides	less than 150 mg/l	less than 150 mg/l	less than 150 mg/l
Iron	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Manganese	less than 0.4 mg/l	less than 0.4 mg/l	less than 0.4 mg/l
Nitrate	less than 100 mg/l	less than 100 mg/l	less than 100 mg/l
Sulfate	less than 200 mg/l	less than 200 mg/l	less than 200 mg/l
Ammonia	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Free Copper	less than 0.10 mg/l	less than 0.10 mg/l	less than 0.10 mg/l

- B. Submit an independent third-party test report for each chemically treated closed-loop system showing compliance with all measured values shown in the above table as part of project closeout documentation.

END OF SECTION 232500

SECTION 233100 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Ductwork Reinforcement
- C. Ductwork Sealants
- D. Rectangular Ductwork
- E. Round and Flat Oval Ductwork
- F. Exposed Ductwork (Rectangular, Round, or Oval)
- G. Flexible Duct
- H. Ductwork Penetrations

1.2 REFERENCES: Conform to all applicable requirements of the following publications:

- A. ADC Flexible Duct Performance and Installation Standards, 3rd Edition 1996.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/AWS A5.11M (1997) - Specification for Nickel and Nickel Alloy Welding Electrodes for Shielded Metal Arc Welding.
- D. ASHRAE - Handbook 2012 Systems and Equipment; Chapter 19 - Duct Construction.
- E. ASHRAE - Handbook 2013 Fundamentals; Chapter 21 - Duct Design.
- F. ASTM A90 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- G. ASTM A167- Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip.
- H. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- J. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- K. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- L. ASTM E413-87 - Classification for Rating Sound Insulation.

- M. AWS A5.14M (1997) - Specification for Nickel and Nickel Alloy Bare Welding Electrodes and Rods.
- N. AWS D9.1M/D9.1 - Sheet Metal Welding Code.
- O. IECC - International Energy Conservation Code (latest published edition)
- P. NADCA Standard 05 1997 - Requirements for the Installation of Service Openings in HVAC Systems.
- Q. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- R. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.
- S. SMACNA - Air Duct Leakage Test Manual.
- T. SMACNA - HVAC Duct Construction Standards.
- U. UL 181 - Factory-Made Air Ducts and Air Connectors.
- V. UL 181A - Closure Systems for Use with Rigid Air Ducts and Air Connectors
- W. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Submit duct fabrication standards in compliance with SMACNA and these specifications. Clearly indicate metal gauges, reinforcement, and joining methods intended for use for each pressure classification. Furnish details of all common duct fittings and joint connections to be used on this project.
- C. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 3. Room names and numbers, ceiling types, and ceiling heights.
 4. Indicate location of all beams, etc. along with bottom of beam elevations for each member.
 5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 230500.

1.4 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
- C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.

- D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
 2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
 3. Location and size of all duct access doors.
 4. Room names and numbers, ceiling types, and ceiling heights.
 5. Indicate location of all beams, etc. along with bottom of beam elevations for each member.
 6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Engineer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS AND SUPPORTS

- A. Rectangular Duct - Single Wall:
 1. General Requirements:
 - a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
 - b. Transitions shall not exceed the angles in Figure 4-7.
 2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
 - a. All ducts shall be cross-broken or beaded.
 - b. Snap lock seams are not permitted.
 - c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
 - 1) Type 1:
 - a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
 - b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.

- 2) Type 2:
 - a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
 - b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
 - 3) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
 - 4) Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
 - 5) Omitting every other vane is prohibited.
- d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
 - e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
 - f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
 - g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
 - h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
 - i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
 - j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
 - k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Manufacturers:
 - a) Ductmate Industries - 25/35/45
 - b) Nexus
 - c) Mez
 - d) WDCI
 - e) Other manufacturers must submit test data and fabrication standards and receive Engineer's approval before any fabrication begins.

- I. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
 - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
 - 2) Flanges shall be 24-gauge minimum (not 26 gauge).
 - 3) Manufacturers:
 - a) Lockformer TDC
 - b) TDF
 - c) United McGill
 - d) Sheet Metal Connectors
 - e) Other manufacturers must submit test data and fabrication standards and receive Engineer's approval before any fabrication begins.

B. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
 - a. Crimped joints are not permitted.
 - b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
 - c. Secure all joints with at least 3 sheet metal screws before sealing.
 - d. Manufacturers, Slide-on Flanges:
 - 1) Ductmate Industries - SpiralMate
 - 2) Accuflange
 - 3) Sheet Metal Connectors are acceptable.

e. Manufacturers, Self-Sealing Duct Systems:

- 1) Lindab
- 2) Ward "Keating Coupling"

C. Round Snap-Lock Seam Ductwork - Single Wall:

1. Factory sealed snap-lock pipe. Transverse and longitudinal seams shall contain factory-applied self-sealing EPDM and co-polymer gasket. Snap-lock shall conform to SMACNA RL-8. Duct and gasket material shall meet the flame/smoke spread rating of 25/50 per ASTM-E84.
2. G-60 galvanized coating meeting ASTM A653 and ASTM A90 G-90 galvanized steel aluminum meeting ASTM B209 Alloy 3003 Temper H14 304 stainless steel meeting ASTM A480 2B Finish.
3. Snap-lock seams are only permitted on systems between -1"w.c. and 2"w.c. pressure class.
4. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
5. Duct and fittings shall meet the required minimum gauges listed in Chapter 3 of the SMACNA requirements for the specified pressure class.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Manufacturers:
 - a. GreenSeam Industries.

D. Hangers and Supports General Requirements:

1. Hanger and support materials shall be as defined within Materials and Application Specific section below.
2. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge attached to the bottom of ducts.
3. Cable Hangers:
 - a. Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork.
 - b. Manufacturers; Supports:
 - 1) Gripple
 - 2) Ductmate
 - 3) Duro Dyne
 - 4) Engineer approved
4. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs.. Install per manufacturer's ratings and instructions.
 - a. Manufacturers; Supports:
 - 1) EZ Hanger

2.2 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:

1. General Requirements:

- a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
- b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
- c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
- d. Ductwork reinforcement shall be of galvanized steel.

2. Duct Hangers and Support Material:

- a. Ductwork hangers and supports shall be of galvanized or painted steel.
- b. All fasteners shall be galvanized or cadmium plated.

B. Exposed Ductwork (Rectangular, Round, and Flat Oval):

1. The following applies to all ductwork exposed in finished areas, when insulation is not required, in addition to requirements noted above:

- a. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
- b. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.
- c. Remove all identification stickers and thoroughly clean exterior of all ducts.
- d. Locate fitting seams on least visible side of duct.
- e. Provide exterior finish suitable for field painting without further oil removal.
- f. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct.
- g. Manufacturers, Slide-on Flanges:

- 1) Ductmate Industries
- 2) Accuflange
- 3) Sheet Metal Connectors

h. Manufacturers, Self-Sealing Duct System:

- 1) Lindab
- 2) Ward "Keating Koupling"

- i. The system shall be free of visible dents and scratches when viewed from normal occupancy.

2. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:

- a. Metal gauge of duct and fittings.
- b. Fitting type and construction.
- c. Type and size of reinforcement.

3. Hangers for Exposed Ductwork:
 - a. Round Ducts:
 - 1) Threaded rod with duct fixing bracket and metal strap. Provide single threaded rod centered on the duct. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel wrapping the circumference of the duct. Spacing as required by SMACNA guidelines.
 - 2) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Spacing and cable size as required by SMACNA guidelines.
 - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Engineer approved.
 - 3) Aircraft cable with 2-point support in standard horseshoe arrangement.
 - b. Rectangular Ducts:
 - 1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" in maximum dimension. Corner saddles are required when supporting rectangular ductwork. Spacing and cable size as required by SMACNA guidelines.
 - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Engineer approved.
 - 2) Aircraft cable with 2-point support in standard horseshoe arrangement. Corner saddles are required when supporting rectangular ductwork.
 - c. Strut-channel and all-thread rod is not acceptable for exposed ductwork.
 - d. All fasteners shall be galvanized or cadmium plated.

2.3 DUCTWORK REINFORCEMENT

- A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
 1. Ducts must be over 18" wide.
 2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
 3. Tie rods must not exceed 1/2" diameter.
 4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.4 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M.
- B. Two-part joint sealers shall consist of a minimum 3" wide mineral-gypsum compound impregnated fiber tape and a liquid sealant. Sealant system shall meet the following requirements: maximum 48-hour cure time, service temperature of 0°F to 200°F, resistant to mold, mildew, and water, flame spread rating below 25 and smoke developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes.

2.5 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.
- E. Standard:
 - 1. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh.
 - 2. Usage:
 - a. Connections to air inlets and outlets. Do not exceed 5'-0" in length.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- F. Repair all duct insulation and liner tears.
- G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- I. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.

- J. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- K. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

3.2 DUCTWORK APPLICATION SCHEDULE

A. General:

- 1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
- 2. Insulation:
 - a. Refer to Section 230713 for insulation types.
 - b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).

B. Constant or Variable Volume from Fan to Outlet:

- 1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
 - c. Round Snap-Lock Seam Ductwork - Single Wall
- 2. Material: Galvanized Steel
- 3. Pressure Class: +2"
- 4. Seal Class: A
- 5. Insulation:
 - a. 1-1/2" thick Type A (R=4.5)
- 6. Additional Requirements: None

C. Return Duct:

- 1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
- 2. Material: Galvanized Steel
- 3. Pressure Class: -2"
- 4. Seal Class: A
- 5. Insulation:
 - a. None
- 6. Additional Requirements: None

D. General Exhaust Duct:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1"
4. Seal Class: A
5. Insulation: None
6. Additional Requirements: None

E. Outside Air Intake from Louver to Heating Coil:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -2"
4. Seal Class: A
5. Insulation: 1 1/2" thick Type A (R=4.5)

F. Transfer Ducts:

1. Shape:
 - a. Rectangular Duct - Single Wall
 - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1/2"
4. Insulation: None,

G. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):

1. Insulation:
 - a. 1-1/2" thick Type A (R=4.5)

3.3 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.

4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

- B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, 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.

3.4 TESTING

- A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Engineer, the leakage appears excessive.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Engineer five business days prior to pressurizing ductwork for testing.

- B. Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
 - a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
 - b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
 - c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
 - d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
 - e. Totalling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
 - f. Contractor shall notify the Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
 - g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
 - h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
 - i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

END OF SECTION 233100

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual Volume Dampers.
- B. Fabric Connectors.
- C. Duct Access Doors.
- D. Duct Test Holes.
- E. Temperature Control Dampers.

1.2 REFERENCES

- A. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- B. SMACNA - HVAC Duct Construction Standards (latest edition).

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 230500.
- B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

2.2 FABRIC CONNECTORS

- A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
- B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.
- C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.
- D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
- E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
- F. Fabric connectors shall not be painted.
- G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.
- H. Materials:
 - 1. Durodyne MFN-4-100
 - 2. Vent Fabrics, Inc.
 - 3. "Ventglas"
 - 4. Proflex PFC3NGA
- I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.
- J. Materials:
 - 1. Durodyne "Duralon MFD-4-100"
 - 2. Vent Fabrics, Inc.
 - 3. "Ventlon"
 - 4. Proflex PFC3HGA

2.3 DUCT ACCESS DOORS

- A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication. Install access doors at motorized dampers, fan bearings, filters, automatic controls, louvers, and other equipment requiring service inside the duct.
- C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors with sheet metal screw fasteners are not acceptable.
- E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.

2.4 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.5 DUCTWORK ACCESSORY SEALANTS

- A. Ductwork accessory sealants and adhesives shall conform to Section 233100.

2.6 CONTROL DAMPERS AND DAMPER ACTUATORS

- A. Control dampers and damper actuators shall be furnished by the Temperature Control Contractor (Section 230900) and shall be installed by this Contractor.
- B. Coordinate exact sizes, locations, and installation requirements with the Temperature Control Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.

C. Control Dampers and Damper Actuators:

1. Install control dampers and damper actuators in accordance with manufacturer's instructions and in coordination with the Temperature Control Contractor.
2. Seal around damper frame inside ductwork with duct sealant to prevent bypass around damper.
3. Provide duct access door at each control damper.

END OF SECTION 233300

SECTION 233700 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grilles And Registers.
- B. Louvers.

1.2 QUALITY ASSURANCE

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

- A. AMCA 500-L-12 - Laboratory Methods of Testing Louvers for Rating.
- B. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. SMACNA - Duct Construction Standards.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230500.
- B. Submit manufacturer's installation instructions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.
- B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 AIR TERMINALS - GRILLES AND REGISTERS

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.

- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect.
- F. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- G. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- H. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- I. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- J. Screw holes for surface fasteners shall be countersunk for a neat appearance.
- K. Manufacturers:
 - 1. Tuttle & Bailey
 - 2. Titus
 - 3. Price
 - 4. Nailor
 - 5. Carnes
 - 6. Metalaire
 - 7. Krueger
 - 8. Anemostat

2.2 LOUVERS - FIXED - ALUMINUM

- A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.
- B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.
- C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.
- D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.
- E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.
- F. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.
- G. Louvers shall be suitable for duct connection.

H. Manufacturers:

1. Air Flow - "EA-403"
2. Arrow - "EA-415-D"
3. American Warming & Ventilating - "LE-21"
4. Construction Specialties - "A4097"
5. Dowco - "DBE-4"
6. Louvers & Dampers, Inc. - "IL-23"
7. Ruskin - "ELF375DX"
8. Vent Products - "2760"
9. Greenheck - ESD "403"
10. Pottorff - EFD
11. United Enertech FL-D-4

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install items in accordance with manufacturers' instructions.
2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
3. Install air terminals to ductwork with air tight connections.
4. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:

1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 230500.

END OF SECTION 233700

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Breechings.
- B. Isolation Dampers.

1.2 REFERENCES

- A. ANSI Z181.1 (UL 959) - Medium Heat Appliance Factory Built Chimneys.
- B. ANSI Z21.66 - Electrically Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
- C. ANSI Z223.1 (NFPA 54) - The National Fuel Gas Code.
- D. ANSI/ASTM C64 - Refractories for Incinerators and Boilers.
- E. ANSI/UL 103 - Standard for Factory Built Chimneys for Residential Type and Building Heating Appliances.
- F. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- G. UL 378 - Standard for Draft Equipment
- H. UL 441 - Standard for Gas Vents.
- I. UL 641 - Standard for Type L Low-Temperature Venting Systems.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include general construction, dimensions, weights, support and layout of breechings. Where factory built units are used submit layout drawings indicating plan view and elevations.
- B. Submit product data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights.
- C. Submit engineering report and manufacturer's certificate that refractory lined metal stacks meet specified requirements.
- D. Submit manufacturer's installation instructions.

1.4 DEFINITIONS

- A. Breeching or Vent Connector: Conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

- C. Combustion Air: Air that is supplied to combustion appliances to be used in the combustion of fuels and the process of venting combustion gases.
- D. Smoke Pipe: Round, single wall vent connector.
- E. Vent: Conveys flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

1.5 DESIGN REQUIREMENTS

- A. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

PART 2 - PRODUCTS

2.1 BREECHINGS

- A. Equipment with Power Burners or Induced Draft Fans:
 1. 10 gauge black steel. All welded construction including joints.
 2. Insulate with high temperature fiberglass insulation as specified in Section 230716.
 3. Provide high temperature gasket at all flanged connections to equipment.
- B. Provide cleanout doors of same gauge as breeching where shown on drawings.
- C. Reinforce rectangular breeching with angle frames and round breeching with flanged girth joints or angle frames. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- D. Fabricate breeching fittings to match adjoining breechings. Fabricate elbows with centerline radius equal to breeching diameter. Limit angular tapers to 20° maximum.

2.2 POSITIVE PRESSURE GAS VENTS AND INTAKES (NON-CONDENSING)

- A. The venting system shall be ANSI/UL 103 listed for use in positive pressure applications. For use with equipment burning gas, liquid or solid fuels as described in NFPA 211, Section 2-3-.1 and Appendix A.
- B. The vent system shall be double wall metal with a minimum of 1" air space between the walls. Outer wall shall be aluminum coated steel 0.034" thick.
- C. The inner pipe shall be Type 316 stainless steel 0.035" thick in all sizes.
- D. Seal each inner pipe joint during field installation with RTV silicone sealant for flue gas temperatures up to 600°F. For gas temperatures over 600°F, seal the joints with #33 joint cement, rated for 125% of design temperature.
- E. The chimney termination must comply with local building codes or Appendix D, NFPA No. 211.
- F. Protect all exposed metal parts with at least one base coat and one finish coat of heat and corrosion resistant primer and exterior paint.
- G. Usage: Non-condensing boiler positive pressure gas vent.
- H. Install ventilated thimble at roof penetration.

I. Manufacturers:

1. AMPCO
2. DuraVent
3. Hart & Cooley
4. Heat Fab
5. Metal-Fab
6. Schebler
7. Security (M&G Group)
8. Selkirk/Metalbestos
9. Van-Packer.

