

General Duty Valves for HVAC Piping

SECTION SS 230523

8/12/2020

Version 22.0

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for all isolation and ball valves as defined in Design, General Arrangement, and Shop Drawings.
- 1.1.2 This specification is applicable for projects or work involving either inch-pounds or SI units. Within the text, inch-pound units are given preference followed by SI units shown within parentheses.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved - Written approval of document(s) by AE Engineer.
- 1.2.4 Contract - The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents - Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor - The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet - A document that AE engineer provides that indicates the design pressure ratings for the Project.
- 1.2.8 Design Drawings - AE Approved for Construction drawings.
- 1.2.9 General Arrangement Drawing - AE Approved not for construction drawings of piping layout.
- 1.2.10 Hold Point - The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer - the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) - body of documents due 20 business days after completion of Project.
- 1.2.13 Owner - City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 Project - the purchase and/or installation of valves for an AE plant or AE mechanical room.

- 1.2.15 Shop Drawings – detailed drawings used for shop personnel to fabricate piping and piping appurtenances.
- 1.2.16 Specification – the Specification is defined as this document, titled General Duty Valves for HVAC Piping SS 230523.
- 1.2.17 Submittal after Award – Body of documents required to be submitted 10 business days after award of work but before any fabrication commences.
- 1.2.18 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.19 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 ASME American Society of Mechanical Engineers
- 1.3.3 CWP Cold working pressure
- 1.3.4 MSS Manufacturers Standardization Society
- 1.3.5 PFI Piping Fabricators Institute

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to valves. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 ASME B31 Pressure Piping Code
- 1.4.3 ASME B1.20.1 Pipe Threads
- 1.4.4 MSS SP-67, SP-68
- 1.4.5 PFI ES-03 Piping Fabrication Tolerances

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications/details shall be followed in their entirety during valve selection and installation
- 1.5.2 AE Details M16 through M29

1.6. QUALITY ASSURANCE

- 1.6.1 Reference 3.1 Examinations.

1.7. WARRANTY

- 1.7.1 Valves shall have a 12 month warranty from the date of Substantial Completion.

1.8. SUBMITTALS

1.8.1 GENERAL

- 1.8.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.8.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.8.1.1.2 Table of Contents page
 - 1.8.1.1.3 Dividing pages with Equipment title
- 1.8.1.2 Submittals must be tailored to each project, generic submittals will not be accepted.
- 1.8.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award. Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.8.1.4 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.8.1.4.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.8.2 SUBMITTAL AFTER AWARD

- 1.8.2.1 Product Data: For each type of valve indicated.
 - 1.8.2.1.1 Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 1.8.2.1.2 Include valve diagram cut sheet:
 - 1.8.2.1.2.1 Cut sheet shall include item number, quantity, description, materials, reorder part number
- 1.8.2.2 Torque setting table: For each type of valve indicated.
 - 1.8.2.2.1 Table shall include for each valve the manufacturer's recommended torque adjustment range for bolt tightening.

1.8.3 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.8.3.1 Operation and Maintenance Manuals shall include the following as a minimum:
 - 1.8.3.1.1 Approved Submittal for all general duty valves
 - 1.8.3.1.2 Updated torque table that includes actual torque Contractor tightened the bolts to on the valves.
 - 1.8.3.1.3 Operation and Maintenance Manual for each type of valve.

2. DESIGN

2.1. NOT APLICABLE

3. PRODUCTS

3.1. GENERAL

- 3.1.1 This item shall govern the valves furnished and installed as indicated on the Shop Drawings.
- 3.1.2 All of the manufacturer's valve pressure ratings shall meet or exceed the Design Data Packet pressure requirements by 1.5 times.
 - 3.1.2.1 The valve in the closed position.
 - 3.1.2.2 The valve body.
 - 3.1.2.3 The valve in the closed position, in dead end service and with no flange connected to the non-pressurized side of the valve.
- 3.1.3 Sizes: Same size as upstream pipe, unless otherwise indicated.
- 3.1.4 Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- 3.1.5 Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- 3.1.6 Threads: ASME B1.20.1

3.2. VALVES

- 3.2.1 Butterfly Valves:
 - 3.2.1.1 Description:
 - 3.2.1.1.1 For pressure rating 150 psig and less:
 - 3.2.1.1.1.1 Standard: MSS SP-67
 - 3.2.1.1.1.2 Body Design: polyester coated ductile iron lug type body, ASME Class 150; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - 3.2.1.1.1.3 Seat: Resilient, EPDM.
 - 3.2.1.1.1.4 Stem: 316 or 416 stainless steel.
 - 3.2.1.1.1.5 Disc: Aluminum-bronze or stainless steel.
 - 3.2.1.1.1.6 Service: Bidirectional.
 - 3.2.1.1.1.7 CWP Rating:
 - 3.2.1.1.1.7.1. 150 psig at 100 deg F.
 - 3.2.1.1.1.8 Model: Series 31H or 36H or AE Engineer approved equal
 - 3.2.1.1.2 For pressure rating between 150 psig and 250 psig:
 - 3.2.1.1.2.1 Standard: MSS SP-67
 - 3.2.1.1.2.2 Body Design: polyester coated ductile iron lug type body, ASME Class 150; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - 3.2.1.1.2.3 Seat: Resilient, EPDM.
 - 3.2.1.1.2.4 Stem: 316 or 416 stainless steel.
 - 3.2.1.1.2.5 Disc: Aluminum-bronze or stainless steel.

- 3.2.1.1.2.6 Service: Bidirectional.
- 3.2.1.1.2.7 CWP Rating:
 - 3.2.1.1.2.7.1. For Valves 20" and below: 250 psig at 100 deg F
 - 3.2.1.1.2.7.2. For Valves greater than 20": 232 psig at 100 deg F.
- 3.2.1.1.2.8 Model: Series 31H or 36H or AE Engineer approved equal
- 3.2.1.1.3 For pressure rating greater than 250 psig
 - 3.2.1.1.3.1 Standard: MSS SP-68
 - 3.2.1.1.3.2 Body Design: carbon steel lug type body, ASME 300 class flanges; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - 3.2.1.1.3.3 Seat: Resilient, RTFE.
 - 3.2.1.1.3.4 Stem: 17-4ph stainless steel.
 - 3.2.1.1.3.5 Disc: Aluminum-bronze or stainless steel.
 - 3.2.1.1.3.6 Service: Bidirectional.
 - 3.2.1.1.3.7 CWP Rating:
 - 3.2.1.1.3.7.1. At a minimum 675 psig at 100 deg F
 - 3.2.1.1.3.8 Model: High Performance Butterfly Series 43 or AE Engineer approved equal.
- 3.2.1.2 Valve arrangement shall be such that any part of the valve hand lever/wheel does not come into contact with or in conflict with the pipe, insulation of pipe or appurtenances of the pipe with full range of motion of valve hand lever/wheel.
 - 3.2.1.2.1 Valve hand lever/wheel shall be at a minimum of 2" from pipe, pipe appurtenance or structure.
- 3.2.1.3 All butterfly valves 4 inches (102 mm) and larger shall be bi-directional, bubble-tight resilient seated butterfly type valves of suitable design and fully equipped for service in water systems, without need for further modification.
- 3.2.1.4 Manufacturer: Subject to compliance with requirements, provide products by:
 - 3.2.1.4.1 Bray Controls; a division of Bray International,
 - 3.2.1.4.2 Or AE approved equal
- 3.2.2 Ball Valves:
 - 3.2.2.1 Bronze body, ASTM 316 stainless steel ball and stem, and stainless steel latch lock handle and nut, min 400 psi CWP, 2 piece construction, standard port, threaded connections.
 - 3.2.2.2 Valve arrangement shall be such that any part of the valve hand lever does not come into contact with or in conflict with the pipe, insulation of pipe or appurtenances of the pipe with full range of motion of valve hand lever/wheel.
 - 3.2.2.2.1 Valve hand lever shall be at a minimum of 2" from pipe, pipe appurtenance or structure.

3.2.2.3 All ball valves shall be lead free full/standard port bronze valves of suitable design and fully equipped for service in water systems, without need for further modification.

3.2.2.4 Manufacturer:

3.2.2.4.1 Apollo model 70-144-27 or 70-145-27

3.2.2.4.2 Nibco model T-580-70-66 with added SS Standard lever handle

3.2.2.4.3 Or AE Engineer approved equal

3.3. OPERATORS

3.3.1 Handwheel, lever handles, and chainwheels shall be at a minimum of 2" from pipe, pipe appurtenance or structure.

3.3.2 Gear Actuator: For quarter-turn valves. Handwheel shall be sized to not interfere with insulation or piping when mounted on horizontally positioned valve.

3.3.3 Lever Handles: For quarter-turn valves 6 inches (DN150) and smaller that are less than 78 inches off floor.

3.3.4 Chainwheel: Device for attachment to valve hand wheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the 3.2 "Valve Installation".

3.3.4.1 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

3.3.4.1.1 Bray Controls

3.3.4.1.2 Babbitt Steam Speciality Co.

3.3.4.1.3 Roto Hammer Industries

3.3.4.1.4 Trumbull Industries

3.3.4.2 Description: Valve actuation assembly with sprocket rim, brackets, and chain

3.3.4.2.1 Brackets: Type, number, size, and fasteners required to mount actuator on valve.

3.3.4.2.2 Attachment: For connection to butterfly valve stems.

3.3.4.2.3 Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.

3.3.4.2.4 Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

3.3.4.2.5 Size: Diameter of chainwheel shall be such that any part of the wheel does not come into contact with or in conflict with the pipe, insulation of pipe or appurtenances of the pipe.