2.3 ISOLATION DAMPERS

A. Industrial grade, round, low leakage control damper designed for isolation of flue gases at elevated temperatures:

1. Damper
 - a. Frame: one piece carbon steel channel.
 - b. Blade: one piece carbon steel blade, 3/8" minimum thickness, with edge seal made of ceramic fibrous material sewn and encased in a woven high temperature sleeve. Seal shall be servicable and removable without damper replacement or damper removal from the system.
 - c. Axle: stainless steel stub, welded permanently on blade center and supported on both ends by bearings mounted outboard of damper frame, complete with adjustable axle shaft seals mounted directly to damper frame.
 - d. Bearings: lubricated ball bearings with high temperature grease.
 - e. Control shaft: 6" extended axle.
 - f. Finish: high temperature aluminum paint.
 - g. Temperature rating: damper and seals shall be designed for normal operating temperature of 500°F, with excursions to 1200°F.
2. Actuator:
 - a. 120-volt, 2-position, spring return, electric actuator with end switches.
 - b. Capable of 75 pounds of linear force and 30-second stroke speed.
 - c. Refer to section 230900 for additional requirements for damper actuators.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to putting boilers into operation, Contractor shall provide full penetration welds for the entire length of each pipe section for all inner and outer shell seams to prevent leakage of flue gases. Riveted, tack, or spot-welded seams are not permitted.
- B. Install all products in accordance with manufacturer's instructions.
- C. Install in accordance with recommendations of ASHRAE - Handbook, Chapter "Chimney, Gas Vent, and Fireplace Systems", NFPA 211, and ANSI Z223.1 (NFPA 54).
- D. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

- E. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Guide vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for duct support configuration and size. Provide expansion compensation approved by the manufacturer.
- F. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- G. Install isolation dampers near draft hood collars and secured to breechings.
- H. Level and plumb chimneys and stacks. Provide 3/4" condensate drain at base of all chimneys and stacks over 12" diameter. Pipe condensate to nearest floor drain.
- I. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- J. Provide slip joints permitting removal of appliances without removal or dismantling of breechings, chimneys, or stacks.

END OF SECTION 235100

SECTION 235239 - FIRE TUBE BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Boilers.
- B. Boiler Trim.
- C. Fuel Burning System.
- D. Controls.
- E. Connections.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Provide authorized factory representatives to conduct initial boiler installation review and start-up. Manufacturer is responsible for burner adjustment and testing.
- C. Conform to ANSI/ASME SEC 1, SEC 4 and SEC 8D and ANSI/AGA Z21.13 Code ANSI/UL 726 for construction of boilers.
- D. Boiler Burner Units: AGA certified and UL labeled.
- E. Conform to ANSI/NFPA 70 code for internal wiring of factory wired equipment.
- F. Installation shall meet the requirements of ASME CSD-1, including remote emergency shutdown switches for boilers, applicable gas train, individual venting of gas regulators, and repackable shutoff valves at all boilers.
- G. Conform to ASHRAE 90.1.

1.3 REFERENCES

- A. AGA - Directory of Certified Appliances and Accessories.
- B. ANSI/AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- C. ANSI/AGA Z223.1 - National Fuel Gas Code.
- D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ANSI/ASME SEC 1 - Boiler and Pressure Vessels Code - Rules for Construction of Power Boilers.
- F. ANSI/ASME SEC 4 - Boiler and Pressure Vessels Code - Rules for Construction of Heating Boilers.
- G. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.

- H. ANSI/NFPA 70 - National Electrical Code.
- I. ANSI/UL 726 - Oil-Fired Boiler Assemblies.
- J. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.
- K. HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.
- L. NFPA 85 - Boiler and Combustion Systems Hazard Code.

1.4 SUBMITTALS

- A. Submit product data per Section 230500. Include general assembly, components, controls, safety controls, electrical power/controls wiring diagrams, and service connections.
- B. Submit manufacturer's installation instructions.
- C. Submit reports to the Owner indicating condition and operation at start-up.
- D. Submit reports to the Owner indicating specified performance and efficiency is met or exceeded.
- E. Submit operation and maintenance data to the Owner. Include manufacturer's literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect boilers by leaving inspection openings and shipping packaging in place until final installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- B. Boilers:
 - 1. Aldrich.
 - 2. Hurst.
 - 3. L.E.S.
- C. Burners:
 - 1. Riello.
 - 2. Power Flame.
 - 3. Weishaupt.

2.2 BOILERS

- A. Boiler shall be designed for minimum 60 psig heating hot water.

- B. Boiler shall be three pass wetback or semi-wetback horizontal firetube updraft boiler with a minimum of 4 square feet of fire side heating surface per rated boiler horsepower. Boiler shall be mounted and shipped on a heavy steel frame with integral forced draft burner, burner controls, boiler trim, refractory, insulation and jacket factory mounted.
- C. Burner shall be approved and listed by Underwriters Laboratories Inc. (UL).
- D. Boiler shall be completely preassembled and fire tested at the factory. The unit shall be ready for immediate setting into place and ready for attachment of heating hot water (supply & return), fuel, electrical, and vent connections.
- E. Boiler shell shall be constructed in accordance with ASME Boiler Code and must receive authorized boiler inspection prior to shipment. A copy of the inspection report shall accompany the boiler to the site.
- F. Provide two lifting eyes on top of boiler, hinged front and rear doors shall be davited, gas tight, and rear door shall be insulated with blanket material and a steel covering.
- G. Front and rear tube sheets and flue fully accessible for inspection and cleaning. Boiler tubes shall not include turbulators, swirlers, or other add-on appurtenances.
- H. Provide observation ports at each end of boiler.
- I. Provide hand holes and manholes for boiler inspection and cleaning.
- J. Insulate casing with readily removable, 2" thick glass fiber blanket insulation covered by sectional preformed sheet metal jacket. Boiler casing temperature not to exceed ambient temperature by over 18°F with surface air velocity of one foot per second.
- K. Factory paint boiler, base, and other components with enamel finish.
- L. Provide stack thermometer, 3-1/2" diameter, black letters on white background, bi-metal type.
- M. Efficiency, verified by factory and site tests shall be minimum 80% from 30 to 100% of maximum firing rate.

2.3 HOT WATER BOILER TRIM

- A. Water pressure and temperature gauge. With ASME rated safety relief valve(s), sized for full boiler capacity.
- B. Low water cut-off with manual reset.
- C. Operating temperature controller to maintain boiler water temperature.
- D. Electronic operating temperature controller with ambient temperature range of 0° to 120°F, adjustable reset ratio of outside air temperature to discharge control point of 1:2 to 100:1, integral setpoint adjustment range of 80° to 230°F, electronic water and outdoor sensors, for on-off switching of pilot duty single throw double pole relays.
- E. High limit temperature controller for burner.
- F. Boiler air vent and drain.

- G. Provide all trim required to meet ASME CSD-1. This includes, but is not limited to, gas train and all terminals and necessary relays for connection to remote shutdown switch(es) to disconnect all power to the burner controls.

2.4 FUEL BURNING SYSTEM

- A. General: Forced draft automatic burner integral with front head of boiler designed to burn fuel oil and natural gas. Burner operation shall be modulating with low fire ignition position and on ratio turndown of minimum 7:1. Maintain fuel-air ratios automatically with flue gas temperature minimum 68°F above dew point temperature of flue gases at boiler outlet.
- B. Blower: Statically and dynamically balanced to supply combustion air. Direct connect to motor and equip with inlet silencer and outlet air dampers.
- C. Combination Gas-Oil Burner: Burner for gas and fuel oil to be built as single unit. Gas burner and oil burner complete with gas pressure regulator. Oil burner must be able to fire without the use of natural gas.
- D. Oil Burner:
 1. Mechanical atomizing forced draft type.
 2. Drip Pan: Provide 24" x24" x2" deep, 16 gauge galvanized steel soldered pan on floor under each oil burner.
 3. Oil Pump: Capacity approximately twice maximum burning rate.
 4. Oil Burner Piping: Include oil pressure regulating devices, oil metering controls, solenoid shutoff valves, oil strainer and instrumentation, integrally mounted on unit and adequate to permit performance adjustment.
- E. Gas Burner:
 1. Forced draft, high radiant annular entry, premix, power burner with gas-electric ignition and gas pressure regulator.
 2. Natural Gas Burner Piping: Provide on unit complete gas train including pressure regulators, safety and operating valves, high and low-pressure switches, main shutoff valve, gas pressure gauge, and airflow safety switch. Gas train to conform to ASME CSD-1 requirements. Vent all gas valves outdoors separately.
 3. Gas Valves: Provide at least 2 motorized gas valves. Provide additional valves as required by local codes or Owner's Insurance Company. Gas control valves, pressure switches, and regulators shall be UL motorized type.
 4. Gas train and all controls shall conform to IRI requirements, unless noted otherwise.
 5. Size gas train for pressure available in boiler room. Provide additional regulators if needed and vent outdoors separately.

2.5 CONTROL PANEL

- A. Mount on boiler. Hinged metal cabinet with key lock containing electronic flame safeguard and programming control, control circuit fusing, control circuit transformer, control circuit switch, manual potentiometer, indicating lights, numbered terminal strip, engraved name plates, relays, magnetic motor starters with thermal overload protection.
- B. Burner motor voltage shall be as scheduled on the drawings. Provide step down transformer for control power.

- C. On modulating burners provide manual-automatic selector switch and damper motor positioning switch to permit automatic firing in accordance with load demand, or manual control of firing rate at any desired point between low fire and maximum rating.
- D. Provide controls for combustion air damper. On a call for heat, the combustion air damper shall open. When the damper proves open, the burner shall be allowed to fire. Provide numbered terminal blocks for remote wiring.
- E. Burner control and safety functions shall be performed by microprocessor based burner management system with self-diagnostics, non-volatile memory, message center, and flame monitor. Program shall control ignition, flame protection, limit controls, burner activation, blower activation, pre-combustion purge and post combustion purge, fuel valve activation, recycling interlocks, and pilot confirmation.
 - 1. Program shall be self-monitoring and indicate any faults on LED message center. Provide all required accessories for a complete and fully operational system.
- F. Panel to include indicating lights to show operating conditions of alarms, flame failure and fuel valve open. Mount indicating lights and switches in hinged drop-panel for access to wiring.
- G. The boiler system control panel shall include contacts for a manual emergency shutdown switch. The switch shall be furnished, installed, and wired by the Mechanical Contractor. A switch shall be located at each exit just outside the boiler room door or as shown on plans. If boiler room door is on exterior of building, the switch shall be located just inside the door or as shown on plans. Verify final location with Engineer. The switch shall disable all boilers and shall be wired to the boiler burner safety control circuit to interrupt burner operation.
- H. The boiler shutdown switch shall be an emergency stop, mushroom head with N.C. contact, turn to release switch with engraved nameplate to read "BOILER EMERGENCY SHUTOFF".
- I. Provide main sequencing panel controlling all boilers with the following specifications:
 - 1. NEMA 1 enclosure with cooling fan
 - 2. 12" touch screen
 - 3. PLC with:
 - a. 64 MB RAM
 - b. 8 MB programming capacity
 - c. 32 GB SD card slot
 - d. Ethernet port
 - e. USB port
 - f. Lithium ion battery
 - 4. Functionality:
 - a. Lead/lag operation with automatic boiler rotation based on number of hours or individual boiler startups
 - b. Parallel, sequential, or sequential PV modulation of burner/boiler firing rate
 - c. Remote enable and setpoint adjustment via Facility Management and Control System (FMCS)
 - d. Time or temperature based hot standby capability
 - e. Low temperature/low fire hold capability
 - f. Monitoring of individual boiler status and alarms
 - g. Monitored analog inputs and outputs configured based on manual input values
 - h. Monitored digital outputs configured based on value in any Modbus registers and associated setpoints

- i. BACNet communication
 - j. Multi-level, password protected screens
 - k. Four analog inputs with field configurable label, span and type.
 - l. Two analog outputs with field configurable span and type.
- J. Manufacturer shall provide a BACnet interface with the Facility Management and Control System (FMCS) in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the boiler package. Wiring between the boiler control panel(s) and the integration panel shall be the responsibility of the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service.
- C. Provide connection of gas service in accordance with ANSI/AGA Z223.1.
- D. Pipe all safety relief valves to nearest floor drain.
- E. Mount thermometer and isolation damper in breeching within 12" of flue nozzle.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under factory authorized supervision.
- B. Provide field representative for starting unit and training operator. Refer to Section 230500 for detailed training requirements.
- C. Provide combustion test using each fuel type and submit report. Tests shall include boiler firing rate, overfire draft, gas/oil flow rate, heat input, burner manifold gas/oil pressure, % carbon monoxide (CO), % oxygen (O₂), % excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, % stack loss, % combustion efficiency, and heat output.
- D. Adjust controls to operate burner and maintain design conditions noted on drawings.

END OF SECTION 235239

SECTION 236430 - AIR COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Chiller Package.
- B. Charge of Refrigerant and Oil.
- C. Controls and Control Connections.
- D. Connections.
- E. Starters.

1.2 REFERENCES

- A. ANSI/AHRI 590 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/UL 1995 - Heating and Cooling Equipment.
- G. ANSI/UL 984 - Safety Standard for Hermetic Motor Compressors.
- H. ANSI/AFBMA 9 - Load ratings and Fatigue Life for Ball Bearings.
- I. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
- J. AHRI 550 - Centrifugal or Rotary Water - Chilling Packages.
- K. ARI-700-99 - Specification for Fluorocarbon Refrigerants.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500 indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, valves, strainers, thermostatic valves, rated capacities, specialties, accessories, electrical requirements and electrical power/control wiring diagrams.
- B. When submitting equipment with refrigerants and/or compressor types other than base design, prior approval shall be obtained from the Engineer before bids are received. Alternative refrigerants and associated equipment shall meet or exceed the sound performance, electrical performance, and information scheduled on the drawings and in the specifications.

- C. Submit manufacturer's installation instructions, including startup service reports and warranty.
- D. Submit operation data, start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide. Operation data shall include emergency, operation, and maintenance manuals.
- E. Submit AHRI Standard 370 sound power octave band data at 25%, 50%, 75%, and 100% load.
- F. Submit AHRI certified performance data indicating energy input versus cooling load output from minimum operating capacity to 100% of full load.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation. Protect insulation from dust, debris, and/or damage.
- C. Unit controls shall be capable of withstanding 150°F storage temperatures for an indefinite period of time.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing of the products specified in this Section with minimum five years' experience.
- B. All manufacturers shall have factory authorized and trained service personnel within 180 miles of the project site.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/AHRI 590, ANSI/UL 1995, ANSI/ASME SEC 8 Boiler and Pressure Vessel Code, ANSI/UL 984, and ANSI/ASHRAE 15.
- B. Conform to ASHRAE 90.1.

1.7 WARRANTY

- A. Provide five year compressor warranty covering materials and labor cost for repair or replacement at the Owner's option.
- B. Provide one year warranty on the entire unit covering materials and labor cost for repair or replacement of defective components at the Owner's option.

1.8 MAINTENANCE SERVICE

- A. Chiller manufacturer or chiller certified representative shall furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Trane.
- B. York.
- C. Daikin.
- D. Carrier.

2.2 AIR COOLED WATER CHILLERS

- A. Provide factory assembled and tested outdoor air cooled liquid chillers consisting of compressors, condenser, fans, evaporator, thermal expansion valve, refrigeration accessories, and control panel.
- B. Evaporator tubes are designed to operate under variable water flow conditions. Chiller manufacturer shall determine the minimum flow rates and maximum rate of water flow rate change. Coordinate with the Controls Subcontractor.
- C. Provide chiller with automatic capacity control down to 15%.
- D. Units shall have efficiency meeting ASHRAE 90.1.
- E. Charge unit with refrigerant at the factory and provide field charging if required after installation.

2.3 COMPRESSORS

- A. Hermetic direct drive scroll compressor(s) with suction strainer, crankcase oil heater, and suction and discharge valves.
- B. Statically and dynamically balance rotating parts. Mount on internal vibration isolators.
- C. Provide oil charging valve, oil level sight glass, oil filter, and magnetic plug on strainer, arranged to ensure adequate lubrication during starting, stopping, and normal operation.
- D. Provide compressor motor, suction gas cooled with solid state sensor and electronic winding overheating protection.
- E. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

2.4 EVAPORATOR

- A. Provide shell and tube evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Provide multiple refrigerant circuits on multiple compressor units.
- B. Design, test, and stamp refrigerant side for the applicable refrigerant working pressure and water side for 300 psi working pressure, in accordance with ANSI/ASME SEC 8.
- C. Insulate with 0.75" thick flexible plastic or rubber elastomeric cellular foam insulation with maximum K value of 0.28.

- D. Provide water drain and vent connection and thermometer wells for temperature controller and low temperature cutout.
- E. Evaporator shall have only one entering and one leaving water mechanical groove 300 psi flange connection. If manufacturer provides two separate evaporators, contractor shall provide manifold and balancing valves conforming to the requirements of Section 232100 to ensure equal flow is provided to each evaporator.
- F. Provide valved differential pressure gauge between supply and return at evaporator.
- G. Provide differential pressure flow switch or thermal dispersion flow switch in evaporator piping with connection to chiller control panel to provide proof of flow. Flow switch shall be factory installed and wired for internal evaporators.

2.5 CONDENSERS

- A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.
- B. Condenser Coil:
 1. Round Copper Tube and Aluminum Fins: Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Air test underwater to 450 psig.
 2. Microchannel: All aluminum brazed fin construction. The maximum allowable working pressure of the condenser is 450 psig. Air test underwater to 450 psig.
- C. Condenser Fans: Provide vertical discharge propeller condenser fans with fan guard on discharge and factory mounted, louvered, galvanized steel coil guard panels to completely protect condenser coils. Wire mesh coil protection is not acceptable.
- D. Condenser Motors: Provide low sound, direct drive, high efficiency fan motors with Class F insulation, permanently lubricated ball bearings, and built-in current and overload protection.
- E. Entire fan assembly shall be statically and dynamically balanced.

2.6 ENCLOSURES

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.

2.7 REFRIGERANT CIRCUIT

- A. Provide refrigerant circuits, factory supplied and piped.
- B. Provide for each refrigerant circuit:
 1. Liquid line solenoid and shutoff valves.
 2. Filter dryer (replaceable core type).
 3. Liquid line sight glass and moisture indicator.
 4. Electronic or thermal expansion valve.
 5. Charging valve.
 6. Insulated suction line.
 7. Discharge and oil line check valves.

8. Compressor suction and discharge service valves.
9. Condenser pressure relief valve.
10. Refrigerant and oil.

- C. Refrigerant may be new or reclaimed. Reclaimed refrigerant shall meet the ARI-700-99 Specification for Fluorocarbon Refrigerants.
- D. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

2.8 CONTROLS

- A. On chiller, mount lockable weatherproof steel control panel, containing starters, power and control wiring, non-fused disconnect switch, factory wired with single point power connection. Provide mechanical interlock to disconnect power when door is open.
- B. For each compressor, provide starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Provide manual reset current overload protection.
- C. Provide the following safety controls with 40-character English display, arranged so any one will shut down machine and require manual reset:
 1. Low chilled water temperature switch.
 2. High discharge pressure switch.
 3. Low suction pressure switch.
 4. Flow switch in chilled water line.
 5. Motor current overload.
 6. Phase reversal/unbalance/single-phasing.
 7. Over/under voltage.
 8. Failure of water temperature sensor used by chiller controller.
 9. Relay for remote mounted emergency shut-down switch.
 10. Low ambient/high ambient.
- D. Provide the following operating controls:
 1. Chilled water temperature controller.
 2. Timer to prevent compressor short cycling.
 3. Anti-coincidental timer.
 4. Load limit thermostat to limit compressor loading on high return water temperature.
 5. High ambient controls for operation over 115°F.
- E. Microprocessor control panel with digital readout. Display shall be multiple character LCD or lighted display with keypad.
 1. User interface shall display at a minimum the following:
 - a. Operating/alarm condition.
 - b. Leaving chilled water temperature set point (with adjustment at the panel and via DDC).
 - c. Entering and leaving chilled water temperature.
 - d. Percent rated load amps output for each compressor.
 - e. Condenser pressure for each circuit.
 - f. Evaporator pressure for each circuit.
 - g. Outside air temperature.
 - h. Voltage.

2. Control panel shall communicate the following points to the DDC system via a BACnet interface:

a. Inputs:

- 1) Chiller enable.
- 2) Leaving chilled water temperature set point.
- 3) Chiller mode.
- 4) Current limit set point.

b. Outputs:

- 1) Chiller status.
- 2) Active chilled water set point.
- 3) Leaving chilled water temperature.
- 4) Entering chilled water temperature.
- 5) Alarm descriptor.
- 6) Average percent Run Load Amps (actual capacity).
- 7) Active current limit set point.

F. Chiller manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135/2001. This may be accomplished through a system integration panel, or "gateway". Integration shall be through an RS-232 connection. Integration panels shall be provided as part of the chiller package. Wiring between the chiller control panel(s) and the integration panel shall be the responsibility of the chiller manufacturer.

2.9 BEARINGS

A. All bearings shall have a L10 life of not less than 200,000 hours per ANSI/AFBMA 9.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install in accordance with manufacturer's instructions.
2. Align chiller package on steel or concrete foundations.
3. Install on vibration isolators as scheduled on the drawings or in Section 230548.
4. Comb all condenser coils to repair bent fins.
5. Provide a coated wire mesh that covers the access area underneath the condenser coils.

B. Piping Requirements:

1. Connect to chilled water piping. On inlet, provide well for temperature controller and shutoff valve. On outlet, provide well for thermometer, and shutoff valve.
2. Arrange piping for easy dismantling for tube cleaning.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide factory trained representation for a period of one day to perform testing, start up, and instruction on operating and maintenance to Owner.

END OF SECTION 236430

SECTION 238200 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Convectors.
- B. Unit Heaters.
- C. Cabinet Heaters.
- D. Fan Coil Units.

1.2 QUALITY ASSURANCE

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.
- C. All gas fired units shall be AGA approved or UL listed.
- D. All gas trains shall comply with utility company and code requirements.
- E. All louvers and dampers shall have AMCA certified ratings.
- F. Factory wired equipment shall conform to ANSI/NFPA 70.

1.3 REFERENCES

- A. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NFPA 70 - National Electrical Code.
- D. ASHRAE 200 - Methods of Testing Chilled Beams

1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.

- E. Submit manufacturers' installation instructions.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ASHRAE 90.1.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.1 CONVECTORS

- A. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins, steel side plates and supports, factory air pressure tested at 100 psi under water.
- B. Cabinet: 16 gauge steel front and top; 18 gauge steel back and ends; exposed corners rounded; easily secured removable front panels, adequately braced and reinforced for stiffness.
- C. Finish: Factory applied baked enamel on exposed surfaces. Color selection by Architect.
- D. At otherwise inaccessible valves, provide 6" x 7" minimum size factory-made hinged access doors integral with cabinet.
- E. Manufacturers:
 1. Sterling
 2. Vulcan
 3. Zehnder-Rittling
 4. Modine
 5. Shaw-Perkins
 6. Sigma

2.2 UNIT HEATERS

- A. Casings shall be heavy gauge steel with a baked finish.
- B. Coils shall have copper heads and tubes, and aluminum fins.
- C. Units shall have threaded pipe connections for hanger rods.
- D. Fans shall be direct drive propeller type, factory balanced, with fan guards and totally enclosed motors with integral thermal overload protection.
- E. Horizontal units shall have adjustable outlet air louvers.

F. Provide unit mounted and wired disconnect switch. Contractor shall be responsible for providing and wiring disconnect when using a manufacturer who does not provide factory mounted option.

G. Products:

1. Trane - S or P
2. Daikin - UHH or UDH
3. Modine - HS or V
4. Vulcan - HV or VV
5. Sterling HS or VS
6. Zehnder-Rittling - H or V
7. Sigma H or V
8. Airtherm HA or VA

2.3 HOT WATER AND STEAM CABINET HEATERS

A. Units shall include cabinet, fan, motor, coil, filter, inlet grille and discharge grille.

B. Cabinets: 16 gauge exposed surfaces and 18 gauge concealed surfaces. Plastic exposed parts are not acceptable.

C. Baked enamel finish. Color selected by Architect.

D. Fans: Centrifugal forward-curved, double-width with galvanized steel scrolls. Fans shall be statically and dynamically balanced to reduce noise levels.

E. Motor: Fan motor voltage shall be as scheduled on the drawings. Motors shall be permanently lubricated, direct drive.

1. Permanent split capacitor type motor.
2. Electronically commutated motor (ECM).

F. Coils shall have finned copper tubes.

G. Provide 1" thick disposable filters or 1/2" thick washable 65% aluminum filters ahead of all coils.

H. Disconnect: Provide unit-mounted disconnect switch.

I. Speed Control: Provide unit-mounted fan speed control.

J. Manufacturers:

1. Trane - 'Force-Flo'
2. Sterling, Modine
3. Zehnder-Rittling
4. Sigma
5. Vulcan
6. Airtherm
7. Beacon Morris
8. Daikin

2.4 FAN COIL UNITS

A. Units shall include cabinet, fan, motor, coil, filter, and either return and discharge grilles, or duct collars where ductwork is shown on plans.

- B. Exposed cabinets shall be minimum 18 gauge steel with baked enamel finish, color selected by the Architect and no plastic exposed parts.
- C. Fans: Centrifugal forward-curved, double-width with galvanized steel scrolls. Fans shall be statically and dynamically balanced to reduce noise levels.
- D. All motors shall be electronically commutated motor (ECM) with integral thermal overload protection.
- E. Coils shall have copper headers and tubes and aluminum fins.
- F. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft² of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- G. Provide auxiliary drain pan to collect condensation in the valve compartment.
- H. Provide condensate piping and tie into drainage system.
- I. Filters: 1" woven glass fiber disposable type.
- J. Disconnect: Provide unit-mounted disconnect switch.
- K. Speed Control: EC motor to be provided with contacts for 0-10VDC signal from FMCS for speed control; refer to section 230513 for more requirements.
- L. Provide oversized left and right end piping compartments.
- M. Provide with tamperproof cabinet front.
- N. Units shall have a single coil for heating and cooling.
- O. Manufacturers:
 - 1. Air-Therm
 - 2. Carrier
 - 3. Trane
 - 4. Daikin
 - 5. IEC
 - 6. Enviro-Tech/JCI
 - 7. Williams

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation Requirements:
 - 1. Install all products per manufacturers' instructions.
 - 2. Coordinate recess sizes for recessed equipment.
 - 3. Protect units with protective covers during construction.
 - 4. Comb all coils to repair bent fins.

B. Fan Coil Unit:

1. Coordinate exact locations of fan coil units with existing conditions.
2. Install fan coil units with vibration isolation as specified in section 230548.

C. Unit Heater:

1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer's recommended mounting height requirements. If unit heaters cannot be installed within manufacturer's recommended range, notify Architect/Engineer prior to mounting.

3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 238200

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Description of Systems shall be as follows:
 - 1. Electrical power system to and including equipment, motors, devices, etc.
 - 2. Grounding system.
 - 3. Wiring of equipment furnished by others.
 - 4. Removal work and/or relocation and reuse of existing systems and equipment.
 - 5. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
- E. Work Not Included:
 - 1. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
 2. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
 3. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
 4. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
 5. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
 6. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
 7. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
- C. General:
1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
 2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
 3. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
 - a. Luminaires.
 - b. Gravity flow piping, including steam and condensate.

- c. Sheet metal.
- d. Other piping.
- e. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
 - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

- b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
 - c. Maintenance clearances and code-required dedicated space shall be included.
 - d. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

- 1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
- 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
 - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
- 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

- 1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
 - a. Scale of drawings:
 - 1) General plans: 1/4 Inch = 1'-0" (minimum).
 - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
 - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
 - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
 - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
- 2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
- 3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
- 4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the Engineer for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the Engineer and Owner's Representative. The Engineer will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The Engineer reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the Engineer.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
 - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
 - b. Potential layout changes shall be made to avoid additional access panels.
 - c. Additional access panels shall not be allowed without written approval from the Engineer at the coordination drawing stage.
 - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the Engineer and the Owner's Representative.
 - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Engineer will be done at the Contractor's risk.
- B. Qualifications:
1. Only products of reputable manufacturers as determined by the Engineer are acceptable.
 2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.
- C. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the State of Missouri Codes, Laws, Ordinances, and other regulations having jurisdiction.
 2. If there is a discrepancy between the codes and regulations and these specifications, the Engineer shall determine the method or equipment used.
 3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
 4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
 5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
 6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
 2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
 3. Pay all charges for permits or licenses.
 4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
 5. Pay all charges arising out of required inspections by an authorized body.
 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
 7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
 8. Pay all telephone company charges related to the service or change in service.
- E. Examination of Drawings:
1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear, and unit substations, shall be determined by the Contractor unless noted in the contract documents.
 3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
 4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.8 SUBMITTALS

- A. Submittals shall be required for items required elsewhere in the specifications or on the drawings.
- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
 1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps

3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
- a. Allow at least two weeks for Engineer's review and processing of each submittal, excluding mailing.
16. Engineer reserves the right to withhold action on a submittal which, in the Engineer's opinion, requires coordination with other submittals until related submittals are received. The Engineer will notify the Contractor, in writing, when they exercise this right.
- C. Electronic Submittal Procedures:
- 1. Distribution: Email submittals as attachments to all parties designated by the Engineer, unless a web-based submittal program is used.
 - 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
 - 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 - 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 26 XX XX.description.YYYYMMDD
 - b. Transmittal file name: 26 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.10 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Engineer.

1.11 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.12 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Engineer shall make the final determination of whether a product is equivalent.

- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Engineer, nor the presence of the Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
 - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
 - 2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.
- B. Excavation:
 - 1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
 3. Trim bottom and sides of excavations to grades required for foundations.
 4. Protect excavations against frost and freezing.
 5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
 6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
 7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
 8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Engineer or their representative, and do no further work until the Engineer or their representative gives further instructions.
 9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
 10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
 11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
 12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.
- C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
 2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Engineer.
- E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
 2. Provide all necessary sand and/or CA6 for backfilling.
 3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
 4. Dispose of the excess excavated earth as directed.
 5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
 6. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
 7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.

8. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
9. Backfill with native soil material (if approved) or sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
10. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
12. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Engineer.

3.3 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Engineer so that the final observation can be scheduled.
3. It is understood that if the Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Engineer will be deducted from the Contractor's final payment.

C. The following must be submitted before Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.

D. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Engineer's review and approval. The electronic copy shall be corrected as required to address the Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div26.contractor.YYYYMMDD
 - b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.5 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Engineer.
- F. Record actual routing of conduits exceeding 2 inches.

3.6 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
- B. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.

- C. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:
 1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
 2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.7 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.8 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.
- D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.
 1. Elevator machine rooms and hoistways.
 2. Exit enclosures.
 3. Other areas restricted by code.
 4. Technology, data, server rooms.

3.9 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Within the Limits of Construction:
 1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.
 2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.
- B. Outside the Limits of Construction:
 1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
 2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
 3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

- C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
1. Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
 2. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
 - a. Minimizing the amount of dust generated.
 - b. Reducing solvent fumes and VOC emissions.
 - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
 3. Request that the Owner designate an IAQ representative.
 4. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
 5. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
 6. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
 7. Request copies of and follow all Owner's IAQ and infection control policies.
 8. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
 9. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
 10. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.10 SYSTEM STARTING AND ADJUSTING

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.11 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Engineer or authority having jurisdiction deems necessary.

B. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

C. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Engineer or authority having jurisdiction deem necessary.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Per Section 260500, cable insulation test results have been submitted.
4. Per Section 260500, ground resistance test results have been submitted.
5. Operation and Maintenance manuals have been submitted as per Section 260500.
6. Bound copies of approved shop drawings have been submitted as per Section 260500.
7. Report of instruction of Owner's representative has been submitted as per Section 260500.
8. Start-up reports from factory representative have been submitted as per Section 260500.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 260500

SECTION 260503 - THROUGH PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2012 International Building Code
- J. NFPA 5000 - Building Construction Safety Code

1.4 SUBMITTALS

- A. Submit Firestopping Installers Certification for all installers on the project.
- B. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Interek/Warnock Hersey Assembly number.
- C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of construction penetrated including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
 - 4. F ratings for each firestop system.

- D. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
 - 1. Review foreseeable methods related to firestopping work.
 - 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
1. 3M; Fire Protection Products Division
 2. Hilti, Inc.
 3. RectorSeal Corporation, Metacaulk
 4. Tremco; Sealant/Weatherproofing Division
 5. Johns-Manville
 6. Specified Technologies Inc. (S.T.I.)
 7. Spec Seal Firestop Products
 8. AD Firebarrier Protection Systems
 9. Wiremold/Legrand: FlameStopper
 10. Dow Corning Corp
 11. Fire Trak Corp
 12. International Protective Coating Corp

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

3.2 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.3 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
 - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Engineer and manufacturer's factory representative. The Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Engineer's discretion and the contractor's expense.

END OF SECTION 260503

SECTION 260505 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.
- B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.
- C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.
- D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.
- E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.
- F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.
- G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.2 PREPARATION

- A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

- B. Coordinate utility service outages with Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.
- D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.
- E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least five (5) working days before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.
- D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.
- E. Disconnect and remove outlets and devices that are to be demolished.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Engineer with a Certificate of Destruction to verify proper disposal.
- I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.
- L. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

- M. Floor slab on grade is a structural slab. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid rebar or utilities encased in floor construction. Provide rebar dowels to replace damaged rebar and pin existing slab with patched slab. Refer to plans for additional information.
- N. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 EXISTING ENCLOSURES - NEW EQUIPMENT

- A. Existing enclosures may be reused to house new equipment including branch panels, industrial controls, and similar systems pending documented verification of the following provided with the applicable new equipment submittals.
 - 1. New equipment or panelboard is listed for the existing enclosure or application.
 - 2. Existing enclosure and new equipment is field evaluated by the manufacturer or nationally recognized testing laboratory for the available fault current, condition, and application.
 - 3. Authority Having Jurisdiction (AHJ) approval.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.6 INSTALLATION

- A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION 260505

SECTION 260513 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Building wire

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. NFPA 70 - National Electrical Code (NEC)
- C. UL 44 - Thermoset-Insulated Wires and Cables
- D. UL 83 - Thermoplastic-Insulated Wires and Cables
- E. UL 854 - Service-Entrance Cables
- F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords
- G. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

1.4 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of Section 26 05 00.
- B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
- C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.
- D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.

- E. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Above Accessible Ceilings:
 - 1. Building wire shall be installed in raceway.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type "THHN".
- D. Underground or In Slab: All conductors shall be type "THWN".
- E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

3.2 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C. Service entrance conductors are based on copper conductor installed in underground electrical ducts.
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Conductor length(s) listed on plans and schedules. The drawings are diagrammatic with intent to convey the components of the electrical distribution system. Conductor length(s) when listed on plans and schedules are for engineering calculation purposes. Conductor length(s) shall NOT be used for bidding purposes.
- D. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.
- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
 - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
 - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
 - 1. Facing the front and operating side of the equipment, the phase identification shall be:
 - a. Left to Right - A-B-C
 - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. Inspect wire and cable for physical damage and proper connection.
- D. Torque test conductor connections and terminations to manufacturer's recommended values.
- E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

- F. Provide documentation of the manufacturer's recommended lug torque value for Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- G. Protection of wire and cable from foreign materials:
 - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
- H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION 260513

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 Grounding and Bonding Equipment.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 99 - Standard for Healthcare Facilities

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ground rods.
- B. Indicate layout of ground field, location of system grounding electrode connections, and routing of grounding electrode conductor and ground ring.

1.5 SUMMARY

- 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.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 260513 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 260553 for insulation color.
- D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

- E. Copper Bonding Conductors: As follows:
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.