3.3.4.2.6 Extension: As needed for chainwheel to clear pipe, insulation and pipe appurtenances.

3.3.4.2.7 Chainwheel chain link connector shall be fabricated to have the same strength as the chain itself.

4. EXECUTION

4.1. EXAMINATION

- 4.1.1 Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Alignment Fit-Up of pipe and flanges to valves shall abide by PFI ES-03. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 4.1.2 Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
 - 4.1.2.1 Valves are to be free of rust and corrosion, and exterior finish is to be uniform, without scrapes or dents exposing metal.
 - 4.1.2.2 Prepare and repaint all marred surfaces with valve manufacturer's paint.
- 4.1.3 Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- 4.1.4 Examine threads on valve and mating pipe for form and cleanliness.
- 4.1.5 Examine mating flange faces for conditions that might cause leakage.
- 4.1.6 Check bolting for proper size, length, and material.
- 4.1.7 Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- 4.1.8 Do not attempt to repair defective valves; replace with new valves.

4.2. INSTALLATION (if APPLICABLE to PROJECT)

- 4.2.1 Install valves where indicated in accordance to manufacturer's written instructions.
- 4.2.2 Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
 - 4.2.2.1 Unions and flanges shall be provided under SS232113 Hydronic Pipe if applicable to Project.
- 4.2.3 Locate valves for easy access and provide separate support where necessary.
- 4.2.4 Piping shall be supported in such a way that removal of valve shall not cause piping to be in a stressed condition or cause to have piping to be supported by temporary means.
- 4.2.5 **Install valves in horizontal piping with stem horizontal.**
- 4.2.6 Install valves in a position to allow full stem movement.
- 4.2.7 Valve indicator shall be in direction of stem. Pointer shall point to the correct wording. If valve is open the pointer shall point to the word open that is etched on valve body.
- 4.2.8 Valve bolts shall be torqued to manufacturer's recommended tightening pattern and applied torque recommendation.
 - 4.2.8.1 Contractor shall record for each valve the torque applied.

- 4.2.8.2 If applied torque is greater than torque range of valve, Contractor shall at Contractor's expense verify from manufacturer of valve in writing that valve is not damaged.
- 4.2.8.3 If valve manufacturer states damage has been done, Contractor shall replace damaged valve at Contractor's expense.
- 4.2.9 Install chainwheels on operators for butterfly valves more than 78 inches above floor.
 - 4.2.9.1 Extend chains to 60 inches above finished floor.

4.3. THREADED CONNECTIONS

- 4.3.1 Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- 4.3.2 Align threads at point of assembly.
- 4.3.3 Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- 4.3.4 Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- 4.3.5 Threaded connections shall be torqued to manufacturer's recommendations.
 - 4.3.5.1 Contractor shall record for each valve the torque applied.
 - 4.3.5.2 If applied torque is greater than torque range of valve, Contractor shall at Contractor's expense verify from manufacturer of valve in writing that valve is not damaged.
 - 4.3.5.3 If valve manufacturer states damage has been done, Contractor shall replace damaged valve at Contractor's expense.
 - 4.3.5.4 ASME B1.20.1 for applied torque requirements if manufacturer does not have recommendations for torqueing.

4.4. ADJUSTMENT (if APPLICABLE to PROJECT)

- 4.4.1 Packing:
 - 4.4.1.1 Adjust or replace packing before piping systems put into service.
 - 4.4.1.2 If packing leak persists, replace valve(s).
- 4.4.2 End Stops:
 - 4.4.2.1 Adjust end stops for valve fully open and fully closed.

4.5. STORAGE, HANDLING, AND SHIPMENT

- 4.5.1 Preparation for Storage
 - 4.5.1.1 Maintain valve end protection.
 - 4.5.1.2 Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- 4.5.2 Handling

- 4.5.2.1 Use sling to handle large valves; rig sling to avoid damage to exposed parts.
- 4.5.2.2 Do not use hand wheels, or stems as lifting or rigging points.
- 4.5.2.3 Follow manufacturer's recommendations on handling.
- 4.5.3 Preparation for shipment
 - 4.5.3.1 Protect internal parts against rust and corrosion.
 - 4.5.3.2 Protect threads, flange faces, grooves, and weld ends.
 - 4.5.3.3 Set ball valves open to minimize exposure of functional services.
 - 4.5.3.4 Set butterfly valves closed or slightly open.

END of SECTION

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

SECTION SS 230529

8/19/2020

Version 22.0

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for the hangers and supports for the Project which includes
 - 1.1.1.1 Metal pipe hangers and supports
 - 1.1.1.2 Trapeze pipe hangers
 - 1.1.1.3 Metal framing systems
 - 1.1.1.4 Thermal-hanger shield inserts
 - 1.1.1.5 Fastener systems
 - 1.1.1.6 Instrumentation Pipe stands
 - 1.1.1.7 Equipment Supports

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved - Written approval of document(s) by AE Engineer.
- 1.2.4 Contract - The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents - Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor - The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Drawings - AE Approved for Construction drawings of layout.
- 1.2.8 General Arrangement Drawing - AE Approved not for construction drawings of layout.
- 1.2.9 Hold Point - The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.10 Engineer - the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.11 Final Submittal (closeout) - body of documents due 20 business days after completion of Project
- 1.2.12 Owner - City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.

- 1.2.13 Project – the design and construction of hangers and supports for AE plant or AE mechanical room.
- 1.2.14 Shop Drawings – detailed drawings used for construction of Project.
- 1.2.15 Specification – the Specification is defined as this document, titled Hangers and Supports for HVAC Piping and Equipment SS 230529.
- 1.2.16 Submittal after Award – Body of documents required to be submitted after award of work to Contractor but before any fabrication commences.
- 1.2.17 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected
- 1.2.18 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.19 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 AISC American Institute of Steel Construction
- 1.3.3 ANSI American National Standards Institute
- 1.3.4 ASCE American Society of Civil Engineers
- 1.3.5 ASME American Society of Mechanical Engineers
- 1.3.6 ASTM American Society of Testing and Materials
- 1.3.7 AWS American Welding Society
- 1.3.8 MSS Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
- 1.3.9 MFMA Metal Framing Manufacturers Association
- 1.3.10 NEMA National Electrical Manufacturers Association
- 1.3.11 NPS Nominal Pipe Size
- 1.3.12 SEI Structural Engineering Institute
- 1.3.13 SSPC Society for Protective Coatings

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Contractor shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The Contractor is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 AISC Manual of Steel Construction
- 1.4.3 ASCE/SEI 7

- 1.4.4 ASME B31
- 1.4.5 ASTM C533, C552, A36, C1107, A780
- 1.4.6 AWS D1.1
- 1.4.7 MFMA 4, 103
- 1.4.8 MSS SP-58, SP-59, SP-69, Type 1 thru Type 42
- 1.4.9 NEMA
- 1.4.10 SSPC PA 1

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Project design and manufacture
- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 General Duty Valves for HVAC Piping SS 230523
- 1.5.4 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.5 Pipe Insulation SS 230719
- 1.5.6 Monitoring Controls SS 230900
- 1.5.7 Hydronic Piping SS 232113
- 1.5.8 Heat Exchangers for HVAC SS 235700
- 1.5.9 AE Details M23

1.6. QUALIFICATIONS

- 1.6.1 Contractor shall have a professionally licensed Structural Engineer (structural supports design) at their disposal.
- 1.6.2 All structural welders shall be qualified to AWS D1.1 for welding on structural base and supports.

1.7. QUALITY ASSURANCE

- 1.7.1 All structural welds shall be visually inspected
 - 1.7.1.1 Record of visual inspection by person other than welder who performed the welding shall be kept, reviewed during site visit and provided with final submittal

1.8. AUDITS AND INSPECTIONS

- 1.8.1 Virtual/Visual Inspection for structural support clearance to pipe and its appurtenances

1.9. SUBMITTALS

1.9.1 GENERAL

- 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.9.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.9.1.1.2 Table of Contents page

- 1.9.1.1.3 Dividing pages with Equipment title
- 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.9.1.3 It is mandatory that the *Submittal with Quotation* documents be submitted with the Quote
 - 1.9.1.3.1 Quotes which do not include all of *Submittal with Quotation* documents will be considered incomplete and therefore rejected
- 1.9.1.4 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.9.1.5 Fabrication may not begin until the *Submittal after Award* documents are received and written approval is received from AE Engineer.
- 1.9.1.6 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.9.1.6.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL WITH QUOTATION

- 1.9.2.1 Structural Welder qualifications
- 1.9.2.2 Structural Welding procedures
- 1.9.2.3 Structural Welding Procedure qualifications

1.9.3 SUBMITTAL AFTER AWARD

- 1.9.4 Structural Steel design calculations and drawings developed, signed and stamped by professionally licensed Structural Engineer.
 - 1.9.4.1 If the Project is for a skid package, see SS 232050 Packaged Heat Exchanger System for listing of requirements for delegated design.
 - 1.9.4.2 Otherwise, Contractor to submit shop drawings of structural support design for approval to licensed Structural Engineer.
- 1.9.5 Product Data: For each type of product indicated.
 - 1.9.5.1 Trapeze pipe hangers
 - 1.9.5.2 Metal framing systems
 - 1.9.5.3 Instrumentation Pipe stands
 - 1.9.5.4 Equipment Supports
- 1.9.6 Shop Drawings: Shop drawing(s) at ½":1' scale shall be provided. Shop drawings shall show all support structures and stanchions for Project.
 - 1.9.6.1 If the Project is for a skid package, see SS 232050 Packaged Heat Exchanger System for detailed requirements.

1.9.7 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.9.7.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.9.7.1.1 Record of structural welding inspection

- 1.9.7.1.2 As-built shop drawings
- 1.9.7.1.3 Approved product data submittal

2. DESIGN

2.1. GENERAL REQUIREMENTS

- 2.1.1 Supports welded directly to the pipe shall be unacceptable.
- 2.1.2 Pipe supports utilizing flange studs/bolting shall be unacceptable
- 2.1.3 Design structural supports in accordance with the heat exchanger manufacturer's nozzle maximum loading requirements.
- 2.1.4 All supports shall be arranged to permit field installation of 2" insulation.

2.2. DELEGATED DESIGN

- 2.2.1 A qualified professional engineer shall design the trapeze pipe hangers and equipment supports.
 - 2.2.1.1 Design shall include a comprehensive engineering analysis and the performance requirements and design criteria used.