2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

2.3 GROUNDING ELECTRODES

- A. Ground Rods Copper-clad steel.

PART 3 - EXECUTION

3.1 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.
 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. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- 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.
- 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.
- H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity.
- I. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: 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. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. In raceways, use insulated equipment grounding conductors.
- D. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.
- B. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:
 1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
 2. Single-phase and three-phase motor and appliance branch circuits.
 3. Flexible raceway runs, including FMC and LFMC.
- C. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

- D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.
- E. Bond metal ducts of dust collectors, particulate conveying, fume hoods, and other hazardous materials to the equipment grounding conductors of associated pumps, fans, or blowers. Use braided-type bonding straps. Provide braided bare copper bonding conductor in nonmetallic dust collector ductwork to each equipment inlet location, and bond to equipment.
- F. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.
- G. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- H. Industrial Control Panels, Terminal Cabinets, and Similar Installation: Terminate bonding conductor on cabinet grounding terminal. Provide an equipment grounding conductor and bond adjacent and associated control panels together.
- I. Equipment Ground Conductor Continuity: All spliced equipment grounding conductors in junction boxes, cabinets, and distribution equipment shall be connected together and bonded to the metal enclosure.
- J. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

3.5 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
 2. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

3. Testing: Perform the following field quality-control testing:
 - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - b. 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.
 - c. 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.
 - 1) Equipment Rated 500 kVA and Less: 10 ohms.
 - d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260527 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and Equipment Supports
- B. Fastening Hardware
- C. Concrete Housekeeping Pads
- D. Foundation and Underground Sleeves and Seals

1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

- A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners
- F. Orbit Industries

2.2 MATERIAL

- A. Support Channel: ; painted steel.
- B. Hardware: Corrosion resistant.
- C. Conduit Sleeves and Lintels:
 - 1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.

2. Lintels:
 - a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
 - b. All lintels shall have a minimum of 8" end bearing.
 - c. All lintels in exterior wall construction shall be hot-dip galvanized.
 - d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
 - 1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
 - 2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
 - 3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (llv)
 - 4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (llv)
 - e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.
3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Engineer or Structural Engineer.
4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
10. Size sleeves large enough to allow expansion and contraction movement.

D. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

2.3 FOUNDATION - UNDERGROUND SLEEVES AND SEALS

A. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, raceways passing through foundation walls to an underground condition shall have their annular space (sleeve or drilled hole or not tapered hole made with knockout plug) sealed by properly sized sealing element consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve.
3. Sleeves shall be at least 2 trade sizes larger than the penetrating raceway.
4. Pressure shall be maintained by stainless steel bolts and accessories. Pressure plates may be of composite materials for Models S and OS.
5. Sealing Elements shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant / Stainless	Nitrile	-40°F to 210°F

6. Approved Manufacturers:
 - a. Thunderline Corporation "Link-Seals"
 - b. O-Z/Gedney Company
 - c. Calpico, Inc
 - d. Innerlynx

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- E. Do not use powder-actuated anchors without specific permission.
- F. Do not drill structural steel members.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

- H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.
 - I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting. Provide steel channel supports to stand surface-mounted panelboard or cabinet one inch off wall.
 - J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
 - K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
 - L. Refer to Section 260533 for special conduit supporting requirements.
- 3.2 FINISH
- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
 - B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION 260527

SECTION 260533 - CONDUIT AND BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings (RMC)
- B. Intermediate metallic conduit and fittings (IMC)
- C. Electrical metallic tubing and fittings (EMT)
- D. Flexible metallic conduit and fittings (FMC)
- E. Liquidtight flexible metallic conduit and fittings (LFMC)
- F. Rigid polyvinyl chloride conduit and fittings (PVC)
- G. Wall and ceiling outlet boxes
- H. Electrical connection
- I. Pull and junction boxes

1.2 RELATED WORK

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
 - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
 - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
 - 4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
 - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
 - 6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):
 - 1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
 - 2. A-A-55810 - Specification for Flexible Metal Conduit
- C. NECA "Standards of Installation"
- D. National Electrical Manufacturers Association (NEMA):
 - 1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
 - 2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit

3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
4. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation

E. NFPA 70 - National Electrical Code (NEC)

F. Underwriters Laboratories (UL): Applicable Listings

1. UL 1 - Flexible Metal Conduit
2. UL 6 - Rigid Metal Conduit
3. UL 360 - Liquid Tight Flexible Steel Conduit
4. UL514-B - Conduit Tubing and Cable Fittings
5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
6. UL651-B - Continuous Length HDPE Conduit
7. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
8. UL797 - Electrical Metal Tubing
9. UL1242 - Intermediate Metal Conduit

G. Definitions:

1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

1.4 SUBMITTALS

- A. Include fittings and conduits 1.5" and larger in coordination files. Include all in-floor and underfloor conduit in coordination files. Refer to Section 260500 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Manufacturers:

1. Allied
2. LTV
3. Steelduct
4. Calbond Calpipe
5. Wheatland Tube Co
6. O-Z Gedney
7. or approved equal.

B. Manufacturers of RMC Conduit Fittings:

1. Appleton Electric
2. O-Z/Gedney Co.
3. Electroline
4. Raco
5. Bridgeport
6. Midwest
7. Regal
8. Thomas & Betts
9. Crouse-Hinds
10. Killark
11. Orbit Industries
12. or approved equal.

C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Manufacturers:

1. Allied
2. LTV
3. Steelduct
4. Wheatland Tube Co
5. O-Z Gedney
6. or approved equal.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
- B. Manufacturers of EMT Conduit:
 1. Allied
 2. Calbond Calpipe
 3. LTV
 4. Steelduct
 5. Wheatland Tube Co
 6. or approved equal.
- C. Fittings and Conduit Bodies:
 1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
 2. Larger than 2": Compression type of steel designed for their specific application.
 3. Manufacturers of EMT Conduit Fittings:
 - a. Appleton Electric
 - b. O-Z/Gedney Co.
 - c. Electroline
 - d. Raco
 - e. Bridgeport
 - f. Midwest
 - g. Regal
 - h. Thomas & Betts
 - i. Orbit Industries
 - j. or approved equal.

2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Maximum length of FMC shall be six (6) feet.
- B. Manufacturers:
 1. American Flex
 2. Alflex
 3. Electri-Flex Co
 4. or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:

1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
 - a. O-Z/Gedney Co.
 - b. Thomas & Betts
 - c. Appleton Electric
 - d. Electroline
 - e. Bridgeport
 - f. Midwest
 - g. Regal
 - h. Orbit Industries
 - i. or approved equal.

2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:

1. Anaconda Type UA
2. Electri-Flex Type LA
3. Alflex
4. Carlon (Lamson & Sessions)
5. or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
 - a. Appleton Electric
 - b. O-Z/Gedney Co.
 - c. Electroline
 - d. Bridgeport
 - e. Thomas & Betts
 - f. Midwest
 - g. Regal
 - h. Carlon (Lamson & Sessions)
 - i. Orbit Industries
 - j. or approved equal.

2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

- B. Acceptable Manufacturers:
 - 1. Carlon (Lamson & Sessions) Type 40
 - 2. Cantex, J.M. Mfg.
 - 3. or approved equal.
- C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.7 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.
- B. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast ferrous alloy, or stainless steel deep type, gasketed cover, threaded hubs.
- C. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.8 ECONN; ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.9 JB; PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.
- B. Installation Schedule: Refer to drawings.
- C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- D. Minimum Conduit Size (Unless Noted Otherwise):
 - 1. Above Grade: 3/4 inch.
 - 2. Below Grade 5' or less from Building Foundation: 3/4 inch.
 - 3. Below Grade More than 5' from Building Foundation: 3/4 inch.
 - 4. Controls Conduit: 3/4 inch.
- E. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):
 - 1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
 - 2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.
- D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

- E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.
 - 1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
 - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
 - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

- A. Conduit Connections:
 - 1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
 - 2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
 - 3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
 - 4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.
- B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.
- C. Conduit Bends:
 - 1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
 - 2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
 - 3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
 - 4. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
 - 5. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Refer to Section 260503 for through penetration firestopping requirements.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
10. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
11. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
12. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 UNDERGROUND CONDUIT INSTALLATION

- A. Conduit Connections:
 - 1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.
- B. Conduit Bends (Lateral):
 - 1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
 - 2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Engineer prior to conduit installation to determine bend radius.
- C. Conduit Elbows (vertical):
 - 1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.
- D. Expansion Fittings at Finished Grade: Provide underground raceways with an expansion fitting after emerging from finished grade and exterior equipment pads. Field locate the expansion fitting above and within 24 inches of finished grade. Raceways extending less than 12 inches above finished grade, transitioning to LFMC within 12 inches of finished grade, and interior concrete building slabs do not require an expansion fitting unless required by code.
- E. Conduit Placement:
 - 1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
 - 2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.

3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum $f'c = 2500$ and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

F. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility located within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

G. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.

3.7 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.

3.8 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.

3.9 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.
- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.10 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
 - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
 - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.11 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION 260533

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Adhesive Markings and Field Labels
- B. Nameplates and Signs
- C. Product Colors

1.2 REFERENCES

- A. NFPA 70E - National Electrical Safety Code
- B. NFPA 70 - National Electrical Code (NEC)
- C. ANSI A13.1 - Standard for Pipe Identification
- D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

1.3 QUALITY ASSURANCE

- A. Electrical identification products shall be suitable for the environment installed. Identification labels damaged by the environment due to ultraviolet light fading, damp or wet conditions, physical damage, corrosion, or other conditions shall be replaced with labels suitable for the environment.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 Specifications Sections and under provisions of Section 260500.
 - 1. Product Data for each type of product specified.
 - 2. Schedule of nomenclature to be used for identification signs and labels for each piece of equipment including, but not limited to, the following equipment types as specified in Division 26.
 - 3. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 21/22/23.

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

- A. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- B. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

- C. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.
- D. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- E. Text Sizes:
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Font: Normal 721 Swiss Bold
 - b. Adhesive Labels: 3/16 inch minimum text height
 - c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.
 - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
 - a. Text Height: 3/8 inch minimum
- B. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
 - 1. All Labels: Black letters on white face
 - 2. Normal Power and General Labels: Black letters on white face
 - 3. Control Labels: Black letters on white face
- B. Nameplates and Signs:
 - 1. NORMAL POWER: Black letters on white face
 - 2. Control Labels: Black letters on white face

C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - a. Normal Power and General Distribution: Silver
 - b. Emergency Power Distribution System:
 - 1) All Emergency: Orange
 - 2) Legally Required Standby: Yellow
 - 3) Optional Standby: Orange
 - c. Fire Alarm System: Red
 - d. Temperature Controls: Refer to mechanical cover sheet for color
 - e. Ground: Green
 - f. Low Voltage and Telephone: Purple
 - g. Clock, Sound, Security System, and Intercom: Black

D. Box Covers:

1. Box covers shall be painted to correspond with system type as follows:
 - a. Normal Power and General: Silver
 - b. Fire Alarm System: Red
 - c. Temperature Controls: Refer to mechanical cover sheet for color
 - d. Ground: Green
 - e. Low Voltage and Telephone: Purple
2. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.
- B. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.
- D. Circuit Identification: Tag or label conductors as follows:
 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.

2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- E. Apply Danger, Warning, Caution and instruction signs as follows:
1. Install Danger, Warning, Caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. 'Danger' indicates a hazardous situation which, if not avoided, will result in death or serious injury. ANSI standard red background, white letters.
 3. 'Warning' indicates a hazardous situation which, if not avoided, could result in death or serious injury. ANSI standard orange background, black letters.
 4. 'Caution' indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. ANSI standard yellow background, black letters.
 5. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- F. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- G. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- H. Install ARC FLASH WARNING signs on all power distribution equipment per Section 260573.
- I. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.
1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to conduits concealed within wall.
 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.
- J. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:
1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.

- K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.2 FEEDER AND BRANCH CIRCUIT DIRECTORIES

- A. Product:
 1. Adhesive labels and field markings
 2. Nameplates and signs
- B. Feeder Directories Branch: Provide each feeder, branch circuit, feeder modification, and branch circuit modification with a typed circuit directory label. Refer to technical equipment specification sections for additional requirements. Include the following with each label:
 1. Load Description: Lighting, receptacles, specific equipment, spare, space, or similar description.
- C. Provide a factory or custom clear plastic sleeve for each branch panel directory and secure to inside panel cover.

3.3 CONDUCTOR COLOR CODING

- A. Products:
 1. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers.
- B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
- C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
- D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.
- E. Conductors shall be color coded as follows:
 1. 208Y/120 Volt, 4-Wire:
 - a. A-Phase - Black
 - b. B-Phase - Red
 - c. C-Phase - Blue
 - d. Neutral - White
 - e. Ground Bond - Green

2. 480Y/277 Volt, 4-Wire:
 - a. A-Phase - Brown
 - b. B-Phase - Orange
 - c. C-Phase - Yellow
 - d. Neutral - Gray
 - e. Ground Bond - Green
3. Grounding Conductors:
 - a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
4. Cabling for Remote Control, Signal, and Power Limited Circuits:
 - a. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.

3.4 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

- A. Products:
 1. Nameplates and signs
- B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.
 1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
 2. Labeling shall include:
 - a. Sample Label:

DISTRIBUTION PANEL DP-H1
- C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:
 1. Nominal system voltage, service wire size, quantity, material, distance
 2. Maximum available fault current; refer to one-line diagram for values
 3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 260573 for value.
 4. Date of fault current study; refer to one-line diagram
 5. Date of label
 6. Sample Label:

480Y/277V, 6 SETS 4#750KCM CU, 75FT
 39,800 AMPS AVAILABLE FAULT CURRENT
 0.07 SECOND CLEARING TIME
 DATE OF STUDY: 1 JAN 2017
 DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
 - a. Label: "This equipment is designed with a [system listed below]".
 - b. Applicable Systems:
 - 1) Zone-selective interlocking system for selective coordination and arc energy reduction
 - 2) Differential relaying system for selective coordination and arc energy reduction
 - 3) Arc energy reducing maintenance switch
 - 4) Energy reducing active arc flash mitigation system

E. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.
 - a. Label:
 - 1) Long-time delay:
 - 2) Long-time pickup:
 - 3) Short-time delay:
 - 4) Short-time pickup:
 - 5) Instantaneous:
 - 6) Ground fault delay:
 - 7) Ground fault:
 - b. Sample Label:

Long-time delay:	10.0
Long-time pickup:	1.0
Short-time delay:	0.15
Short-time pickup:	5.0
Instantaneous:	2.0
Ground fault delay:	0.25
Ground fault:	50.0

F. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

G. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

4#3/0 CU & 1#6 CU GND, 125FT
4#250KCM AL & 1#6 GND CU, 125FT
2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

- H. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 260500 for other requirements.

3.5 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

- B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Sample Label:

TRANSFORMER TR-15

END OF SECTION 260553

SECTION 260573 - POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Low voltage distribution system power study.
- B. Short-circuit analysis and report.
- C. Selective coordination analysis and report.
- D. Arc-flash hazard analysis and report.

1.2 RELATED SECTIONS

- A. Section 260500 - Basic Electrical Requirements
- B. Section 262416 - Panelboards

1.3 QUALITY ASSURANCE

- A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections.

1.4 SUBMITTALS

- A. Documentation shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.
- B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths and field investigation of existing equipment types, sizes, ratings provided by the Electrical Contractor.
- C. Documentation of the analyses shall be submitted in a single bound electronic (PDF or equal) format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. The submittal of these related specification sections will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.
- D. Power system study project model shall be submitted on electronic media for review and the Owner's operating and maintenance records.

1.5 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)
- B. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations, latest version
- C. ANSI Z535.4 - Products Safety Signs and Labels

1.6 SCOPE

- A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.
- B. Contractor is required to provide a fully coordinated system for the normal and essential electrical system or essential electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 - PRODUCTS

2.1 POWER SYSTEM STUDY

- A. Power systems study shall be completed in Power Tools for Windows (PTW) version 10 or later version or pre-approved equivalent program.
- B. Power system studies including, but not limited to short-circuit analysis, selective coordination, and arc-flash analysis are inherently iterative in nature. The initial and subsequent analysis commonly requires engineering evaluation, equipment modification, setting adjustments, and revised analysis report. The power system analysis scope shall not be considered complete until all outstanding engineering, equipment and device setting solutions have been resolved and documented by a final report. The power system study vendor shall provide inclusive bid provisions for the initial, subsequent, final analysis and associated reports.

PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

- A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.
- B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.
- C. Short-circuit analysis documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted and made available to the AHJ if requested.

3.2 SELECTIVE COORDINATION ANALYSIS

- A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

- B. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second. Overcurrent protective devices serving the normal shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second.
- C. Existing Distribution, Selective Coordination, and Analysis:
1. The scope of work includes modification, replacement, adjustments, or additions of the emergency distribution system. A complete analysis and evaluation of the existing Emergency and Legally required branches is required in addition to the evaluation and analysis of the new distribution system components.
 2. The contractor shall provide field investigation service to collect all pertinent information required for a complete analysis and evaluation including but not limited to:
 - a. Over Current Protection Device (OCPD): Manufacturer, model, ratings, and settings
 - b. Feeder and Branch Circuit Conductor: Wire gauge sizes, lengths, and material type
 - c. Transformers: Manufacturer, model, transformer KVA, impedance, phase, voltage, configuration
 - d. Transfer Switch: Manufacturer, model, transfer switch voltage, amp rating, 3 or 4 pole configurations, switch style, short circuit withstand current rating
 - e. Emergency Power Supply: Manufacturer, model, power source type, voltage, amperage, ratings, fault current contribution values
 - f. Existing Distribution System Documentation: One line or riser diagram relationship of all distribution equipment including switchboards, switchgear, distribution panels, branch panelboards, transformers, transfer switches, emergency power supply, all line side normal and emergency power systems serving the applicable branches from the main electrical service and emergency power supply to the final branch circuit over current protection device.
- D. Provide trip settings for all (selectively coordinated and non-selectively coordinated) adjustable trip over current protection devices including long time delay, long time pickup, short time delay, short time pickup, instantaneous and ground fault. Selectively coordinated branches shall be based on the selective coordination study results. Non-selective coordinated branches shall be based on the design trip ratings. Provide selective coordination between all ground fault trip settings.
- E. The analysis shall include primary protective device, secondary main switchboard/switchgear device(s), switchboard/switchgear branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.
- F. The analysis shall include all normal, critical, equipment legally required, and optional standby overcurrent protection devices served by the same electrical bus and directly in parallel with the life safety branch requiring selective coordination.
- G. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.
1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.
 2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.

3. Each primary protective device required for the transformer shall be selected so the characteristics or operating band is within the transformer parameters, which shall include a parameter equivalent to 58% of the withstand point to afford protection for secondary line-to-ground faults. The transformer damage curve shall be included for the transformer when the selected protective device is not within the associated parameters.
4. Molded case circuit breakers shall be separated from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.
5. Include zone selective interlocking, differential relaying, and other selective coordination technology in the study when required by other specification sections.
6. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
7. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
 - a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

- H. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.3 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.
- C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
- G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- H. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.
- I. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- J. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- K. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.
- L. Labels shall be vinyl or laminated, with a self-adhesive backing, conform with ANSI Z535.4 Products Safety Signs and Labels standard, and include the following:
 - 1. Arc flash boundary
 - 2. Available incident energy calculated in the analysis and the corresponding working distance, or the arc flash personal protective equipment (PPE category) for the equipment, but not both.
- M. Examples showing the minimum required information follow:
- N. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.4 ADJUSTMENTS

- A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study. Apply settings prior to placing equipment into operation. When the scope of work or execution includes remodel or phases construction, the contractor shall adjust applicable settings as required prior to each system component placed in operation.
- B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. greater than 8 cal/cm^2), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.5 TRAINING

- A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION 260573

SECTION 262200 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dry type two winding transformers

1.2 REFERENCES

- A. NEMA - ST 1 - Specialty Transformers
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
- D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
- E. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 260500.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products under provisions of Section 260500.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 DRY TYPE TWO WINDING TRANSFORMERS

- A. Acceptable Manufacturers:
 - 1. Square D 7400 EX##T / SK300##KB Series
 - 2. Eaton V48M / H48M / B48M Series

- 3. ABB 9T Series
- 4. Siemens 3F3 Series

B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

Ratings	Class	Rise (degree C)
Less than 15	185	As shown on the drawings
or higher	220	As shown on the drawings

D. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on four 3"x3"x1/2" thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.
- E. Install primary, secondary, and grounding electrode conductors using factory or field fabricated enclosure entries. Conductors shall not be routed through ventilated openings.

3.2 FIELD QUALITY CONTROL

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Lighting and appliance branch circuit panelboards

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

1.3 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA FU 1 - Low voltage cartridge fuses
- C. NEMA KS 1 - Enclosed Switches
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
- G. UL 248 - Low-Voltage Fuses
- H. UL 67 - Panelboards

1.4 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 260500.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.
- D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.
- E. Submit manufacturer's instructions under provisions of Section 260500.

1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.

PART 2 - PRODUCTS

2.1 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 260553 for additional requirements.
2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.2 BRANCH CIRCUIT PANELBOARDS

A. General

1. Manufacturers:

- a. Square D NQ, NF
- b. ABB A Series
- c. Siemens P1
- d. Eaton PRL1, PRL2

- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

- C. Enclosure: NEMA PB 1; Type 1.

- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

- K. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- L. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.
- E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

END OF SECTION 262416

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fuses

1.2 REFERENCES

- A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types
- B. UL 198E - Class R Fuses
- C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- D. NEMA FU 1 - Low Voltage Cartridge Fuses
- E. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 260500.

1.4 EXTRA MATERIALS

- A. Provide two fuse pullers.
- B. Provide three of each size and type of fuse installed.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - FUSES

- A. Bussman, Division of Eaton
- B. Edison Fuse, Division of Cooper Industries
- C. Mersen

2.2 FUSES

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

- C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.
- D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.
- E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.
- F. Control transformer fuses: Class CC (time delay).
- G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses where indicated on the drawings and specifications.
- B. Install fuses in accordance with manufacturer's instruction.
- C. Install fuses in packaged equipment as required by equipment manufacturer.
- D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262816 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-fusible switches

1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 260500.
- B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components 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 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Acceptable Manufacturers:
 - 1. Square D 3110 Series
 - 2. Eaton DH Series
 - 3. ABB TH Series
 - 4. Siemens HNF / HF Series
- B. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position.
- C. Enclosures: Type as indicated on the disconnect schedule.

- D. Accessories: Provide the following accessories. Refer to Disconnect Schedule for additional requirements for each application.
 - 1. Lockable
 - 2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Field coordinate installation with other contractors and equipment to maintain code required working space requirements.

END OF SECTION 262816

SECTION 312301 - EXCAVATION AND BACKFILL (SITE)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rough grading and filling the site for base course and paving.
- B. Over excavation and stabilization of unsuitable pavement subgrades.
- C. Excavation and backfill of trenches for utilities.
- D. Final grading of site.

1.2 RELATED SECTIONS

- A. Section 32 13 13 – Concrete Pavement

1.3 REFERENCES

- A. Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- B. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2000a.
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994 (2001).
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2000.
- G. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2001.
- H. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2001.
- I. ASTM D4253 – Standard test Method for Maximum Index Density and Unit Weight of Soils Using a vibratory Table.
- J. ASTM D4254 – Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.4 PROJECT CONDITIONS

- A. Contractor is to provide construction layout stakes for all necessary grading, lines, and control points for the work.
- B. Mark and protect above and below grade utilities that remain.
- C. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs to remain from grading equipment and vehicular traffic.
- D. Protect materials from tracking off site.

PART 2 PRODUCTS

2.1 MATERIALS

- A. HDPE Storm Sewer Pipe Bedding Material: Bedding material shall conform to MDOT specifications and placed in a manner consistent with Section 206 in the direction provided in MDOT specifications.
- B. General Fill: Suitable Subsoil from on site or off-site borrow.
 - 1. Free of organic soil lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 2. Off Site Borrow: Conforming to ASTM D 2487 Group Symbol GC, GW, GM, SC, SM, SW, and SP or a combination of these groups. Soils classified with ASTM D 2487 Group Symbol CL, CL-ML, OR ML may also be used. When using soil classified as CL the liquid limit and plasticity index shall be less than 45 and 20 respectively.
 - 3. Soil conforming to ASTM D 2487 Group Symbol OL, OH, MH, CH, or PT shall not be used under paving, structures, or as backfill around foundations.
- C. Topsoil: Contains at least 3% organic matter, according to ASTM D 2974, has a high degree of fertility, is free of herbicides that prohibit plant growth, has a pH level between 6.0 and 8.0, and meets the following mechanical analysis requirements:

Sieve	Percent Passing
1"	100
1/2"	95 to 97
1/4"	40 to 60
No. 100	40 to 60
No. 200	10 to 30

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey benchmarks and intended elevations for the work are as indicated.
- B. Fill areas in the order shown on the drawings. Other fill sources: Excavations from on-site provided they meet the requirements of 2.1 Materials above.

- C. Topsoil – Salvage from on-site sources if it meets the above criteria. Otherwise, off site material may be brought in.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain, from damage.
- D. Notify utility companies to remove and relocate utilities, as necessary.
- E. Mark and verify removal items and limits.
- F. Protect plant life, lawns, and other features remaining as a portion of the finish landscaping.
- G. Provide separate stockpiles for different soil material types as required.
- H. Comply with the site erosion control plan and permit requirements.
- I. Clean and maintain a tire cleaning area at the entrance to the site during operations.
- J. Protect benchmarks, survey control points, fences, paving, and curbs to remain from excavating equipment and vehicular traffic. Prevent fill materials from tracking off site.

3.3 ROUGH GRADING

- A. Identify required lines, levels, contours, and datum.
- B. Before placing fill, prepare existing ground according to the project soils report, smooth and level the surface of the existing soil and compact using heavy vibratory equipment until there is no loss of elevation. Remove any debris, vegetation, or organic material.
- C. Do not remove wet subsoil unless it is subsequently processed to obtain optimum moisture content.
- D. Prepare subgrades in accordance with Missouri DOT: Standard Specifications for Highway Construction, Latest Edition.
- E. In general, areas within the influence lines of building foundations, walks, and other hard features (cohesive soils) will require 95% Standard Proctor density. Non-cohesive soils in these areas will require 98% Standard Proctor density, (ASTM D698).
- F. Provide allowance for 6" of topsoil in areas adjacent to the building, sidewalk, and in the construction laydown areas. Topsoil must be left smooth, uniform, without debris, lumps, and rocks larger than 1/2" and ready to be seeded by Contractor.
- G. Final landscaping will be performed by the Contractor.
- H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- I. Remove large stones, boulders, and debris from the site. Rough grading shall be finished by blading to reasonably smooth contours with uniform transitions and slopes.

- J. Place and maintain silt fence and other erosion control items to prevent silt from entering adjacent properties or ROW. Comply with erosion control requirements and permit.

3.4 UNDERCUT/STABILIZATION STONE

- A. Provide 12" of additional excavation on and replacement with stabilization backfill of 1" to 3" clean stone.
- B. Procedure to determine need for over excavation and stabilization:
 - 1. Grade surface to proposed subgrade elevation, as relevant to proposed pavement section.
 - 2. Proof roll subgrade under the supervision of the Engineer.
 - 3. Engineer to establish area of need for over excavation and stabilizing.
 - 4. Leave the stabilized subgrade at the appropriate elevation to receive base course as indicated on the pavement section detail.

3.5 SOIL REMOVAL

- A. In areas to receive new construction and where grades are changed, remove all organic soils (topsoil) and fill materials placed without adequate compaction. Store materials for reuse.
- B. Stockpiles: Use areas designated on site or as agreed to; pile depth not to exceed 8 feet; protect from erosion. Grade stockpile area to prevent standing water.

3.6 FINAL GRADING

- A. Before Final Grading:
 - 1. Verify subgrade backfilling has been inspected.
 - 2. Verify subgrade has been contoured and compacted.
 - 3. Verify utility excavation is complete, utilities are installed, tested, and are ready for use.
- B. Remove any subgrade debris, roots, branches, stones, in excess of 1/2 inch in size.
- C. Verify landscape locations and depths to receive topsoil.

3.7 TOLERANCES

- A. Top Surface of Subgrade areas: Plus, or minus 0.08 foot from required elevation.
- B. Grading around buildings, between curbs, adjacent to sidewalks as final surfaces, slope to drain and plus or minus .05 foot.

3.8 TESTING

- A. Verify soil materials comply with Section 2.1 above.
- B. Verify that the Contractor's testing agency has moisture density curves for the material and is ready to perform testing.

- C. Spread soils in loose lifts not to exceed 8" in depth. Disk or dry soils to optimum moisture plus or minus 2% prior to applying compactive effort. Roll as required to obtain density. Adjust moisture content by adding water or disking as needed to reach moisture required. No additional pay allowance will be made for moisture adjustment.
- D. Shape fills such that water does not pond.
- E. Additional lifts may not be made unless the density requirements are met on the in-place lift.
- F. Density testing will be performed at the intervals specified by the Owner's independent testing company. Initially testing will be required continuously until the required densities are achieved and a workable process is in place. Continuous testing will start again if the material source changes, or the Contractor's quality assurance testing indicates the results are inconsistent.

3.9 CLEANING AND PROTECTION

- A. Leave site clean uniform, ready to receive future work or temporary seeding. Clean mud from the tire cleaning area and the accessway periodically during the work.
- B. Remove sediment from site as needed, and at project completion, prior to final topsoil application.
- C. Rake and clean entire disturbed areas for seeding.

END OF DOCUMENT 312301

SECTION 321313 - CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-structural concrete flatwork.
- B. Compacted granular base.
- C. Backfilling form lines with appropriate material.
- D. Miscellaneous Concrete.

1.2 RELATED SECTIONS

- A. Section 312301 – Excavation and Backfill (Site)

1.3 REFERENCES

- A. Missouri Department of Transportation (MDOT): Standard Specification for Highway Construction, Latest Edition.

1.4 PROJECT CONDITION

- A. Verify that subgrade elevations meet tolerances in Section 31 23 01 Excavation and Backfill (Site).
- B. Provide sufficient paving operations to meet project schedule and requirements.
- C. Verify that survey benchmarks and intended elevations for the Work are as indicated, and that building floor elevations, curb elevations, and pavement elevations are clear and coordinated prior to commencing.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All products must meet or exceed the requirements of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- B. Portland Cement Concrete Pavements and Sidewalks as per Division 500 of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- C. Miscellaneous Concrete shall conform to Division 500 of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.

- D. Aggregate Base: shall conform to the material requirements of Section 203.4.4.2.1 (a) or (b) of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- E. Provide from a Missouri DOT certified source, P.C. concrete meeting all of the following characteristics:
 - Compressive Strength at 28 days: 4,000 psi.
 - Slump: 4 inches maximum.
 - Air Entrainment: 5 - 8 percent.

2.2 ACCESSORIES

- A. None

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify gradients and elevations of base.
- B. Verify compacted sub-grade is dry and ready to support paving and imposed loads.
- C. Verify that all utilities within the work area have been installed, tested, and are ready to be paved over.

3.2 PREPARATION

- A. Scarify sub-grade surface to a depth of 6 inches in all areas compacted by construction activities prior to placing fill.
- B. Cut out soft areas of sub-grade not capable of compaction in place. Backfill with aggregate or recycled concrete, of which shall meet the material requirements of Section 203.4.4.2.1 (a) or (b) and have a 1-1/2" to 3" topsize with 100 % \pm 5%, retained on a 1" screen. AASHTO Gradation #2 or #3 are acceptable materials.
- C. Compact sub-grade to density equal to or greater than the requirements for subsequent fill material.
- D. Moisten substrate to minimize absorption of water from fresh concrete.

3.3 BASE CONSTRUCTION

- A. Fill areas to contours and elevations using unfrozen materials.
- B. Place aggregate fill materials in continuous layers not exceeding 8" on top of geotechnical fabric (if specified).
- C. Aggregate Base: Verify specific aggregate bases needed for individual pavement sections, as they differ. Compact aggregates in 8" deep lifts maximum, within 0 to +4% above optimum moisture content, and compact each lift by approved methods to not less than 95% of the maximum density given by ASTM D698 (Standard Proctor Density). Keep compacted lifts relatively smooth and level.

- D. Maintain optimum moisture content of fill materials to attain required compaction density.

3.4 FORMING

- A. Place and secure forms to correct location, dimension, and profile.
- B. Place joint filler in joints, vertical in position, in straight lines. Secure to formwork.
- C. Place joint filler between paving components and other appurtenances.

3.5 PLACING CONCRETE

- A. Mixing and handling of fresh concrete, including transit time, shall be as per Section 501 of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- B. Place Portland Cement Concrete in accordance with Section 500 of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.

3.6 FINISHING

- A. Paving shall be finished according to Section 500 of the Missouri Department of Transportation (MDOT): Standard Specifications for Highway Construction, Latest Edition.
- B. Architecturally treated surfaces must be water cured unless membrane curing can be demonstrated which does not alter the appearance of the work. Adjacent facilities and vehicles must be protected if membrane curing is used.

3.7 TOLERANCES

- A. Flatness: Maximum variation of one-quarter inch in ten feet as measured with a ten-foot straight edge.
- B. Compacted Scheduled Thickness (sub-grades): Within one-quarter inch of design thickness.
- C. Variation from True Elevation: One half inch.

3.8 TESTING

- A. Contractor furnished testing.

3.9 JOINTS

- A. Joints shall be tooled.
- B. 5" PCC pavement shall be jointed at 10 feet maximum O.C. All cold joints shall be doweled. Jointing shall be in accordance with SUDAS standard detail 7010.101.

- C. 10" PCC pavement shall be jointed at 20 feet maximum O.C. All cold joints shall be doweled. Jointing shall be in accordance with SUDAS standard detail 7010.101. Longitudinal joints shall be type "L-1" or "KT-1". Transverse joints shall be type "CD".
- D. Joints shall be sealed with a polyurethane sealant, color matched to the finished concrete color. Paving joints in the vehicular use areas shall be hot sealed.