2.3. PERFORMANCE REQUIREMENTS

- 2.3.1 Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions in accordance with ASCE/SEI 7.
- 2.3.2 Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and wet weight.
- 2.3.3 Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.4. STRUCTURAL STEEL SUPPORTS

- 2.4.1 If a skid Project, supports shall be welded to the base structural members to support skid components.
- 2.4.2 Structural steel supports shall be designed to comply with AISC Manual of Steel Construction, Part 4, "Welded Joints."
- 2.4.3 Piping shall be supported independently of heat exchanger connections, if applicable.
- 2.4.4 ASTM A 36/A 36M, carbon steel plates, shapes, and bars; galvanized.

2.5. HANGER AND SUPPORT SCHEDULE

- 2.5.1 Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in 3.0 Products.
- 2.5.2 Use hangers and supports with galvanized metallic coatings for piping and equipment.

- 2.5.3 Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- 2.5.4 Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.
- 2.5.5 Use thermal-hanger shield inserts for insulated piping and tubing.
- 2.5.6 Double-nut hanger rods above and below pipe hangers and trapeze structures.
- 2.5.7 Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 2.5.7.1 Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2.5.7.2 Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 2.5.7.3 Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
- 2.5.8 Vertical-Piping Clamps: Unless otherwise indicated and except as specified in 3.0 Products, install the following types:
 - 2.5.8.1 Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2.5.8.2 Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- 2.5.9 Hanger-Rod Attachments: Unless otherwise indicated and except as specified in 3.0 Products, install the following types:
 - 2.5.9.1 Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2.5.9.2 Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 2.5.9.3 Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- 2.5.10 Building Attachments: Unless otherwise indicated and except as specified in 3.0 Products, install the following types:
 - 2.5.10.1 Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2.5.10.2 Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 2.5.10.3 Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 2.5.10.4 Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

- 2.5.10.5 Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
- 2.5.10.6 C-Clamps (MSS Type 23): For structural shapes.
- 2.5.10.7 Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
- 2.5.10.8 Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- 2.5.10.9 Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
- 2.5.10.10 Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
- 2.5.10.11 Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- 2.5.10.12 Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 2.5.10.12.1 Light (MSS Type 31): 750 lb.
 - 2.5.10.12.2 Medium (MSS Type 32): 1500 lb.
 - 2.5.10.12.3 Heavy (MSS Type 33): 3000 lb.
- 2.5.10.13 Saddles and Shields: Unless otherwise indicated and except as specified in 3.0 Products, install the following types:
 - 2.5.10.13.1 Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 2.5.10.13.2 Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- 2.5.10.14 Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in 3.0 Products.
- 2.5.10.15 Comply with MFMA-103 for metal framing system selections and applications that are not specified in 3.0 Products.
- 2.5.10.16 Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3. PRODUCTS

3.1. METAL PIPE HANGERS AND SUPPORTS

- 3.1.1 Carbon-Steel Pipe Hangers and Supports.
 - 3.1.1.1 Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 3.1.1.2 Galvanized Metallic Coatings: Hot dip galvanized.

3.2. TRAPEZE PIPE HANGERS

- 3.2.1 Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

3.3. METAL FRAMING SYSTEMS

- 3.3.1 MFMA Manufacturer Metal Framing Systems:
 - 3.3.1.1 Description: Shop or field fabricated pipe support assembly for supporting multiple parallel pipes.
 - 3.3.1.2 Standard: MFMA-4.
 - 3.3.1.3 Channels: Continuous slotted steel channel within turned lips.
 - 3.3.1.4 Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 3.3.1.5 Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 3.3.1.6 Metallic Coating: Hot-dip galvanized.
 - 3.3.1.7 Manufacturers:
 - 3.3.1.7.1 Allied Tube & Conduit
 - 3.3.1.7.2 Cooper B-Line, Inc.
 - 3.3.1.7.3 Flex-Strut Inc.
 - 3.3.1.7.4 Thomas & Betts Corporation
 - 3.3.1.7.5 Unistrut Corporation
 - 3.3.1.7.6 Or AE Engineer Approved equal

3.4. THERMAL-HANGER SHIELD INSERTS

- 3.4.1 Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier or polyisocyanurate insulation.
- 3.4.2 For Trapeze or Clamped Systems: Insert and shield to cover entire circumference of pipe.
- 3.4.3 For Clevis or Band Hangers: Insert and shield to cover lower 180 degrees of pipe.
- 3.4.4 Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

3.5. FASTENER SYSTEMS

- 3.5.1 Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6. EQUIPMENT SUPPORTS

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

3.7. INSTRUMENT PIPE STANDS

- 3.7.1 Instrument support for mounting measurement instrumentation or control devices
- 3.7.2 Instruments shall be securely supported on stands or brackets of satisfactorily heavy material to prevent excess vibration or movement.
- 3.7.3 2" sch. 40 carbon steel pipe support stanchions shall be used.

- 3.7.4 Top of pipe shall have a flat or domed cap.
- 3.7.5 Base plate shall be at a minimum of 5/16" thick with 8"x8" base.
- 3.7.6 Pipe support shall come with weep holes for drainage and have an open style base plate.
- 3.7.7 Pipe stand shall be hot dip galvanized.
- 3.7.8 Provide gussets if additional bracing is required
- 3.7.9 Pipe stand shall be at a minimum 54" high.
- 3.7.10 Anchors, bolts, nuts, and washers
 - 3.7.10.1 Shall be designed by structural engineer
 - 3.7.10.2 Material: 316 stainless steel

3.8. GROUT

- 3.8.1 Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 3.8.1.1 Properties: Non-staining, noncorrosive, and nongaseous.
 - 3.8.1.2 Design Mix: 5000-psi, 28-day compressive strength.

4. EXECUTION

4.1. HANGER AND SUPPORT INSTALLATION

- 4.1.1 Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- 4.1.2 Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 4.1.2.1 Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 4.1.2.2 Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- 4.1.3 Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
 - 4.1.3.1 Grouting when support by concrete floor: Place minimum 2 inch high by min 6"x6" grout pad beneath support footers of framing system where they are floor-supported, and make bearing surface smooth.
 - 4.1.3.2 Connection to Steel Floor: Steel plate for bearing on metal structure. Structural engineer as referenced in Part 1 and Part 2 shall design plate based on the loading the plate will support. Plate shall be attached and sealed to steel surface to eliminate any water from seeping under plate.

- 4.1.4 Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- 4.1.5 Fastener System Installation: Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- 4.1.6 Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- 4.1.7 Use double nuts and lock washers on threaded rod supports.
- 4.1.8 Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- 4.1.9 Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.
- 4.1.10 Do not install metal supports and hangers in direct contact with metal pipe.
- 4.1.11 Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
 - 4.1.11.1 If a skid Project,
 - 4.1.11.1.1 All external piping shall not exceed maximum loading to the piping connection flanges of skid.
 - 4.1.11.1.2 External piping shall be supported independently of skid piping.
- 4.1.12 Pipe Slopes: Install hangers and supports to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- 4.1.13 Insulated Piping:
 - 4.1.13.1 Attach clamps and spacers to piping.
 - 4.1.13.1.1 Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 4.1.13.1.2 Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 4.1.13.2 Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier.
 - 4.1.13.2.1 Shields shall span an arc of 180 degrees.
 - 4.1.13.2.2 Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4.1.13.3 Shield Dimensions for Pipe: Not less than the following:
 - 4.1.13.3.1 NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inches thick.
 - 4.1.13.3.2 NPS 4: 12 inches long and 0.06 inches thick.
 - 4.1.13.3.3 NPS 5 and NPS 6: 18 inches long and 0.06 inches thick.
 - 4.1.13.3.4 NPS 8 to NPS 14: 24 inches long and 0.075 inches thick.

4.1.13.3.5 NPS 16 to NPS 24: 24 inches long and 0.105 inches thick.

4.1.13.4 Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate insulation inserts of length at least as long as protective shield.

4.1.13.5 Thermal-Hanger Shields: Install with insulation; same thickness as piping insulation.

4.2. METAL FABRICATIONS

4.2.1 Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

4.2.2 Fit exposed connections together to comply with AISC standards. Field weld connections that cannot be shop welded because of shipping size limitations.

4.2.3 Pipe supports system shall allow for addition of insulation once support is set into place.

4.2.4 Pipe support system shall maintain all equipment and instrumentation clearances as per the specification details and design drawings.

4.2.5 Floor stanchions

4.2.5.1 For skids, floor stanchions of less than 30 inches shall be constructed in such a way that they are adjustable with an integrated anti-skid rubber base of not less than 2 inches.

4.2.5.2 For non-skid Projects, floor stanchions of less than 30 inches and welded to the pipe shall be constructed in such a way that they are adjustable with an integrated anti-skid rubber base of not less than 2 inches.

4.2.5.3 Floor stanchions that are welded to the decking shall be constructed in such a way that they are adjustable and have a cradle of the appropriate radius for the supported pipe and insulation to rest in.

4.2.5.4 Stanchions of more than 30 inches shall be approved by AE engineer.

4.2.5.5 No stanchions shall be designed to be welded on both ends unless approved by AE engineer.

4.2.6 Support rod ends shall be covered with approved safety caps.

4.2.7 Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

4.2.7.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

4.2.7.2 Obtain fusion without undercut or overlap.

4.2.7.3 Remove welding flux immediately.

4.2.7.4 Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
SECTION SS 230529**

- 4.2.8 Grouting: Provide minimum 2 inch high by min 6"x6" grout pad beneath support footers of metal fabrications where they are floor-supported, and make bearing surface smooth.

4.3. ADJUSTMENT

- 4.3.1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- 4.3.2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

4.4. PAINTING

- 4.4.1 Touchup:
- 4.4.1.1 Clean field welds and abraded areas of shop paint.
 - 4.4.1.2 Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
 - 4.4.1.3 Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 4.4.1.4 Apply paint to provide minimum dry film with a thickness as defined by painting manufacture.
- 4.4.2 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END of SECTION

HVAC Pipe Identification

SECTION SS 230553

8/22/2020

Version 22.0

REVISION HISTORY			
DATE	VERSION	DESCRIPTION	AUTHOR
8/22/2020	21.0	Re-format specification	
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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for pipe and equipment identification.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidenced by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project layout.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of Project
- 1.2.13 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 Project – the design and construction of a specific building's mechanical room's chilled water system delivery
- 1.2.15 Shop Drawings – detailed drawings used for shop personnel to fabricate the Project
- 1.2.16 Specification – the Specification is defined as this document, titled HVAC Pipe Identification SS 230553.

- 1.2.17 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.18 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.19 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. AUSTIN ENERGY SPECIFICATIONS

- 1.3.1 The following AE specifications/details shall be followed in their entirety during pipe and equipment label selection and installation
- 1.3.2 HVAC Pipe Identification SS 230553
- 1.3.3 Hydronic Piping SS 232113
- 1.3.4 Heat Exchangers for HVAC SS 235700

1.4. SUBMITTALS

1.4.1 GENERAL

- 1.4.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.4.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.4.1.1.2 Table of Contents page
 - 1.4.1.1.3 Dividing pages with Equipment title
- 1.4.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.4.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.4.1.4 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.4.1.5 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.4.1.5.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.4.2 SUBMITTAL AFTER AWARD

- 1.4.2.1 Product Data: For each type of product indicated.
- 1.4.2.2 Samples: For color, letter style, and graphic representation required for each identification material and device.
- 1.4.2.3 Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.4.3 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.4.3.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.4.3.1.1 Approved Submittal for all pipe and equipment identification.
 - 1.4.3.1.2 A piping sketch of each label location on piping.
 - 1.4.3.1.3 Provide equipment and pipe label schedule indicating label description, location of label and type of label used.

1.5. COORDINATION

- 1.5.1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- 1.5.2 Coordinate installation of identifying devices with locations of access panels and doors.
- 1.5.3 Install identifying devices before installing acoustical ceilings and similar concealment.

2. DESIGN

2.1. NOT APPLICABLE

3. PRODUCTS

3.1. GENERAL

- 3.1.1 This item shall govern the pipe labels furnished and installed as indicated on approved HVAC pipe identification submittal.

3.2. EQUIPMENT LABELS

- 3.2.1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- 3.2.2 Fasteners: Stainless-steel rivets or self-tapping screws.
- 3.2.3 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 3.2.4 Identification:
 - 3.2.4.1 Minimum Label Size: Length and width vary for required label content, but not less than 3 by 1 inch.
 - 3.2.4.2 Lettering Size: Minimum 1 inches high.
 - 3.2.4.3 Text: "HX-1", "HX-2", or as indicated otherwise in drawings.
 - 3.2.4.4 Color: White lettering on green background.

3.3. PIPE LABELS

- 3.3.1 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- 3.3.2 Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

- 3.3.3 Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 3.3.4 Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 3.3.4.1 Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 3.3.4.1.1 Arrows shall traverse completely around pipe, 360 degrees.
 - 3.3.4.2 Identification:
 - 3.3.4.2.1 Lettering Size: Minimum 1-1/2 inches high.
 - 3.3.4.2.2 Text:
 - 3.3.4.2.2.1 For AE chilled water piping "AE CHR" or "AE CHS" as applicable.
 - 3.3.4.2.2.2 For Building chilled water piping: "BLDG CHR" or "BLDG CHS" as applicable.
 - 3.3.4.2.2.3 For all other piping, see Shop Drawings for pipe labeling.
 - 3.3.4.2.3 Color: White lettering on green background

4. EXECUTION

4.1. PREPARATION

- 4.1.1 Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

4.2. EQUIPMENT LABEL INSTALLATION

- 4.2.1 Install or permanently fasten labels on each heat exchanger.
- 4.2.2 Install or permanently fasten labels on each control valve.
- 4.2.3 Locate equipment labels where accessible and visible.

4.3. PIPING LABEL INSTALLATION

- 4.3.1 Space pipe labels at maximum intervals of 25 feet along each run.
- 4.3.2 Locate near inlet and outlet from mechanical room, near each valve and control device, near each branch connection, excluding short takeoffs for fixtures and terminal units.
- 4.3.3 Mark inlet and outlet of each heat exchanger.
- 4.3.4 Where flow pattern is not obvious, mark each pipe at branch.

END of SECTION

PIPE INSULATION

SECTION SS 230719

10/7/2020

Version 21.0

REVISION HISTORY			
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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for the following:
 - 1.1.1.1 Pipe insulation;
 - 1.1.1.2 Insulating cements;
 - 1.1.1.3 Field-applied jackets;
 - 1.1.1.4 Accessories and attachments;
 - 1.1.1.5 Sealing compounds.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Drawings – AE Approved for Construction drawings of Project.
- 1.2.8 General Arrangement Drawing – AE Approved not for construction drawings of Project.
- 1.2.9 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.10 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.11 Final Submittal (closeout) – body of documents due 20 business days after Substantial Completion of Project
- 1.2.12 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.13 Project - the design and construction of pipe and piping specialties for AE plant or AE mechanical room.
- 1.2.14 Shop Drawings – detailed drawings used for shop personnel to fabricate Project
- 1.2.15 Specification – the Specification is defined as this document, titled Pipe Insulation SS 230719.

- 1.2.16 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.17 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected.
- 1.2.18 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.19 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 ASTM American Society of Testing and Materials
- 1.3.3 FM Factory Mutual

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 ASTM A666, B209, C450, C534, C585, C921, C1126, E84

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Project design and manufacture
- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 General Duty Valves for HVAC Piping SS 230523
- 1.5.4 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.5 HVAC Pipe Identification SS 230553
- 1.5.6 Pipe Insulation SS 230719
- 1.5.7 Chilled Water Monitoring Controls SS 230900
- 1.5.8 Hydronic Piping SS 232113
- 1.5.9 Heat Exchangers for HVAC SS 235700

1.6. QUALIFICATIONS

- 1.6.1 Manufacturer shall have a minimum seven years' experience specializing in manufacturing products specified in this Section 3.0.
- 1.6.2 Applicator shall have a minimum seven years' experience specializing in performing Work of this Section 4.0.

- 1.6.3 Installers shall be skilled insulators who have successfully completed a structured documented apprenticeship program or another craft training program for insulation as reference in this Specification.

1.7. QUALITY ASSURANCE

- 1.7.1 Fire rated per standard E84

1.8. AUDITS AND INSPECTIONS

- 1.8.1 Contractor shall provide 48 hour written notification prior to performing the following tasks for AE inspection.
 - 1.8.1.1 Surface Preparation
 - 1.8.1.2 Insulation for compliance to Approved Submittal
 - 1.8.1.3 Installation per Manufacturer's installation instructions and this Specification

1.9. SUBMITTALS

1.9.1 GENERAL

- 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.9.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.9.1.1.2 Table of Contents page
 - 1.9.1.1.3 Dividing pages with Equipment title
- 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.9.1.3 It is mandatory that the *Submittal with Quotation* documents be submitted with the Quote
 - 1.9.1.3.1 Quotes which do not include all of *Submittal with Quotation* documents will be considered incomplete and therefore rejected
- 1.9.1.4 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.9.1.5 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.9.1.6 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.9.1.6.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL WITH QUOTATION

- 1.9.2.1 Insulation Installer qualifications
- 1.9.2.2 Document describing apprenticeship program/certification certificate

1.9.3 SUBMITTAL AFTER AWARD

- 1.9.3.1 Product Data for each type of product indicated:
 - 1.9.3.1.1 Identify type,

- 1.9.3.1.2 Thermal conductivity,
- 1.9.3.1.3 Thickness,
- 1.9.3.1.4 Jackets (both factory and field applied, if any).
- 1.9.3.2 Provide Shop Drawing or other detailed description of insulation for pipe, heat exchanger, valves, flowmeters, strainer and other appurtenances.

1.9.4 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.9.4.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.9.4.1.1 Approved Submittal(s)
 - 1.9.4.1.2 Shop drawing or detail as defined in Section 1.9.3.2.

1.10. SCHEDULING

- 1.10.1 Schedule insulation application after successful hydraulic or pneumatic pressure testing of piping systems as defined in SS 232113 Hydronic Piping.

2. DESIGN

2.1. DRAWINGS

- 2.1.1 Design and Shop Drawings shall indicate insulation type and thickness as detailed in Hydronic Piping SS 232113.

2.2. FIRE TEST RATING

- 2.2.1 Fire-Test-Response Characteristics:
 - 2.2.1.1 Comply with ASTM E 84.
 - 2.2.1.2 All insulation, jacket materials, sealer and cement material containers shall have the proper ASTM markings.
 - 2.2.1.3 Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke developed rating of 50 or less.
 - 2.2.1.4 Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke developed rating of 150 or less.

2.3. COORDINATION

- 2.3.1 Coordinate size and location of supports, hangers, and insulation shields specified in SS 230529 Hangers and Supports for HVAC Piping and Equipment.
- 2.3.2 Coordinate clearance requirements with piping Installer for insulation application.