END OF DOCUMENT 321313

APPENDIX A

REFERENCES

References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Comply with the publication in effect as of date of the Contract Documents. Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z9.2 (1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems

ANSI Z87.1 (1989; Errata; Z87.1a) Occupational and Educational Eye and Face Protection

ANSI Z88.2 (1992) Respiratory Protection

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 732 (1995) Aging Effects of Artificial Weathering on Latex Sealants

ASTM D 522 (1993a) Mandrel Bend Test of Attached Organic Coatings

ASTM D 1331 (1989; R 1995) Surface and Interfacial Tension of Solutions of Surface-Active Agents

ASTM D 2794 (1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

ASTM D 4397 (1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

ASTM E 84 (1998e1) Surface Burning Characteristics of Building Materials

ASTM E 96 (1995) Water Vapor Transmission of Materials

ASTM E 119 (1998) Fire Tests of Building Construction and Materials

ASTM E 736 (1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members

ASTM E 1368 (2007) Visual Inspection of Asbestos Abatement Projects

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1926 Safety and Health Regulations for Construction

40 CFR 61 National Emissions Standards for Hazardous Air Pollutants 40 CFR 763
Asbestos

42 CFR 84 Approval of Respiratory Protective Devices 49 CFR 107 Hazardous
Materials Program Procedures

49 CFR 171 General Information, Regulations and Definitions

49 CFR 172 Hazardous Materials Table, Special Provisions, Hazardous Materials
Communications, Emergency Response Information, and Training Requirements

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7 (1990) Compressed Air for Human Respiration

CGA G-7.1 (2007) Commodity Specification for Air

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90-018 (1990) Asbestos/NESHAP Regulated Asbestos Containing
Materials Guidance

EPA 340/1-90-019 (1990) Asbestos/NESHAP Adequately Wet Guidance

EPA 560/5-85-024 (1985) Guidance for Controlling Asbestos-Containing Materials
in BUILDING

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701 (1996; TIA 96-1, 96-2) Methods of Fire Tests for Flame-Resistant
Textiles and Films

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH Pub No. 84-100 (1984; Supple 1985, 1987, 1988 & 1990)

NIOSH Manual of Analytical Methods

UNDERWRITERS LABORATORIES (UL)

UL 586 (1996) High-Efficiency, Particulate, Air Filter Units

MISSOURI DEPARTMENT OF NATURAL RESOURCES (MDNR)

10 CSR 10-6.240 TO 250 Asbestos Abatement Projects - Certification, Accreditation and Business Exemptions Requirements

10 CSR 25-16.273 - Missouri Hazardous Waste Management Law and Regulations

References, Page 2 of 3

MISSOURI DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

House Bill 1549; Sections 285.525 - 285.550

STATE OF MISSOURI

Section 285.525 - 285.550; Effective January 1, 2009

APPENDIX B

DEFINITIONS

Definitions

Accident Prevention Plan: A document that outlines occupational safety and health policy, responsibilities, and program requirements.

Activity Hazard Analysis: A document process by which the steps (procedures) required to accomplish a work activity is outlined, the actual or potential hazards of each step are identified and measures for the elimination or control of those hazards are developed.

Adequately Wet: A term defined in 40 CFR 61, Subpart M, and EPA 340/1-90-019 meaning to sufficiently mix or penetrate with liquid to prevent the release of particulate. (Visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.

Aggressive Method: Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact asbestos-containing material (ACM).

Amended Water: Water containing a wetting agent or surfactant with a surface tension of at least 29 dynes per square centimeter when tested in accordance with ASTM D 1331.

Asbestos: Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered.

Asbestos-Containing Material (ACM): Any materials containing more than one percent asbestos.

Asbestos Fiber: A particulate form of asbestos, 5 micrometers or longer, with a length-to-width ratio of at least 3 to 1.

Asbestos Hazard Abatement Plan: A written plan detailing compliance with OSHA, EPA, State of Missouri and local asbestos abatement requirements.

Authorized Person: Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

Building Inspector: Individual who inspects BUILDING for asbestos and has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

Certified Industrial Hygienist (CIH): An Industrial Hygienist certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.

Class I Asbestos Work: Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM.

Class II Asbestos Work: Activities defined by OSHA involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos - containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glove bag may be classified as a Class 111 job.

Class III Asbestos Work: Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is actively disturbed or asbestos-containing debris is actively disturbed.

Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.

Clean room: An uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.

Competent Person: One who can identify existing and predictable hazards in the working environment or working conditions that are dangerous to personnel and who has authorization to take prompt corrective measures to eliminate them.

Confinement Curtain: A curtain that is intended to restrict the movement of air into, and from, an unventilated and contaminated area. This curtain shall consist of three constructed baffles that covers the entire area of the entryway and are securely fastened across the top of the entryway framework and along alternate sides of it at locations and in a manner that will allow two of the curtains to fully cover the entryway opening while a person passes through the third curtain. The curtain shall be constructed of not less than six-mil plastic sheeting.

Critical Barrier: One or more layers of plastic sealed over all openings into-a regulated area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in a regulated area from migrating to an adjacent area.

Decontamination Area: An enclosed area adjacent and connected to the regulated area

and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

Demolition: The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

Designated Competent Person: In addition to the definition in 29 CFR 1926, Section .32(f), a person who is capable of identifying existing asbestos hazards as defined in 29 CFR 1926, Section 1101, selecting the appropriate control strategy, has the authority to take prompt corrective measures to eliminate them and has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

Disposal Bag: A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926, Section 1101, used for transporting asbestos waste from containment to disposal site.

Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glove bag or waste bag, not larger than 1.5 m 60 inches in length and width in order to access a building component.

Equipment Room or Area: An area adjacent to the regulated area used for the decontamination of employees and their equipment.

Employee Exposure: That exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

Fiber: A fibrous particulate, 5 micrometers or longer, with a length to width ratio of at least 3 to 1.

Friable ACM: A term defined in 40 CFR 61, Subpart M and EPA 340/1-90-018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent, as determined by a method other than point counting by PLM, the asbestos content is verified by point counting using PLM.

Glove bag: Not more than a 1.5 by 1.5 m 60 by 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled. Have no seams on the bottom of the bag.

High-Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

Homogeneous Area: An area of surfacing material or thermal system insulation that is uniform in color and texture.

Industrial Hygienist: A professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational health hazards.

Intact: ACM which has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix. Removal of "intact" asphaltic, resinous, cementitious products does not render the ACM non-intact simply by being separated into smaller pieces.

Model Accreditation Plan (MAP): USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763, Subpart E, and Appendix C.

Modification: A changed or altered procedure, material or component of a control system, which replaces a procedure, material or component of a required system.

Negative Exposure Assessment: A demonstration by the Contractor to show that employee exposure during an operation is expected to be consistently below the OSHA Permissible Exposure Limits (PELs).

NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.

Nonfriable ACM: A NESHAP term defined in 40 CFR 61, Subpart M and EPA 34011-90-018

Meaning any material containing more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

Nonfriable ACM (Category I): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 34011-90-018 meaning asbestos-containing packing's, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy.

Nonfriable ACM (Category II): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90-018 meaning any material, excluding Category I nonfriable ACM,

containing more than 1 percent asbestos, as determined using the methods specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Permissible Exposure Limits (PELs): (1) PEL-Time weighted average(TWA): Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (flee) as an 8 hour time weighted average (TWA), as determined by the method prescribed in 29 CFR 1926, Section 1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400. (2) PEL-Excursion Limit: An airborne concentration of asbestos not in excess of 1.0 *flee* of air as averaged over a sampling period of 30 minutes as determined by the method prescribed in 29 CFR 1926, Section 1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.

Qualified Person: One who, by possession of a recognized degree, certificate, or professional standing, or extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems related to the subject matter, the work, or the project.

Regulated Area: An OSHA term defined in 29 CFR 1926, Section 1101 meaning an area established by the Contractor to demarcate areas where Class I, II, and III asbestos work is conducted; also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.

Removal: All operations where ACM is taken out or stripped from structures or substrates, and include demolition operations.

Repair: Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM attached to structures or substrates. If the amount of asbestos is so disturbed it cannot be contained in 1 standard glove bag or waste bag, Class I precautions are required.

Spills/Emergency Cleanups: Cleanup of sizable amounts of asbestos waste and debris which has occurred, for example, when water damage occurs in a building, and sizable amounts of ACM are dislodged. A Competent Person evaluates the site and ACM to be handled, and based on the type, condition and extent of the dislodged material, classifies the cleanup as Class I, II, or III. Only if the material was intact and the cleanup involves mere contact of ACM, rather than disturbance, could there be a Class IV classification.

Supervisor: Individual who supervises asbestos abatement work and has EPA Model Accreditation Plan "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, and Appendix C.

Surfacing ACM: Asbestos-containing material which contains more than 1% asbestos and is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and Definitions, Fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.

Thermal system insulation (TSI) ACM: ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.

Transite: A generic name for asbestos cement wallboard and pipe.

Ventilation Curtain: A curtain that is intended to allow unrestricted air flow movement into a contaminated area when it is being ventilated with an exhaust fan. This curtain shall consist of a single flap that opens into the contaminated area and is securely fastened across the top of the entryway framework in a manner that will allow it to overlap both sides of the entryway by a distance of no fewer than 12 inches and base of the entryway by a distance of no fewer than three inches.

The curtain shall be constructed of not less than six-mil plastic sheeting. Definitions, Worker: Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926, Section 1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation required by 40 CFR 763, Subpart E, Appendix C, if required by the OSHA Class of work to be performed or by the state where the work is to be performed.

APPENDIX C

CERTIFICATE OF WORKERS ACKNOWLEDGMENT

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME: MARYVILLE TREATMENT CENTER

PROJECT ADDRESS: Maryville, Missouri 64468

ABATEMENT

CONTRACTOR: _____

WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the owner for the above referenced project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided to at no cost to you. By signing this certificate you are indicating to the Government that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of, or access to, the respiratory protection manual issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project

MEDICAL EXAMINATION: I have had a medical examination and a blood lead level test within the last 12 months which was paid for by my employer. This examination included: Health History, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. I was personally informed of the results of that examination and any medical conditions resulting from asbestos/lead exposure. My employers Component Person and/or Industrial hygienist evaluated the medical certification provided by the physician. The physical examination determination that there (were / were no) limitations to performing the required work.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

- | | |
|--|--|
| Physical characteristics of asbestos | Respiratory protection |
| Health Hazards associated with asbestos | Use of protective equipment |
| Negative air/pressure differential systems | Work practices including hands on or on-job training |
| Personal decontamination procedures | Air monitoring, personal and area |

Print Name

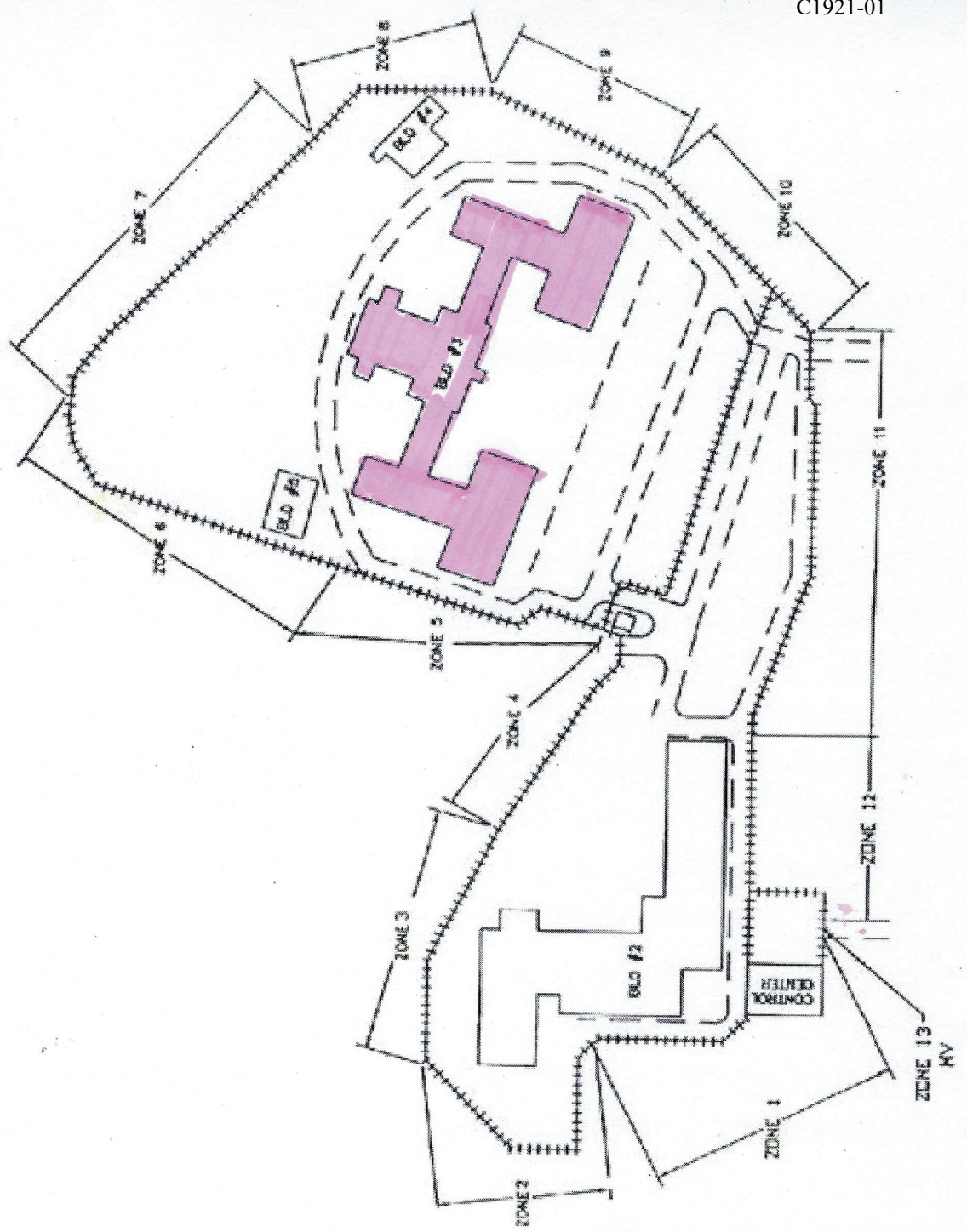
Worker's Signature

Date

Attach Current refresher and Missouri certificate, current fit test, medical and OSHA Training / Public Work certificate to this form.

APPENDIX D

FACILITY MAP



APPENDIX E

Asbestos Abatement Drawings

On this project, the Asbestos Abatement Drawings are not included in Appendix E. Refer to sheets ENV100 and ENV200 in the project drawing set.

APPENDIX F

ASBESTOS CONTAINING BUILDING MATERIAL (ACBM) SCHEDULES

Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: Pipe Tunnels

ACBM (Asbestos Containing Building Material) SCHEDULE

Roth Environmental Consultants, Inc.

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019

Building Name: Building 3

Project # 103-AI-2019.001

Address: 30227 US Highway 136, Maryville, Missouri 64468.

Inspector: Mark Liechti & Kody Tramm

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3	Pipe Tunnel									
	Steam line	TI	12"		120'					
		MF	12"	0						
		MH	12"	18						
	Steam line	TI	6"		120'					
		MF	6"	0						
		MH	6"	42						
	Hot water	TI	4"		120'					
		MF	4"	0						
		MH	4"	18						
	Cold water	TI	4"		120"					
		MF	4"	0						
		MH	4"	18						
	Return	TI	4"		120'					
		MF	4"	0						
		MH	4"	18						
	Supply	TI	2"		112'					
	(to registers	MF	2"	84						
	above floor)	MH	2"							
	Return (from)	TI	2"		112'					
		MF	2"							
		MH	2"							
	TI - thermal insulation			FT - floor tile				TP - transite panels		
	LF - linear feet			CT - ceiling tile				BA - baseboard adhesive		
	FD - Fire Doors			MF - mudded fittings				NF - non-friable		
				MH- Mudded Hangers				SF - square feet		

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-A1-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
--------------	-------------------	---------------	------	--------------	-----------------	-------	---------	-----------------	-----------------	-------------------

Runs Verticle to floor above)										
4	Pipe Tunnel	TI	6"							
	Top Steam line	MF	6"	4	135'					
		MH	6"	19						
	Hot water	TI	4"		21'					
		MF	4"	3						
		MH	4"	2						
	Cold water	TI	4"		21'					
		MF	4"	3						
		MH	4"	2						
	Return	TI	4"		21'					
		MF	4"	1						
		MH	4"	2						
	Hot water	TI	2"		72'					to registers above, next floor.
		MF	2"	63						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"		72'					
	(from Register)	MF	2"							ittings unknown, in walls
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Roth Environmental Consultants, Inc.