2.4. INSULATION MATERIALS

- 2.4.1 No mineral-fiber or Fiberglass insulation will be allowed for use on any water piping systems.
- 2.4.2 Use accessories compatible with insulation materials and suitable for the service.
- 2.4.3 Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

2.5. INSULATION APPLICATION SCHEDULE

- 2.5.1 Service: Chilled-water supply and return, **interior application.**
 - 2.5.1.1 Operating Temperature: 32 to 75 deg F (0 to 24 deg C).
 - 2.5.1.2 Insulation Material: Closed-cell phenolic foam.
 - 2.5.1.3 Insulation Thickness: 2".
 - 2.5.1.4 Field-Applied Jacket: PVC jacket and fitting covers.
 - 2.5.1.5 Vapor Retarder Required: Yes.
 - 2.5.1.6 Finish: None.
- 2.5.2 Service: Chilled-water supply and return, **exterior or unconditioned application.**
 - 2.5.2.1 Operating Temperature: 32 to 75 deg F (0 to 24 deg C).
 - 2.5.2.2 Insulation Material: Closed-cell phenolic foam.
 - 2.5.2.3 Insulation Thickness: 2".
 - 2.5.2.4 Field-Applied Jacket:
 - 2.5.2.4.1 Exterior: Aluminum jacket.
 - 2.5.2.4.2 Interior unconditioned application: Aluminum jacket or PVC jacket and fitting covers.
 - 2.5.2.5 Vapor Retarder Required: Yes.
 - 2.5.2.6 Finish: None.
- 2.5.3 Service: Drains, pipe specialties, control valves, flowmeter, and other service connections.
 - 2.5.3.1 Operating Temperature: 32 deg F to 60 deg F.
 - 2.5.3.2 Insulation Material: Flexible elastomeric.
 - 2.5.3.3 Vapor Retarder Required: No.
 - 2.5.3.4 Drain lines, air releases, ball valves:
 - 2.5.3.4.1 Insulation Thickness: 1".
 - 2.5.3.4.2 Finish: Paint with two coats of white paint.
 - 2.5.3.4.3 Field-Applied Jacket: None.
 - 2.5.3.5 Strainers:
 - 2.5.3.5.1 Insulation Thickness: 2".
 - 2.5.3.5.2 Finish: None.
 - 2.5.3.5.3 Field-Applied Jacket: Section around basket to be removable. Apply caulk to all seams where adjacent metal surfaces meet.
 - 2.5.3.5.4 Fill voids with elastomeric insulation; do not use fiberglass insulation.
 - 2.5.3.6 Heat Exchanger bolts, upper and lower frame rails, and around pipes at heat exchanger connection.
 - 2.5.3.6.1 Insulation Thickness: 2".
 - 2.5.3.6.2 Finish: None.
 - 2.5.3.6.3 Field-Applied Jacket: None.

- 2.5.3.7 Control Valves and Flowmeter
 - 2.5.3.7.1 Insulation Thickness: 2".
 - 2.5.3.7.2 Finish: None.
 - 2.5.3.7.3 Field-Applied Jacket: None.
 - 2.5.3.7.4 Fill voids with elastomeric insulation; do not use fiberglass insulation.

3. PRODUCTS

3.1. INSULATION MATERIALS

- 3.1.1 Closed-Cell Phenolic-Foam Insulation:
 - 3.1.1.1 Preformed pipe insulation of rigid, expanded, closed-cell structure.
 - 3.1.1.2 Comply with ASTM C 1126, Type III, Grade 1.
 - 3.1.1.3 Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- 3.1.2 Flexible Elastomeric Thermal Insulation:
 - 3.1.2.1 Closed-cell, sponge- or expanded-rubber materials.
 - 3.1.2.2 Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- 3.1.3 Adhesive: As recommended by insulation material manufacturer.
- 3.1.4 Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- 3.1.5 Prefabricated Thermal Insulating Fitting Covers:
 - 3.1.5.1 Comply with ASTM C 450 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.
- 3.1.6 Spray foam: (AE Approval Only for a specific application identified see Section 4.3.11)
 - 3.1.6.1 Disposable, closed-cell, two component polyurethane low-pressure spray foam kit.
 - 3.1.6.2 Closed cell content greater than 90%
 - 3.1.6.3 Density greater than or equal to 3 lb/ft³
 - 3.1.6.4 Compressive Strength greater than 19.5 psi.
 - 3.1.6.5 R value at 1" thick greater than 7.5
 - 3.1.6.6 Manufacturer: Versi-Foam or AE Approved equal

3.2. FIELD APPLIED JACKETS

- 3.2.1 Comply with ASTM C 921, Type 1, unless otherwise indicated.
- 3.2.2 PVC Jacket:
 - 3.2.2.1 High-impact, ultraviolet-resistant PVC;
 - 3.2.2.2 Minimum of 30 mils (0.75 mm) thick;
 - 3.2.2.3 Roll stock ready for shop or field cutting and forming;
 - 3.2.2.4 White color.
- 3.2.3 PVC Fitting Covers:
 - 3.2.3.1 Factory-fabricated fitting covers

- 3.2.3.1.1 Manufactured from minimum of 30-mil- (0.75-mm-) thick,
- 3.2.3.1.2 High-impact,
- 3.2.3.1.3 Ultraviolet-resistant PVC;
- 3.2.3.1.4 White color.
- 3.2.3.2 Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, mechanical joints.
- 3.2.3.3 Fitting Covers shall match radius type of pipe.
 - 3.2.3.3.1 If pipe elbow is a long radius type then fitting cover for elbow shall be long radius.
- 3.2.4 Adhesives: As recommended by insulation material manufacturer.
- 3.2.5 Aluminum Jacket (For outside and non-conditioned inside applications):
 - 3.2.5.1 Aluminum roll stock,
 - 3.2.5.2 Ready for shop or field cutting and forming to indicated sizes.
 - 3.2.5.3 Comply with ASTM B 209 (ASTM B 209M), 3003 alloy, H-14 temper.
 - 3.2.5.4 Finish and Thickness: Smooth finish, minimum of 0.016 inch (0.40 mm) thick.
 - 3.2.5.5 Moisture Barrier: minimum of 1-mil- (0.025-mm-) thick, heat-bonded polyethylene.
 - 3.2.5.6 Elbows: Pre-formed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

3.3. ACCESSORIES AND ATTACHMENTS

- 3.3.1 Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket.
 - 3.3.1.1 Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
 - 3.3.1.2 Aluminum: ASTM B209, Aluminum alloy, 0.020 inch (0.5 mm) thick

3.4. VAPOR RETARDERS

- 3.4.1 Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

4. EXECUTION

4.1. EXAMINATION

- 4.1.1 Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- 4.1.2 Proceed with installation only after unsatisfactory conditions have been corrected.

4.2. PREPARATION

- 4.2.1 Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

4.3. GENERAL APPLICATION REQUIREMENTS

- 4.3.1 Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- 4.3.2 Refer to schedules in Section 2.5 for materials, forms, jackets, and thicknesses required for each piping system.
- 4.3.3 Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- 4.3.4 Apply multiple layers of insulation with longitudinal and end seams staggered.
- 4.3.5 Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- 4.3.6 Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- 4.3.7 Keep insulation materials dry during application and finishing.
- 4.3.8 Apply insulation with tight longitudinal seams and end joints.
 - 4.3.8.1 Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- 4.3.9 Apply insulation with the least number of joints practical.
- 4.3.10 Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 4.3.10.1 Refer to special instructions Section 4.5.2 thru 4.5.4 and 4.6.2 thru 4.6.4 for applying insulation over fittings, valves, and specialties.
- 4.3.11 Utilize spray in foam in locations where voids occur only with AE Approval for each application and location.
- 4.3.12 Insulation Terminations:
 - 4.3.12.1 For insulation application where vapor retarders are indicated, taper insulation ends.
 - 4.3.12.2 Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- 4.3.13 Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- 4.3.14 Apply insulation with integral jackets as follows:
 - 4.3.14.1 Pull jacket tight and smooth.
 - 4.3.14.2 Circumferential Joints: Cover with minimum of 3-inch (75-mm) wide strips, of same material as insulation jacket.
 - 4.3.14.2.1 Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
 - 4.3.14.3 Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm).
 - Apply insulation with longitudinal seams at bottom of pipe.
 - 4.3.14.3.1 Clean and dry surface to receive self-sealing lap.
 - 4.3.14.3.2 Do not staple longitudinal laps on insulation having a vapor retarder.

- 4.3.14.4 Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
- 4.3.14.5 At penetrations in jackets fill and seal voids with vapor-retarder mastic.
- 4.3.15 Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- 4.3.16 Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 4.3.16.1 Firestopping and fire-resistive joint sealers shall be FM approved.

4.4. HANGERS AND SUPPORTS INSULATION APPLICATION

- 4.4.1 Where vapor retarder is indicated,
 - 4.4.1.1 Seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 4.4.1.2 Apply insulation continuously through hangers and around anchor attachments.
 - 4.4.1.3 For insulation application where vapor retarders are indicated,
 - 4.4.1.3.1 Extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends.
 - 4.4.1.3.2 Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 4.4.1.4 Install insert materials and apply insulation to tightly join the insert.
 - 4.4.1.4.1 Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4.4.1.5 Cover inserts with jacket material matching adjacent pipe insulation.
 - 4.4.1.6 Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

4.5. CLOSED-CELL PHENOLIC FOAM INSULATION APPLICATION

- 4.5.1 Apply insulation to straight pipes and tubes as follows.
 - 4.5.1.1 Secure each layer of insulation to pipe with tape, or bands without deforming insulation materials.
 - 4.5.1.2 Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 - 4.5.1.3 For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - 4.5.1.4 For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- 4.5.2 Apply insulation to flanges as follows:
 - 4.5.2.1 Apply preformed pipe insulation to outer diameter of pipe flange.

- 4.5.2.2 Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
- 4.5.2.3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
- 4.5.2.4 Apply PVC fitting cover material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.
- 4.5.3 Apply insulation to fittings and elbows as follows:
 - 4.5.3.1 Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available.
 - 4.5.3.1.1 Secure according to manufacturer's written instructions.
 - 4.5.3.2 When pre-molded sections of insulation are not available, apply mitered sections of phenolic-foam insulation.
 - 4.5.3.2.1 Secure insulation materials with tape, or bands.
 - 4.5.3.3 Cover fittings with PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end.
 - 4.5.3.3.1 Secure fitting covers with manufacturer's attachments and accessories.
 - 4.5.3.3.2 Seal seams with tape and vapor-retarder mastic.
- 4.5.4 Apply insulation to valves and specialties as follows:
 - 4.5.4.1 Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available.
 - 4.5.4.2 Secure according to manufacturer's written instructions.
 - 4.5.4.3 When pre-molded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body.
 - 4.5.4.4 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4.5.4.5 For isolation valves, arrange insulation for access to strainer basket without disturbing insulation.
 - 4.5.4.6 Apply insulation to flanges as specified for flange insulation application.
 - 4.5.4.7 Use preformed PVC fitting covers for valve sizes where available.
 - 4.5.4.7.1 Secure fitting covers with manufacturer's attachments and accessories.
 - 4.5.4.7.2 Seal seams with tape and vapor-retarder mastic.

4.6. FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- 4.6.1 Apply insulation to straight pipes and tubes as follows:
 - 4.6.1.1 Seal longitudinal seams and end joints with manufacturer's recommended adhesive.
 - 4.6.1.1.1 Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

- 4.6.2 Apply insulation to flanges as follows:
 - 4.6.2.1 Apply pipe insulation to outer diameter of pipe flange.
 - 4.6.2.2 Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 - 4.6.2.3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 - 4.6.2.4 Secure insulation to flanges and seal seams with manufacturer's recommended adhesive.
 - 4.6.2.5 Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- 4.6.3 Apply insulation to fittings and elbows as follows:
 - 4.6.3.1 Apply mitered sections of pipe insulation.
 - 4.6.3.2 Secure insulation materials and seal seams with manufacturer's recommended adhesive.
 - 4.6.3.3 Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- 4.6.4 Apply insulation to valves and specialties as follows:
 - 4.6.4.1 Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 - 4.6.4.2 Apply cut segments of pipe and sheet insulation to valve body.
 - 4.6.4.3 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4.6.4.4 For isolation valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
 - 4.6.4.5 Apply insulation to flanges as specified for flange insulation application.
 - 4.6.4.6 Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive.
 - 4.6.4.7 Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

4.7. FIELD APPLIED JACKET APPLICATION

- 4.7.1 Apply PVC jackets where indicated, with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels.
 - 4.7.1.1 Seal with manufacturer's recommended adhesive.
 - 4.7.1.2 Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- 4.7.2 Apply metal jacket where indicated, with 2-inch (50-mm) overlap at longitudinal seams and end joints.

- 4.7.2.1 Overlap longitudinal seams arranged to shed water.
- 4.7.2.2 Seal end joints with weatherproof sealant recommended by insulation manufacturer.
- 4.7.2.3 Secure jacket with stainless-steel or aluminum bands 12 inches (300 mm) o.c. and at end joints

END of SECTION

AUSTIN ENERGY CHILLED WATER MONITORING CONTROLS

SECTION SS 230900

9/23/2020

Version 22.0

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for test plugs, controls, control enclosures, control wiring and conduit, and control devices.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project layout.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of Project
- 1.2.13 Loop Check – The verification process of determining if the instrumentation installed and wired is functioning properly from terminal strip in PLC cabinet to field device
- 1.2.14 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.15 PLC Drawings – A set of drawings outlining the components and fabrication details for the PLC cabinet. If in a Skid package project, these documents will be located

in the Design Data Packet. Otherwise, these drawings will be in the Contract Documents.

- 1.2.16 Project – the design and construction of a specific building’s mechanical room’s chilled water system delivery
- 1.2.17 Skid – Packaged heat exchanger system
- 1.2.18 Shop Drawings – detailed drawings used for shop personnel to fabricate Project.
- 1.2.19 Specification – the Specification is defined as this document, titled Austin Energy Chilled Water Monitoring Controls SS 230900.
- 1.2.20 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.21 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected.
- 1.2.22 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.23 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 CDL Customer Data Link
- 1.3.3 DDP Design Data Packet
- 1.3.4 EMS Energy Management System
- 1.3.5 RTD Resistance Temperature Detector
- 1.3.6 PLC Programmable Logic Controller
- 1.3.7 PTX Pressure Transmitter

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 National Electric Code
- 1.4.3 National Electrical Manufacturers Association

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Project design and manufacture

- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.4 Chilled Water Monitoring Controls SS 230900
- 1.5.5 Hydronic Piping SS 232113
- 1.5.6 Conductor & Cables SS 260519
- 1.5.7 Raceways SS 260533
- 1.5.8 AE Details M20 through M29
- 1.5.9 AE PLC Drawings PLC-01 – PLC-10

1.6. QUALIFICATIONS

- 1.6.1.1 Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- 1.6.1.2 Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7. QUALITY ASSURANCE

- 1.7.1 Contractor shall provide calibration certificates for their calibrating equipment include in Final Submittal.
- 1.7.2 Contractor to verify calibration range of each instrument
- 1.7.3 Contractor to verify calibration of each instrument
- 1.7.4 Contractor to Loop Check all instruments to the terminal strip of PLC control cabinet.

1.8. AUDITS AND INSPECTIONS

- 1.8.1 AE Inspector/AE Engineer may inspect all controls components that have been installed and/or terminated.

1.9. SUBMITTALS

- 1.9.1 GENERAL
 - 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.9.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.9.1.1.2 Table of Contents page
 - 1.9.1.1.3 Dividing pages with Equipment title
 - 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
 - 1.9.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award
 - 1.9.1.4 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
 - 1.9.1.5 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.

- 1.9.1.5.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL WITH QUOTATION

- 1.9.2.1 Contractor shall supply a quote for both manufacturers of control valves. The control valves should be priced as an assembly of valve, actuator, mounting bracket and coupling.
 - 1.9.2.1.1 AE will decide which control valve the contractor shall purchase dependent on lead time, price and availability after contractor submits pricing for each control valve manufacturer.

1.9.3 SUBMITTAL AFTER AWARD

- 1.9.3.1 PLC Shop Drawings
 - 1.9.3.1.1 Detail equipment assemblies; indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1.9.3.1.2 Detail method of field installation of control cabinet, and support structure and anchorage.
- 1.9.3.2 PLC Wiring Drawings indicating all components housed and wired within the PLC cabinet.
- 1.9.3.3 Bill of materials of equipment indicating quantity, manufacturer, and model number.
- 1.9.3.4 Product Data: For each type of product indicated.

1.9.4 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.9.4.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.9.4.1.1 All approved submittals
 - 1.9.4.1.2 Product Certificates: For each type of instrument, from manufacturer.
 - 1.9.4.1.2.1 Flowmeter: High Accuracy calibration and certificate required.
 - 1.9.4.1.2.2 RTD:
 - 1.9.4.1.2.3 Pressure Devices:
 - 1.9.4.1.2.4 Control Valves and its Actuators:
 - 1.9.4.1.2.5 Level Sensors:
 - 1.9.4.1.2.6 Any other instrumentation supplied but not directly listed above.
 - 1.9.4.1.2.7 All calibrating equipment used.
 - 1.9.4.1.3 Operation and Maintenance Data: For instruments to include operation and Maintenance manuals.

1.10. COORDINATION

- 1.10.1 Coordinate with representatives of Austin Energy in all aspects of controls installation and testing

- 1.10.2 Provide Austin Energy representative with 48 hours advance notice of planned installation of control devices and sensors. Prior to installation, obtain direct AE representative Approval for precise locations within piping where control devices are to be installed.
- 1.10.3 Contractor shall coordinate control panel termination of power wiring with building Owner.

2. DESIGN

2.1. CONTROL PANEL

2.1.1 General

- 2.1.1.1 In addition to the normal power ground referenced in Section 4.1.1, provide 3/4" EMT conduit and #12 ground wire from the DC ground bar (1GB-IE) within the AE PLC cabinet to the secondary-side ground connection at transformer feeding the service panel.
- 2.1.1.2 AE PLC cabinet location will be specified by AE.
 - 2.1.1.2.1 Mounting:
 - 2.1.1.2.1.1 Skid Structure: Mount the cabinet on a free-standing self-supporting structure. Unistrut shall not be used.
 - 2.1.1.2.1.2 Concrete Wall: Mount the cabinet using vertical double unistrut.
 - 2.1.1.2.1.2.1. Unistrut must be securely anchored to base along length of Unistrut at points with maximum 10" separation.
 - 2.1.1.2.2 Cabinet must be securely anchored, and installed level.
 - 2.1.1.2.3 Do not use plastic anchoring devices.
 - 2.1.1.2.4 Refer to detail AE detail M29.

2.1.1.3

2.1.2 Wire and Labels

- 2.1.2.1 Labels shall be black lettering on white heat shrink type labels. Labels shall be sized to cable/wire for a seamless fit.
- 2.1.2.2 Labels shall be easily seen and readable without movement of the label or the wire/cable it was applied.

2.2. CONTROL DEVICE

- 2.2.1 Within 3 Feet of field device: Installation of flexible conduit (Liquatite EF) must be adequate for repeated removal and reinstallation at the field device to facilitate future maintenance.
- 2.2.2 Pressure Transmitters:
 - 2.2.2.1 3/8" stainless steel tubing from pressure transmitters to CHS/CHR pipe.
 - 2.2.2.2 Refer to AE detail M20, M22 and M29, in location approved by AE.

- 2.2.2.3 Pressure transmitters are to be located at a lower elevation than the main piping tap points for connecting transmitter tubing.
- 2.2.2.4 All interconnecting tubing is to be installed with slope downwards from tap points to transmitter so as to leave no high points in tubing which can collect air.
- 2.2.2.5 Do not install pressure transmitters above electrical panels, or electrical devices utilizing 120V or higher power.
- 2.2.3 RTDs:
 - 2.2.3.1 Maintain 18 inches minimum clearance above RTD's or to the side of RTD if RTD is mount on side of piping to allow for ease of removal.
- 2.2.4 Flowmeter:
 - 2.2.4.1 Refer to AE Detail M22 and M28.
- 2.2.5 Control Valve:
 - 2.2.5.1 Refer to AE Detail M22 and M27
- 2.2.6 Test Plug:
 - 2.2.6.1 Install test plugs in piping as defined by Shop Drawings.
 - 2.2.6.2 Test Plug installation: Provide the following, in order from connection at main chilled water pipe (reference standard AE details):
 - 2.2.6.2.1 ¾" Threadolet
 - 2.2.6.2.2 Minimum 2" long, threaded, 1" NPT, schedule 80, 316 stainless steel nipple; insulate nipple with 1/2" elastomeric insulation.
 - 2.2.6.2.3 Shutoff valve: Ball valve, 1"; reference SS 230523 GENERAL-DUTY VALVES FOR HVAC PIPING.
 - 2.2.6.2.4 Test plug, with transition bushing as required.
 - 2.2.6.3 Install test plugs in the following locations:
 - 2.2.6.3.1 Inlet and outlet of each heat exchanger.
 - 2.2.6.3.2 In piping where it enters and leaves mechanical room.
 - 2.2.6.3.3 Within 6" of a pressure transmitter connection tap in the pipe.
 - 2.2.6.3.4 Other locations as indicated in drawings.
 - 2.2.6.4 Refer to AE Detail M21 and M22

2.3. CONTROL CONDUITS

- 2.3.1 Conduit Sizes for Belden Cables and Control Wires:
 - 2.3.1.1 Use the following conduit sizes versus quantity of wires installed within conduit:
 - 2.3.1.1.1 Conduits shall be no smaller than ¾".
 - 2.3.1.1.2 For 2 or more cables or wires, conduits shall have no more than 40% fill.