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019

Building Name: Building 3 Project # 103-AI-2019.001

Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
5 Pipe Tunnel										
	Steam line	TI	6"		72					
		MF	6"	42						
		MH	6"	0						
	Steam line	TI	6"		48'					
		MF	6"	0						
		MH	6"	6						
	Hot water	TI	4"		48'					
		MF	4"	0						
		MH	4"	5						
	Cold water	TI	4"		48'					
		MF	4"	0						
		MH	4"	5						
	Return	TI	4"		48'					
		MF	4"	0						
		MH	4"	5						
6 Pipe Tunnel										
	Top Steam line	TI	6"							Pipe tunnel 6 all fiberglass-appears abated
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
TI - thermal insulation										
LF - linear feet										
FD - Fire Doors										
				FT - floor tile			TP - transite panels			
				CT - ceiling tile			BA - baseboard adhesive			
				MF - mudded fittings			NF - non-friable			
				MH- Mudded Hangers			SF - square feet			

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
11	Top Steam line	TI	6"		58'					
		MF	6"							
		MH	6"	4						
	Hot water	TI	2"							to registers, above floor
	(to registers)	MF	2"	63						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"			63				fittings unknown, in walls
		MH	2"							
12	Pipe Tunnel									
	Top Steam line	TI	6"		63'					
		MF	6"							
		MH	6"	5						
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	2"							to registers, above floor.
	(to registers)	MF	2"			63				
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
	MH	2"								
Return	TI	2"			63				fittings unknown, in walls.	
	MF	2"								
	MH	2"								

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
13	Pipe Tunnel									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"		28'					
		MF	6"	1						
		MH	6"	2						
	Hot water	TI	4"		10'					
		MF	4"	2						
		MH	4"	2						
	Cold water	TI	4"		10'					
		MF	4"	2						
		MH	4"	2						
Return	TI	4"								
	MF	4"								
	MH	4"								
14	Pipe Tunnel									
	Top Steam line	TI	6"		46'					
		MF	6"							
		MH	6"	5						
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"		46'					
		MF	4"							
		MH	4"	5						
	Cold water	TI	4"		46'					
		MF	4"							
		MH	4"	5						
Return	TI	4"								
	MF	4"								
	MH	4"								

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
14	Pipe Tunnel									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	2"		32'					to registers, above floor
	(to registers)	MF	2"	28						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"		32'					fittings unknown, in walls.
		MF	2"							
		MH	2"							
	Pipe Tunnel									
	Top Steam line	TI	10"							
		MF	10"							
		MH	10"							
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
	thermal insulation									

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
15	Pipe Tunnel									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"							
		MF	6"	2		36'				
		MH	6"	4						
	Hot water	TI	4"			36'				
		MF	4"	2						
		MH	4"	4						
	Cold water	TI	4"			36'				
		MF	4"	2						
		MH	4"	4						
	Return	TI	4"			36'				
		MF	4"	2						
	MH	4"	4							
16	Pipe Tunnel									
	Top Steam line	TI	10"			110'				
		MF	10"	2						
		MH	10"	21						
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"			110'				
		MF	4"	5						
		MH	4"	20						
Cold water	TI	4"			110'					
	MF	4"	5							
	MH	4"	20							
Return	TI	4"								
	MF	4"								
	MH	4"								

TI - thermal insulation
 LF - linear feet
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 TP - transite panels
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ACBM (Asbestos Containing Building Material) SCHEDULE

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
17	Pipe Tunnel									
	Steam line	TI	10"							
		MF	10"	9						
		MH	10"	7						
	Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"			54'				
		MF	4"	7						
		MH	4"	7						
	Cold water	TI	4"			54'				
		MF	4"	7						
		MH	4"	7						
	Return	TI	4"							
		MF	4"							
		MH	4"							
	18	Pipe Tunnel								
Top Steam line		TI	10"							
		MF	10"							
		MH	10"							
Bottom Steam line		TI	6"			18'				
		MF	6"	1						
		MH	6"	2						
Hot water		TI	4"			18'				
		MF	4"	2						
		MH	4"	3						
Cold water		TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
TI - thermal insulation										
LF - linear feet										
FD - Fire Doors										

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ACBM (Asbestos Containing Building Material) SCHEDULE

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
18	Pipe Tunnel									
(cont.)	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	2"		24					to registers, above floor
	(to registers)	MF	2"	20						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"		24					fittings unknown, in walls.
		MF	2"							
		MH	2"							
	Pipe Tunnel									
	Top Steam line	TI	10"							
		MF	10"							
		MH	10"							
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
	thermal insulation	TI	4"							
	linear feet									
	Fire Doors									

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
19	Pipe Tunnel									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"		28'					
		MF	6"	1						
		MH	6"	6						
	Hot water	TI	4"		28'					
		MF	4"	1						
		MH	4"	4						
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
	Hot water	TI	2"		42'					to registers, above floor
	(to registers)	MF	2"	36						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"		42'					fittings unknown, in walls.
		MF	2"							
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Thermal insulation	TI								
	Linear feet									
	Fire Doors									

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 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
20	Pipe Tunnel									
	Top Steam line	TI	10"							
		MF	10"							
		MH	10"							
	Bottom Steam line	TI	6"		80'					
		MF	6"							
		MH	6"	14						
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
	Pipe Tunnel									
	Top Steam line	TI	10"							
		MF	10"							
		MH	10"							
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
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 MH - Mudded Hangers
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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
21	Pipe Tunnel									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"		28'					
		MF	6"	1						
		MH	6"	6						
	Hot water	TI	4"		28'					
		MF	4"	1						
		MH	4"	4						
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							
	Hot water	TI	2"		77'					to registers, above floor
	(to registers)	MF	2"	66						
		MH	2"							
	Cold water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"		77'					fittings unknown, in walls.
		MF	2"							
		MH	2"							

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 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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Space Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	Attic- C Side									
	Steam line	TI	12"							
		MF	12"							
		MH	12"							
	Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	2"		401'					
		MF	2"	57						
		MH	2"	43						
	Return	TI	4"							
		MF	4"							
		MH	4"							
	Top Steam line	TI	10"							
		MF	10"							
		MH	10"							
	Bottom Steam line	TI	6"							
		MF	6"							
		MH	6"							
	Hot water	TI	4"							
		MF	4"							
		MH	4"							
	Cold water	TI	4"							
		MF	4"							
		MH	4"							
	Return	TI	4"							
		MF	4"							
		MH	4"							

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 MH - Mudded Hangers
 TP - transite panels
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 NF - non-friable
 SF - square feet

Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: Basement

ACBM (Asbestos Containing Building Material) SCHEDULE

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Building Name: Building 3 Project # 103-AI-2019.001
Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
141	Hot water	TI	2"	2	12'					Rm. 120
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
142	Hot water	TI	2"	2	12'					Rm. 120
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
143	Hot water	TI	2"	2	12'					staircase
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
144	Hot water	TI	2"	2	12'					Rm. 118
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							

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FD - Fire Doors
FT - floor tile
CT - ceiling tile
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TP - transite panels
BA - baseboard adhesive
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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	Main Bldg Heating Registers-Basement									
145	Hot water	TI	2"		12'					West side of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
146	Hot water	TI	2"		12'					West side of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
147	Hot water	TI	2"		12'					West side of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
148	Hot water	TI	2"		12'					West side of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
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 FD- Fire Doors

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 BA - baseboard adhesive
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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
149	Main Bldg Heating Registers-Basement	TI	2"		12'					West side of Rm. 117
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
168	Hot water	TI	2"		12'					Rm. 123
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
169	Hot water	TI	2"		12'					Corridor east of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
170	Hot water	TI	2"		12'					Corridor east of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C:1921-01 Hazardous Materials Investigation Date: September 6, 2019
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 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
Main Bldg Heating Registers-Basement										
171	Hot water	TI	2"	2	12'					Corridor east of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
172	Hot water	TI	2"	2	12'					Corridor east of Rm. 117
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
173	Hot water	TI	2"	2	12'					Rm. 122
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
174	Hot water	TI	2"	2	12'					Rm. 122
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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 MH - Mudded Hangers
 TP - transite panels
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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	Main Bldg Heating Registers-Basement									
175	Hot water	TI	2"		12'					Rm. 122
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							

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 LF - linear feet
 FD- Fire Doors

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 MH- Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kodj Tramm

Register Number	Space Description East Wing-Heating Registers	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1	Hot water	TI	2"		12'					Rm. 129
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
2	Hot water	TI	2"		12'					Rm. 129
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
3	Hot water	TI	2"		12'					Rm. 129 closet
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
4	Hot water	TI	2"		12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 FD- Fire Doors
 FT - floor tile
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 MF - mudded fittings
 MH- Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Unts	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	East Wing-Heating Registers									
5	Hot water	TI	2"		12'					hallway outside Rm. 129B
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
6	Hot water	TI	2"		12'					Rm. 129A
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
7	Hot water	TI	2"		12'					N. side of hallway to Main Bldg. to west
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
8	Hot water	TI	2"		12'					N. side of hallway to Main Bldg. to west
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C:1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
East Wing Heating Registers										
9	Hot water	TI	2"		12'					N. side of hallway to Main Bldg. to west
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
10	Hot water	TI	2"		12'					S. side of hallway to Main Bldg. to west
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
11	Hot water	TI	2"		12'					S. side of hallway to Main Bldg. to west
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
12	Hot water	TI	2"		12'					Rm. 112
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
East Wing Heating Registers										
13	Hot water	TI	2"		12'					N/S hallway west of Rm. 131
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
14	Hot water	TI	2"		12'					N/S hallway west of Rm. 131
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
15	Hot water	TI	2"		12'					N/S hallway west of Rm. 131
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
16	Hot water	TI	2"		12'					N/S hallway west of Rm. 131
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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TP - transite panels
 BA - baseboard adhesive
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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AL-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
17	Hot water	TI	2"		12'					Rm. 140
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
18	Hot water	TI	2"		12'					Rm. 140
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
19	Hot water	TI	2"		12'					Rm. 130
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
20	Hot water	TI	2"		12'					Rm. 120
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 FD - Fire Doors
 FT - floor tile
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AL-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Notes - Condition
21	Hot water	TI	2"	2	12'			E. of Rm. 130 in its own room
	Return	MH	2"					
	Return	TI	2"	2	12'			
		MF	2"					
		MH	2"					
22	Hot water	TI	2"	2	12'			Rm. 136
	Return	MH	2"					
	Return	TI	2"	2	12'			
		MF	2"					
		MH	2"					
23	Hot water	TI	2"	2	12'			Rm. 135
	Return	MH	2"					
	Return	TI	2"	2	12'			
		MF	2"					
		MH	2"					
24	Hot water	TI	2"	2	12'			Rm. 24
	Return	MH	2"					
	Return	TI	2"	2	12'			
		MF	2"					
		MH	2"					

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 FD- Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH- Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	East Wing Heating Registers									
25	Hot water	TI	2"		12'					Rm. 133
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
26	Hot water	TI	2"		12'					Rm. 133
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
27	Hot water	TI	2"		12'					Rm. 132
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
28	Hot water	TI	2"		12'					Rm. 131 (east wall)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
29	Hot water	TI	2"		12'					Rm. 131 (east side)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
30	Hot water	TI	2"		12'					small Rm. North of Rm. 131
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"	2						
		MH	2"							
	Return	TI	2"							
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"	2						
		MH	2"							
	Return	TI	2"							
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-A1-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1	Heating Registers									
	Hot water	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
2	Hot water	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
3	Hot water	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
4	Hot water	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	Heating Registers									
5	Hot water	TI	2"		12'					small room
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
6	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
7	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
8	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
West Wing Heating Registers										
9	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
10	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
11	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
12	Hot water	TI	2"		12'					Rm. 113
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
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 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
Heating Registers										
13	Hot water	TI	2"		12'					Rm 112
		MF	2"	2						
		MH	2"							
Return	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
14	Hot water	TI	2"		12'					Rm. 112
		MF	2"	2						
		MH	2"							
Return	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
15	Hot water	TI	2"		12'					Rm. 112
		MF	2"	2						
		MH	2"							
Return	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
16	Hot water	TI	2"		12'					Rm. 109
		MF	2"	2						
		MH	2"							
Return	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C:1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AL-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kodv Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
21	Heating Registers	TI	2"		12'					Rm. 106	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
22	Hot water	TI	2"		12'					Rm. 106	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
23	Hot water	TI	2"		12'					Rm. 106	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
24	Hot water	TI	2"		12'					Staircase	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								

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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
25	Heating Registers									
	Hot water	TI	2"		12'					Rm. 104
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
26	Hot water	TI	2"		12'					Rm. 104
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
27	Hot water	TI	2"		12'					Rm. 104
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
28	Hot water	TI	2"		12'					Rm. 104
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 MH- Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-A1-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
29	Heating Registers									
	Hot water	TI	2"		12'					Rm. 103
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
30	Hot water	TI	2"		12'					Rm. 102
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
31	Hot water	TI	2"		12'					Rm. 101a
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
32	Hot water	TI	2"		12'					Hallway
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kodj Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
33	Heating Registers	TI	2"		12'					Hallway
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
34	Hot water	TI	2"		12'					Hallway
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
35	Hot water	TI	2"		12'					Hallway
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
36	Hot water	TI	2"		12'					Hallway
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: 1st Floor

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-Main Bldg. Heating Registers									
153	Hot water	TI	2"	2	12'					Transept area in NE corner of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
154	Hot water	TI	2"	2	12'					east side of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
155	Hot water	TI	2"	2	12'					east side of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
156	Hot water	TI	2"	2	12'					east side of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

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 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
157	1st floor-Main Bldg. Heating Registers									
	Hot water	TI	2"	2	12'					east side of Sunctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
158	Hot water	TI	2"		12'					Rm. 225
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
159	Hot water	TI	2"		12'					Rm. 225
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
160	Hot water	TI	2"		12'					Rm. 226
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-Main Bldg. Heating Registers									
161	Hot water	TI	2"	2	12'					Rm. 226
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
162	Hot water	TI	2"		12'					Toilet area in Rm. 227
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
163	Hot water	TI	2"		12'					Rm. 227
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
164	Hot water	TI	2"		12'					Rm. 227 -west wall
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1st floor-Main Bldg. Heating Registers										
165	Hot water	TI	2"	2	12'					Rm. 223
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
166	Hot water	TI	2"	2	12'					NW corner of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
167	Hot water	TI	2"	2	12'					West side of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
168	Hot water	TI	2"	2	12'					West side of Sanctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
169	1st floor-Main Bldg. Heating Registers									
	Hot water	TI	2"	2	12'					West side of Sunctuary
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
170	Hot water	TI	2"	2	12'					SW corner of Sunctuary next to Confessional
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
171	Hot water	TI	2"	2	12'					SW staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
172	Hot water	TI	2"	2	12'					SE corner toilet area
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
173	Hot water	TI	2"	2	12'					West side of Sanctuary
		MF	2"							
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							

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	1st floor-East Wing Heating Registers									
32	Hot water	TI	2"		12'					E. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
33	Hot water	TI	2"		12'					E. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
34	Hot water	TI	2"		12'					E. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
35	Hot water	TI	2"		12'					N side of coridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1st floor-East Wing Heating Registers										
36	Hot water	TI	2"		12'					N. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
		MH	2"							
37	Hot water	TI	2"		12'					W. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
		MH	2"							
38	Hot water	TI	2"		12'					W. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
		MH	2"							
39	Hot water	TI	2"		12'					W. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-East Wing Heating Registers									
40	Hot water	TI	2"		12'					W. side of Rm. 230
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
41	Hot water	TI	2"		12'					N. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
42	Hot water	TI	2"		12'					N. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
43	Hot water	TI	2"		12'					N. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1st floor-East Wing Heating Registers										
44	Hot water	TI	2"		12'					S. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
45	Hot water	TI	2"		12'					S. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
46	Hot water	TI	2"		12'					S. side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
47	Hot water	TI	2"		12'					Rm. 250
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-East Wing Heating Registers									
48	Hot water	TI	2"		12'					Corridor outside Rm. 248
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
49	Hot water	TI	2"		12'					Corridor outside Rm. 248
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
50	Hot water	TI	2"		12'					Corridor outside Rm. 2246
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
51	Hot water	TI	2"		12'					Rm. 243
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

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	1st floor-East Wing Heating Registers									
52	Hot water	TI	2"	2	12'					west rm. Not marked
		MF	2"							
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
53	Hot water	TI	2"	2	12'					west rm. Not marked
		MF	2"							
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
54	Hot water	TI	2"	2	12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
55	Hot water	TI	2"	2	12'					west rm. Not marked
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
56	Hot water	TI	2"	2	12'					west rm. Not marked
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
57	Hot water	TI	2"	2	12'					west rm. Not marked
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
58	Hot water	TI	2"	2	12'					Rm. 242
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
59	Hot water	TI	2"	2	12'					Rm. 241
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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1st floor-East Wing Heating Registers										
60	Hot water	TI	2"	2	12'					Rm. 240
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
61	Hot water	TI	2"	2	12'					Rm. 240 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
62	Hot water	TI	2"	2	12'					Rm. 239
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
63	Hot water	TI	2"	2	12'					Rm. 239
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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	1st floor-East Wing Heating Registers									
64	Hot water	TI	2"	2	12'					E: end of Corridor between Rm.'s 238, 239
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
65	Hot water	TI	2"		12'					Rm. 238
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
66	Hot water	TI	2"		12'					Rm. 238
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
67	Hot water	TI	2"		12'					Rm. 238 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
1st floor-East Wing Heating Registers										
68	Hot water	TI	2"	2	12'					Rm. 237
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
69	Hot water	TI	2"	2	12'					Rm. 235
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
70	Hot water	TI	2"	2	12'					Rm. 234
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
71	Hot water	TI	2"	2	12'					Rm. 233
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
72	Hot water	TI	2"	2	12'					Rm. 232
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-West Wing Heating Registers									
35	Hot water	TI	2"	2	12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
36	Hot water	TI	2"		12'					S side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
37	Hot water	TI	2"		12'					S side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
38	Hot water	TI	2"		12'					S side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
39	1st floor-Heating Registers									
	Hot water	TI	2"	2	12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
40	Hot water	TI	2"	2	12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
41	Hot water	TI	2"	2	12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
42	Hot water	TI	2"	2	12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
43	Hot water	TI	2"	2	12'					East side of Rm. 221	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
44	Hot water	TI	2"	2	12'					East side of Rm. 221	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
45	Hot water	TI	2"	2	12'					East side of Rm. 221	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
46	Hot water	TI	2"	2	12'					North end of Rm. 221	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								

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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 109-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition		
47	Hot water	TI	2"	2	12'					North end of Rm. 221		
		MF	2"	2								
		MH	2"									
		TI	2"		12'							
48	Hot water	MF	2"	2	12'					West side of Rm. 221		
		MH	2"									
		TI	2"		12'							
		MH	2"									
49	Hot water	TI	2"		12'					West side of Rm. 221		
		MF	2"	2								
		MH	2"									
		TI	2"		12'							
50	Hot water	MF	2"	2	12'					West side of Rm. 221		
		MH	2"									
		TI	2"		12'							
		MH	2"	2								

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ACBM (Asbestos Containing Building Material) SCHEDULE