- 2.3.1.1.3 For one cable or wire, conduits shall have no more than 30% fill
- 2.3.2 Control cabinet conduit penetrations:
 - 2.3.2.1 Fiber: Provide 1-1/2" conduit; penetrate cabinet at the bottom on either side. All other conduit for controls will run out of the bottom right side of cabinet.
 - 2.3.2.2 Power: All conduits with 120VAC are to penetrate cabinet at bottom left hand side.
- 2.3.3 Customer Data Link (CDL) (where applicable)
 - 2.3.3.1 Reference PLC Drawings for wire type and connections.

3. PRODUCTS

3.1. CONTROLLERS

- 3.1.1 Provide PLC controller, cabinet, and wiring per Design Data Packet

3.2. CONTROL VALVES

- 3.2.1 V-notch control ball valve:
 - 3.2.1.1 Full bore
 - 3.2.1.2 90 deg. V notch
 - 3.2.1.3 Straight-thru flow
 - 3.2.1.4 Stainless steel ball and stem
 - 3.2.1.5 PTFE packing
 - 3.2.1.6 Class 150 flange
 - 3.2.1.7 Stainless steel bracket and coupling to actuator.
 - 3.2.1.8 Corrosion resistant fasteners shall be used.
- 3.2.2 Actuator:
 - 3.2.2.1 120V electric actuator
 - 3.2.2.2 4-20mA input signal
 - 3.2.2.3 Selectable direct or reverse acting
 - 3.2.2.4 Limit switches
 - 3.2.2.5 Mechanical stop
 - 3.2.2.6 Rated for continuous operation
 - 3.2.2.7 Potentiometer position detector
 - 3.2.2.8 NEMA 4X enclosure
 - 3.2.2.9 Reversible motor with thermal protection.
 - 3.2.2.10 4-20mA output signal to indicate position of valve
 - 3.2.2.11 Actuator capable of Continuous Operation
 - 3.2.2.12 Ability to designate Fail position of valve (Close, Open or Last)
- 3.2.3 Pentair KTM Valve:

- 3.2.3.1 Seat: Single seat design.
- 3.2.3.2 Seat Material: Laminated 316SST.
- 3.2.3.3 Manufacturer/Model:
 - 3.2.3.3.1 4" valve size: Pentair/KTM VA11-32.3L/4.0 valve, Nucom 10NM actuator.
 - 3.2.3.3.2 6" valve size: Pentair/KTM VA11-32.3L/6.0, Nucom 10NM actuator.
 - 3.2.3.3.3 8" valve size: Pentair/KTM VA11-32.3L/8.0, Nucom 10NL actuator.
 - 3.2.3.3.4 10" valve size: Pentair/KTM VA11-32.3L/10.0, Nucom 10NL-100 actuator.

3.2.4 Bray Controls Valve

- 3.2.4.1 Seat: Dual seat design.
- 3.2.4.2 Seat material: Stainless Steel PTFE 50/50.
- 3.2.4.3 Manufacturer/Model:
 - 3.2.4.3.1 4" valve size: Bray/Flow-tek F15-V-WCB 4", Nucom 10NM actuator
 - 3.2.4.3.2 6" valve size: Bray/Flow-tek F15-V-WCB 6", Nucom 10NL actuator.
 - 3.2.4.3.3 8" valve size: Bray/Flow-tek F15-V-WCB 8", Nucom 10NL-100 actuator.
 - 3.2.4.3.4 10" valve size: Bray/Flow-tek F15-V-WCB 10", Nucom 10NL-200 actuator

3.3. FLOWMETERS

3.3.1 Magnetic Flowmeter:

- 3.3.1.1 Lining Material: PTFE
- 3.3.1.2 Electrode Material: 316L SST
- 3.3.1.3 Electrode Type: 2 measurement electrodes
- 3.3.1.4 Flange Rating: Class 150#
- 3.3.1.5 Flange Type: Slip-On Flanged process connections.
- 3.3.1.6 Coil housing: Welded, sealed.
- 3.3.1.7 Mounting Configuration: 8732 transmitter mounting style defined in Design Data Packet
- 3.3.1.8 Calibration: High Accuracy with Certificate
- 3.3.1.9 Pulse DC technology.
- 3.3.1.10 Transmitter with built in transient protection compliant with IEC 611185-2.2000 Class 3.

3.3.2 Flow Transmitter:

- 3.3.2.1 Transmitter Mount: as defined in Design Data Packet

- 3.3.2.2 Power Supply: 120VAC
- 3.3.2.3 Transmitter Output: 4-20mA output.
- 3.3.2.4 Conduit Entry: ½" – 14 NPT
- 3.3.2.5 Display: Local Operator Interface
- 3.3.2.6 Calibration: High Accuracy with Certificate
- 3.3.3 Manufacturer:
 - 3.3.3.1 Rosemount 8700 series with 8732EMT transmitter.
 - 3.3.3.2 Refer to Design Data Packet for specific model number.

3.4. TEMPERATURE ELEMENTS

- 3.4.1 RTD:
 - 3.4.1.1 Element Type: Platinum Pt-100 RTD temperature sensor.
 - 3.4.1.2 Wire configuration: 4 wire.
 - 3.4.1.3 Tube diameter: 3/8" 316 SS closed tip tube.
 - 3.4.1.4 Tube Material: 316 SST
 - 3.4.1.5 Process NPT: ½" process connection.
 - 3.4.1.6 Accuracy: 0.03 Deg C.
 - 3.4.1.7 Termination Head: Aluminum connection head and chain.
 - 3.4.1.7.1 Six terminals at a minimum.
 - 3.4.1.7.2 Flat cover.
 - 3.4.1.8 Options: SST tag with model and serial number and tag name as defined in PLC drawings.
- 3.4.2 Thermowell:
 - 3.4.2.1 Size: ½" NPT
 - 3.4.2.2 Shank Style: Tapered
 - 3.4.2.3 Process Engagement: Threaded well design
 - 3.4.2.4 Bore Size: 0.385" ID
 - 3.4.2.5 Well Material: 316 SS
 - 3.4.2.6 Sensor: with lag extension
- 3.4.3 Manufacturer:
 - 3.4.3.1 JMS 3SSAK series temperature element
 - 3.4.3.2 JMS 51TT3 series thermowell
 - 3.4.3.3 Refer to Design Data Packet for specific model number.

3.5. PRESSURE TRANSMITTER

- 3.5.1 Gage Pressure Transmitter:
 - 3.5.1.1 Transmitter Type: Gage measurement
 - 3.5.1.2 Diaphragm: 316L SST / 316L SST construction
 - 3.5.1.3 Fill Fluid: Silicone

- 3.5.1.4 Range: -14.7 to 150 psi pressure range
- 3.5.1.5 Transmitter Output: 4-20 mA dc / Digital HART Protocol output
- 3.5.1.6 Process Connection: ½"-14 NPT Female
- 3.5.1.7 Conduit Entry: ½" – 14 NPT
- 3.5.1.8 Display: LCD Display scaled 0-150 psig
- 3.5.1.9 Mounting Bracket : SST with SST Bolts
- 3.5.1.10 Assemble to Rosemount 306 integral manifold.
- 3.5.1.11 Manufacturer/model:
 - 3.5.1.11.1 Rosemount model 2088G2S22A1M5B4S5
- 3.5.2 Manifold:
 - 3.5.2.1 Manifold Style: Threaded manifold
 - 3.5.2.2 Manifold Type: Block and bleed type
 - 3.5.2.3 Materials of Construction: 316 Stainless steel
 - 3.5.2.4 Process Connection Style: ½" – 14 male ANPT
 - 3.5.2.5 Packing material: PTFE
 - 3.5.2.6 Valve seat: Integral
 - 3.5.2.7 Manufacturer/model:
 - 3.5.2.7.1 Rosemount model 0306RT12AA11 Integral Manifold

3.6. TEST PLUGS

- 3.6.1 Corrosion-resistant brass or stainless-steel body with core inserts.
- 3.6.2 Gasketed and threaded cap.
- 3.6.3 Extended stem for units to be installed in insulated piping.
- 3.6.4 Minimum Pressure and Temperature Rating: 500 psig at 200 deg F
- 3.6.5 Core Inserts: One or two self-sealing rubber valves.
 - 3.6.5.1 Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
 - 3.6.5.2 Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.
- 3.6.6 Manufacturers:
 - 3.6.6.1 Peterson Equipment Co., Inc
 - 3.6.6.2 Or AE approved equal

3.7. CONTROL WIRING

- 3.7.1.1 RTD's: Belden 9365 or AE approved equal for each RTD.
- 3.7.1.2 PTX's: Belden 9318 or AE approved equal for each PTX.
- 3.7.1.3 Flow Tubes:
 - 3.7.1.3.1 Signal:
 - 3.7.1.3.1.1 Belden 9318

- 3.7.1.3.1.2 or AE approved equal
- 3.7.1.3.2 Power: 120 VAC 14 AWG.
- 3.7.1.4 Actuator:
 - 3.7.1.4.1 Signal:
 - 3.7.1.4.1.1 Belden 9318
 - 3.7.1.4.1.2 Or AE approved equal
 - 3.7.1.4.2 Power: 120 VAC 14 AWG.