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
51	Hot water	TI	2"	2	12'					Rm. 219
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
52	Hot water	TI	2"	2	12'					Rm. 219
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
53	Hot water	TI	2"	2	12'					Rm. 218
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
54	Hot water	TI	2"	2	12'					Rm. 217
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tamm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	1st floor-West Wing Heating Registers									
55	Hot water	TI	2"	2	12'					Rm. 215
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
56	Hot water	TI	2"		12'					Rm. 214
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
57	Hot water	TI	2"		12'					Rm. 213
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
58	Hot water	TI	2"		12'					Rm. 212
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
59	Hot water	TI	2"	2	12'					Rm. 211
		MF	2"	2						
	Return	MH	2"							
60	Hot water	TI	2"	2	12'					Rm. 209
		MF	2"	2						
	Return	MH	2"							
61	Hot water	TI	2"	2	12'					Rm. 208
		MF	2"	2						
	Return	MH	2"							
62	Hot water	TI	2"	2	12'					Rm. 207
		MF	2"	2						
	Return	MH	2"							
		TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
		TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
		TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
		TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
		TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
63	Hot water	TI	2"	2	12'					Rm. 207
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
64	Hot water	TI	2"	2	12'					Rm. 207
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
65	Hot water	TI	2"	2	12'					Rm. 206
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
66	Hot water	TI	2"	2	12'					Rm. 206
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
67	1st floor-West Wing Heating Registers	TI	2"	2	12'					Rm. 203	
		MF	2"	2							
		MH	2"								
		TI	2"			12'					
		MF	2"	2							
		MH	2"								
68	Hot water	TI	2"	2	12'					Rm. 201	
		MF	2"	2							
		MH	2"								
		TI	2"			12'					
		MF	2"	2							
		MH	2"								
69	Hot water	TI	2"	2	12'					Rm. 201	
		MF	2"	2							
		MH	2"								
		TI	2"			12'					
		MF	2"	2							
		MH	2"								
	Hot water	TI	2"								
	Hot water	MF	2"								
	Hot water	MH	2"								
	Return	TI	2"								
	Return	MF	2"	2							
	Return	MH	2"								
		TI	2"								
		MF	2"								
		MH	2"								
		TI	2"								
		MF	2"								
		MH	2"								
		TI	2"								
		MF	2"								
		MH	2"								
		TI	2"								
		MF	2"								
		MH	2"								
		TI	2"								
		MF	2"								
		MH	2"								

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
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 MH - Mudded Hangers SF - square feet

Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: 2nd Floor

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Building Name: Building 3 Project # 103-AI-2019.001
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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
73	2nd floor-East Wing Heating Registers	TI	2"	2	12'					Corridor outside Rm. 352	
		MF	2"	2							
		MH	2"								
		TI	2"								
		MF	2"	2							
		MH	2"								
74	Hot water	TI	2"	2	12'					Corridor outside Rm. 351	
		MF	2"	2							
		MH	2"								
		TI	2"								
		MF	2"	2							
		MH	2"								
75	Hot water	TI	2"	2	12'					Corridor outside Rm. 350	
		MF	2"	2							
		MH	2"								
		TI	2"								
		MF	2"	2							
		MH	2"								
76	Hot water	TI	2"	2	12'					Corridor outside Rm. 349	
		MF	2"	2							
		MH	2"								
		TI	2"								
		MF	2"	2							
		MH	2"								

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
77	2nd floor-East Wing Heating Registers	TI	2"	2	12'					Corridor outside Rm. 348	
		MF	2"	2							
		MH	2"								
		Return	TI	2"		12'					
		Return	MF	2"	2						
		Return	MH	2"							
		Return	TI	2"							
78	Hot water	TI	2"	2	12'					Corridor outside Rm. 345	
		MF	2"	2							
		MH	2"								
		Return	TI	2"		12'					
		Return	MF	2"	2						
		Return	MH	2"							
		Return	TI	2"							
79	Hot water	TI	2"	2	12'					Rm. 344	
		MF	2"	2							
		MH	2"								
		Return	TI	2"		12'					
		Return	MF	2"	2						
		Return	MH	2"							
		Return	TI	2"							
80	Hot water	TI	2"	2	12'					Toilet Rm between Rm. 343-344	
		MF	2"	2							
		MH	2"								
		Return	TI	2"		12'					
		Return	MF	2"	2						
		Return	MH	2"							
		Return	TI	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
81	2nd floor-East Wing Heating Registers									
	Hot water	TI	2"	2	12'					Rm. 343
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
82	Hot water	TI	2"		12'					Rm. 343
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
83	Hot water	TI	2"		12'					West end of Corridor between Rm. 342-343
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
84	Hot water	TI	2"		12'					Rm. 342
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
85	2nd floor-East Wing Heating Registers									
	Hot water	TI	2"		12'					Rm. 342
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
86	Hot water	TI	2"		12'					Toilet Rm between Rms. 342-341
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
87	Hot water	TI	2"		12'					Rm. 341
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
88	Hot water	TI	2"		12'					Rm. 342
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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ACBM (Asbestos Containing Building Material) SCHEDULE

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
89	Hot water	TI	2"	2	12'					Rm. 339
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
90	Hot water	TI	2"		12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
91	Hot water	TI	2"		12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
92	Hot water	TI	2"		12'					Rm. 338
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
93	Hot water	TI	2"	2	12'					Rm. 337
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
94	Hot water	TI	2"		12'					Rm. 336
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
95	Hot water	TI	2"		12'					Toilet Rm. 335
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
96	Hot water	TI	2"		12'					Rm. 335
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
105	Hot water	TI	2"	2	12'					Rm. 328
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
106	Hot water	TI	2"	2	12'					Rm. 327
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
107	Hot water	TI	2"	2	12'					Rm. 325
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
108	Hot water	TI	2"	2	12'					Closet Rm. 325
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	2nd floor-East Wing Heating Registers									
109	Hot water	TI	2"	2	12'					Rm. 324
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
110	Hot water	TI	2"		12'					Rm. 323
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
111	Hot water	TI	2"		12'					Rm. 322
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
112	Hot water	TI	2"		12'					Rm. 321 (Toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-A1-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Lechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
113	2nd floor-East Wing Heating Registers	TI	2"	2	12'					Rm. 320
	Hot water	TI	2"	2						
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
114	Hot water	TI	2"	2	12'					Rm. 320
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
115	Hot water	TI	2"	2	12'					North end of Corridor between Rms. 320 & 319
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
116	Hot water	TI	2"	2	12'					Rm. 319
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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 FD - Fire Doors
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 TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tamm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
117	Hot water	TI	2"	2	12'					Rm. 319
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
118	Hot water	TI	2"		12'					Rm. 318 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
119	Hot water	TI	2"		12'					Rm. 317
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
120	Hot water	TI	2"		12'					Rm. 316
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
121	Hot water	TI	2"	2	12'					Rm. 315
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
122	Hot water	TI	2"		12'					North side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
123	Hot water	TI	2"		12'					North side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
124	Hot water	TI	2"		12'					North side of Corridor to Main Bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
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 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
Building Name: Building 3 Project # 103-AI-2019.001
Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
125	2nd floor-East Wing Heating Registers	TI	2"		12'					South side of Corridor to Main Bldg.
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
126	Hot water	TI	2"		12'					South side of Corridor to Main Bldg.
		MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
127	Hot water	TI	2"		12'					South side of Corridor to Main Bldg.
		MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							

TI - thermal insulation
LF - linear feet
FD - Fire Doors
FT - floor tile
CT - ceiling tile
MF - mudded fittings
MH - Mudded Hangers
TP - transite panels
BA - baseboard adhesive
NF - non-friable
SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
70	Hot water	TI	2"	2	12'					staircase west of the corridor to the main bldg.
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
71	Hot water	TI	2"	2	12'					S side of corridor to main bldg.
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
72	Hot water	TI	2"	2	12'					S side of corridor to main bldg.
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
73	Hot water	TI	2"	2	12'					S side of corridor to main bldg.
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							

TI - thermal insulation
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 TP - transite panels
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tamm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
74	Hot water	TI	2"		12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
75	Hot water	TI	2"		12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
76	Hot water	TI	2"		12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
77	Hot water	TI	2"		12'					North side of cooridor to main bldg.
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
	MF	2"	2							
	MH	2"								

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
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 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition	
78	2nd floor-West Wing Heating Registers	TI	2"		12'					East side of Rm. 312	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
79	Hot water	TI	2"		12'					East side of Rm. 312	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
80	Hot water	TI	2"		12'					East side of Rm. 312	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								
81	Hot water	TI	2"		12'					North side of Rm. 312	
		MF	2"	2							
		MH	2"								
		TI	2"		12'						
		MF	2"	2							
		MH	2"								

- TI - thermal insulation
- LF - linear feet
- FD - Fire Doors
- FT - floor tile
- CT - ceiling tile
- MF - mudded fittings
- MH - Mudded Hangers
- TP - transite panels
- BA - baseboard adhesive
- NF - non-friable
- SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tamm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
82	2nd floor-West Wing Heating Registers									
	Hot water	TI	2"	2	12'					North side of Rm. 312
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
83	Hot water	TI	2"	2	12'					West side of Rm. 312
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
84	Hot water	TI	2"	2	12'					West side of Rm. 312
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
85	Hot water	TI	2"	2	12'					West side of Rm. 312
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							

TI - thermal insulation
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 FT - floor tile
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 MH - Mudded Hangers
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 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	2nd floor-West Wing Heating Registers									
94	Hot water	TI	2"	2	12'					West side of Rm. 304
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
95	Hot water	TI	2"	2	12'					South side of Rm. 304
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
96	Hot water	TI	2"	2	12'					South side of Rm. 304
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
97	Hot water	TI	2"	2	12'					South side of Rm. 304
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
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 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
98	Hot water	TI	2"	2	12'					South side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
99	Hot water	TI	2"	2	12'					South side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
100	Hot water	TI	2"	2	12'					South side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
101	Hot water	TI	2"	2	12'					East side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

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TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	2nd floor-West Wing Heating Registers									
102	Hot water	TI	2"	2	12'					East side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
103	Hot water	TI	2"	2	12'					North side of Rm. 303
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
104	Hot water	TI	2"	2	12'					Corridor outside Rm. 302
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
105	Hot water	TI	2"	2	12'					Corridor outside Rm. 302
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

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 LF - linear feet
 FD - Fire Doors
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 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
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 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Leechli & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
106	Hot water	TI	2"		12'					Corridor outside toilet between Rm. 301 & 302
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
107	Hot water	TI	2"		12'					Corridor outside Rm. 301
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							
	Hot water	TI	2"							
		MF	2"							
		MH	2"							
	Return	TI	2"							
		MF	2"							
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
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 MF - mudded fittings
 MH - Mudded Hangers

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 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: 3rd Floor

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
129	Hot water	TI	2"	2	12'					Rm. 444
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
130	Hot water	TI	2"		12'					Rm. 443
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
131	Hot water	TI	2"		12'					Rm. 442
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
132	Hot water	TI	2"		12'					Rm. 441
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
133	Hot water	TI	2"	2	12'					Rm. 440
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
134	Hot water	TI	2"	2	12'					Rm. 437
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
135	Hot water	TI	2"	2	12'					Rm. 436
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
136	Hot water	TI	2"	2	12'					Rm. 436 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Lechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
137	3rd floor-East Wing Heating Registers	TI	2"	2	12'					Rm. 435
		MF	2"	2						
	Return	MH	2"		12'					
		MF	2"	2						
		MH	2"							
138	Hot water	TI	2"		12'					Rm. 435
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
139	Hot water	TI	2"		12'					West end of corridor between Rms. 435 & 434
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
140	Hot water	TI	2"		12'					Rm. 434
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
141	Hot water	TI	2"	2	12'					Rm. 434
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
142	Hot water	TI	2"		12'					Rm. 434 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
143	Hot water	TI	2"		12'					Rm. 433
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
144	Hot water	TI	2"		12'					Rm. 432
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

- TI - thermal insulation
- LF - linear feet
- FD - Fire Doors
- FT - floor tile
- CT - ceiling tile
- MF - mudded fittings
- MH - Mudded Hangers
- TP - transite panels
- BA - baseboard adhesive
- NF - non-friable
- SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
145	Hot water	TI	2"	2	12'					Rm. 431
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
146	Hot water	TI	2"	2	12'					Rm. 430
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
147	Hot water	TI	2"	2	12'					Rm. 428
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
148	Hot water	TI	2"	2	12'					Rm. 427
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
149	Hot water	TI	2"	2	12'					Rm. 427
	Return	MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
150	Hot water	TI	2"	2	12'					Rm. 426
	Return	MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
151	Hot water	TI	2"	2	12'					Rm. 426
	Return	MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
152	Hot water	TI	2"	2	12'					Rm. 425
	Return	MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	3rd floor-East Wing Heating Registers									
153	Hot water	TI	2"	2	12'					Rm. 422
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
154	Hot water	TI	2"		12'					Rm. 421
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
155	Hot water	TI	2"		12'					Rm. 420
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
156	Hot water	TI	2"		12'					Rm. 419
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	3rd floor-East Wing Heating Registers									
157	Hot water	TI	2"	2	12'					Rm. 417
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
158	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
159	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
160	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tamm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
161	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
162	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
163	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
164	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-East Wing Heating Registers										
165	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
166	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
167	Hot water	TI	2"	2	12'					Rm. 416
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
128	Hot water	TI	2"	2	12'					hallway by elevator
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
	2nd floor-West Wing Heating Registers									
102	Hot water	TI	2"	2	12'					East side of Rm. 303
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
103	Hot water	TI	2"	2	12'					North side of Rm. 303
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
104	Hot water	TI	2"	2	12'					Corridor outside Rm. 302
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							
105	Hot water	TI	2"	2	12'					Corridor outside Rm. 302
		MF	2"							
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"							
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
108	Hot water	TI	2"	2	12'					staircase
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
109	Hot water	TI	2"	2	12'					Rm. 413
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
110	Hot water	TI	2"	2	12'					Rm. 413
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
111	Hot water	TI	2"	2	12'					Rm. 413
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
116	Hot water	TI	2"	2	12'					West side of Rm. 413
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
117	Hot water	TI	2"	2	12'					Rm. 412
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
118	Hot water	TI	2"	2	12'					Rm. 410 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							
119	Hot water	TI	2"	2	12'					Rm. 409 (toilet)
		MF	2"	2						
		MH	2"							
	Return	TI	2"	2	12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors

FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers

TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
120	Hot water	TI	2"	2	12'					Rm. 207
	3rd floor-West Wing Heating Registers	MF	2"							
	Return	MH	2"							
	Return	TI	2"		12'					
	Return	MF	2"	2						
	Return	MH	2"							
121	Hot water	TI	2"		12'					Rm. 406
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
	Return	MF	2"	2						
	Return	MH	2"							
122	Hot water	TI	2"		12'					Rm. 405
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
	Return	MF	2"	2						
	Return	MH	2"							
123	Hot water	TI	2"		12'					Rm. 405
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"		12'					
	Return	MF	2"	2						
	Return	MH	2"							

TI - thermal insulation
 LF - linear feet
 FD - Fire Doors
 FT - floor tile
 CT - ceiling tile
 MF - mudded fittings
 MH - Mudded Hangers
 TP - transite panels
 BA - baseboard adhesive
 NF - non-friable
 SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
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 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
124	Hot water	TI	2"	2	12'					Rm. 405
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
125	Hot water	TI	2"		12'					Rm. 405
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
126	Hot water	TI	2"		12'					Rm. 405
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
127	Hot water	TI	2"		12'					Rm. 405
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

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 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-West Wing Heating Registers										
128	Hot water	TI	2"	2	12'					Rm. 405
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
129	Hot water	TI	2"		12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
130	Hot water	TI	2"		12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
131	Hot water	TI	2"		12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

- TI - thermal insulation
- LF - linear feet
- FD - Fire Doors
- FT - floor tile
- CT - ceiling tile
- MF - mudded fittings
- MH - Mudded Hangers
- TP - transite panels
- BA - baseboard adhesive
- NF - non-friable
- SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
3rd floor-West Wing Heating Registers										
132	Hot water	TI	2"	2	12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
133	Hot water	TI	2"	2	12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
134	Hot water	TI	2"	2	12'					Rm. 404
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							
135	Hot water	TI	2"	2	12'					Rm. 403
		MF	2"	2						
		MH	2"							
	Return	TI	2"		12'					
		MF	2"	2						
		MH	2"							

TI - thermal insulation FT - floor tile TP - transite panels
 LF - linear feet CT - ceiling tile BA - baseboard adhesive
 FD - Fire Doors MF - mudded fittings NF - non-friable
 MH - Mudded Hangers SF - square feet

ACBM (Asbestos Containing Building Material) SCHEDULE

Client: Maryville Treatment Center #C1921-01 Hazardous Materials Investigation Date: September 6, 2019
 Building Name: Building 3 Project # 103-AI-2019.001
 Address: 30227 US Highway 136, Maryville, Missouri 64468. Inspector: Mark Liechti & Kody Tramm

Register Number	Space Description	Material Code	Size	No. of Units	Length Quantity	ACM %	Assess.	Pot. For Damage	Response Action	Notes - Condition
136	3rd floor-West Wing Heating Registers	TI	2"	2	12'					Rm. 401
	Hot water	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"	2	12'					
	Return	MF	2"	2						
	Return	MH	2"							
	Return	TI	2"	2	12'					
	Return	MF	2"	2						
	Return	MH	2"							
	Hot water	TI	2"							
	Hot water	MF	2"	2						
	Hot water	MH	2"							
	Return	TI	2"	2	12'					
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	Return	TI	2"	2	12'					
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	Return	MH	2"							
	Hot water	TI	2"							
	Hot water	MF	2"	2						
	Hot water	MH	2"							
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	Return	TI	2"	2	12'					
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Project C1921-01, Bldg. 3
Replace Water & Sewer Lines
Maryville Treatment Center
Maryville, Missouri 64468

ACBM Schedule: Attic