3.8. POWER WIRING

3.8.1 Use the following wire types and coloring:

3.8.1.1 For Heat Exchanger Systems:

Service	Color	AWG/PN	Wire Type
120 VAC Hot from Customer Dedicated Circuit Breaker	Black	12	THHN or THWN, stranded, CU
120 VAC Neutral from Customer Dedicated Neutral	White	12	THHN or THWN, stranded, CU
120 VAC Equipment Ground from Customer Dedicated Ground	Green	12	THHN or THWN, stranded, CU
Isolated Ground	Green	12	THHN or THWN, stranded, CU
120 VAC Valve Circuit Breaker in Panel to Field device	Red	14	THHN or THWN, stranded, CU
120 VAC Neutral in Panel to Field device Neutral	White	14	THHN or THWN, stranded, CU
120 VAC Equipment Ground in Panel to Field device Ground	Green	14	THHN or THWN, stranded, CU

3.8.1.2 For all other Systems:

Service	Color	AWG/PN	Wire Type
120 VAC Hot from Dedicated Circuit Breaker	Black	See DDP	THHN or THWN, stranded, CU
120 VAC Neutral from Dedicated Neutral	White	See DDP	THHN or THWN, stranded, CU
120 VAC Equipment Ground from Dedicated Ground	Green	See DDP	THHN or THWN, stranded, CU
Isolated Ground	Green	See DDP	THHN or THWN, stranded, CU
120 VAC Valve Circuit Breaker in Panel to Field device	Red	14	THHN or THWN, stranded, CU

120 VAC Neutral in Panel to Field device Neutral	White	14	THHN or THWN, stranded, CU
120 VAC Equipment Ground in Panel to Field device Ground	Green	14	THHN or THWN, stranded, CU

3.9. CONTROL CONDUIT

3.9.1 Reference specifications section SS 260533 RACEWAYS AND BOXES, and Section 4.3 CONTROL CONDUIT below.

3.10. CUSTOMER DATA LINK (where applicable)

3.10.1 CDL:

- 3.10.1.1 Allen Bradley 4 channel analog input module, part # 1769-OF4.
Weidmuller DC/DC Loop Isolators, part #14774200000 (qty. 4).
- 3.10.1.2 Mounted in main metering panel.
- 3.10.1.3 Refer to PLC drawings in Design Data Packet for additional parts and wiring details.

3.10.2 Cabinet:

- 3.10.2.1 Hoffman Panel A808CH with Hoffman Plate A8P8.
- 3.10.2.2 Refer to PLC drawings.

4. EXECUTION

4.1. GENERAL

- 4.1.1 For Heat Exchanger Skid Packages, Building Side Contractor to provide 120V 20 Amp dedicated single use power to control cabinet.
- 4.1.2 Contractor shall terminate 120V power wiring at control panel from dedicated circuit.
- 4.1.3 Contractor shall not splice any wiring.
- 4.1.4 Pull power wires and instrument cables from the PLC cabinet to field devices and terminate both ends.
- 4.1.5 The maximum length of any flexible connection is 3 feet unless otherwise AE Engineer approved before installation.
- 4.1.6 Install control devices in strict accordance with manufacturer’s recommendations.
- 4.1.7 Insulate piping and fittings to prevent condensation from forming and dripping. Refer to SS 230719 Pipe Insulation.
- 4.1.8 Reference Shop drawings, and Manufacturer’s installation drawings for installation details and requirements.

- 4.1.9 Contractor shall Loop Check all instrumentation connected to terminal strip inside PLC cabinet.

4.2. INSTALLATION

- 4.2.1 Control Panel:
 - 4.2.1.1 Controls enclosure and mounting thereof.
 - 4.2.1.2 Programmable controllers.
 - 4.2.1.3 Wires and cables should be labeled correctly at each end of the cable/wire with easy to read wire numbers and instrument names that match cabinet drawings.
 - 4.2.1.4 Identify incoming power supply breaker circuit number with a permanent phenolic label attached to the AE PLC door's exterior upper left hand corner.
- 4.2.2 Control Devices:
 - 4.2.2.1 Reference Section 2.2 for components in this Section.
 - 4.2.2.2 Provide and install control devices and sensors, including flow meter, flow control valves, temperature sensors, pressure sensors, thermowells, all required pipe fittings.
 - 4.2.2.3 Provide and install low voltage control wiring and conduit from controller terminal connections to control and sensing devices: flow meter, flow control valves, temperature sensors, and pressure sensors.
 - 4.2.2.4 Pressure Transmitters:
 - 4.2.2.4.1 Install pressure transmitters and pressure taps as defined by Shop Drawings.
 - 4.2.2.4.2 Mount pressure transmitters with manufacturer-provided mounting brackets and hardware on vertical Unistrut/square tubing channels, refer to AE detail M20, M22 and M29, in location approved by AE.
 - 4.2.2.5 RTDs:
 - 4.2.2.5.1 Install RTDs in thredolet as defined by Shop Drawings
 - 4.2.2.6 Flowmeter:
 - 4.2.2.6.1 Install flowmeters in piping as defined by Shop Drawings.
 - 4.2.2.6.2 Flowmeter shall be installed with vendor supplied grounding straps. Contractor shall install the grounding straps according to manufacturer's recommendations.
 - 4.2.2.6.3 Mount flowmeter in an upright position or no more than 45 degrees from vertical.
 - 4.2.2.7 Control Valve:
 - 4.2.2.7.1 Install control valves in piping as defined by Shop Drawings.

4.2.2.7.2 Mount control valve in an upright position or no more than 45 degrees from vertical.

4.2.2.8 Test Plug:

4.2.2.8.1 Install test plugs in piping as defined by Shop Drawings.

4.3. CONTROL CONDUIT

4.3.1 Fiber Conduit: Provide 1-1/2" metal EMT conduit to the PLC cabinet from the fiber pull box located in the mechanical room (size to be determined on a per building basis and indicated on mechanical room drawing)

4.3.2 Provide independent power and signal conduits from AE's PLC cabinet to all instruments.

4.3.3 Approved materials:

4.3.3.1 Above 5 ft.: Metal EMT conduit

4.3.3.2 Below 5 ft.:

4.3.3.2.1 Rigid Metal Steel

4.3.3.2.2 EMT (AE Approval on a case by case basis)

4.3.3.3 Metal J-boxes and covers.

4.3.3.4 Liquatite-EF (flexible conduit) or AE Engineer approved equal for termination to instruments.

4.3.3.5 Thomas & Betts liquid tight fittings or AE Engineer approved equal

4.3.4 Customer Data Link (CDL) (where applicable)

4.3.4.1 Mount the CDL cabinet in location specified by AE. Mount cabinet on vertical Unistrut channels.

4.3.4.2 Provide 3/4" conduit from the PLC to the CDL. Penetrate the PLC cabinet at the bottom, and the CDL cabinet from bottom left or bottom right side.

4.3.4.3 Provide wiring from PLC to CDL.

4.4. PROGRAMMABLE LOGIC CONTROLLER AND ETHERNET MODULES

4.4.1 Flash the PLC controller with firmware version provided by AE in DDP.

4.4.2 Set each Ethernet module to the IP Address as indicated by AE in DDP.

4.5. AUSTIN ENERGY PROVIDED WORK

4.5.1 Austin Energy will provide the firmware revision for the PLC controller(s) and all IP Addresses for each Ethernet module.

4.5.2 Austin Energy will provide all programming and PLC commissioning of controllers.

4.6. COMMISSIONING

4.6.1 For skid packages, refer to SS 232050 Packaged Heat Exchanger System for commissioning.

4.6.2 For other Projects, refer to specific commissioning documentation.

END of SECTION

Packaged Heat Exchanger System

SECTION SS 232050

7/29/2020

Version 22.0

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SECTION SS 232050**

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1. GENERAL REQUIREMENTS

1.1. SCOPE

1.1.1 This specification defines the requirements for the design, manufacture, transportation, and installation of the complete Packaged Heat Exchanger System which includes

- 1.1.1.1 Structural steel base
- 1.1.1.2 Structural supports
- 1.1.1.3 Piping
- 1.1.1.4 Heat exchangers
- 1.1.1.5 Valves
- 1.1.1.6 Instrumentation
- 1.1.1.7 PLC Controls

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidenced by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of skid layout.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of skid layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of skid

- 1.2.13 Installer – Building Contractor for each project that provides the work for installation of the packaged heat exchanger system
- 1.2.14 Manufacturer – the company awarded the work to design, build and deliver the packaged heat exchanger system
- 1.2.15 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.16 Project – the design and construction of a specific building’s mechanical room’s chilled water system delivery
- 1.2.17 Skid – Packaged heat exchanger system
- 1.2.18 Shop Drawings – detailed drawings used for shop personnel to fabricate the Skid
- 1.2.19 Specification – the Specification is defined as this document, titled Packaged Heat Exchanger System SS 232050.
- 1.2.20 Submittal after Award – Body of documents required to be submitted 10 business days after award of work to Manufacturer but before any fabrication commences.
- 1.2.21 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected
- 1.2.22 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.23 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 AISC American Institute of Steel Construction
- 1.3.3 ANSI American National Standards Institute
- 1.3.4 ASME American Society of Mechanical Engineers
- 1.3.5 ASTM American Society of Testing and Materials
- 1.3.6 AWS American Welding Society
- 1.3.7 BPVC ASME Boiler Pressure Vessel Code
- 1.3.8 FAT Factory Acceptance Testing
- 1.3.9 HX Heat Exchanger
- 1.3.10 SSPC Society for Protective Coatings
- 1.3.11 SP2 Surface Preparation Specification Number 2

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to skid components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 AISC Manual of Steel Construction
- 1.4.3 ASME B31 Pressure Piping Code
- 1.4.4 ASME BPVC Section IX
- 1.4.5 AWS D1.1
- 1.4.6 Building Officials and Code Administrators International, Inc
- 1.4.7 Electrical Testing Laboratories
- 1.4.8 Hydraulic Institute
- 1.4.9 National Association of Corrosion Engineers
- 1.4.10 National Electric Code
- 1.4.11 National Electrical Manufacturers Association
- 1.4.12 Surface Preparation Specification No. 2
- 1.4.13 Uniform Building Code
- 1.4.14 Underwriters Laboratories

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Skid design and manufacture
- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 General Duty Valves for HVAC Piping SS 230523
- 1.5.4 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.5 HVAC Pipe Identification SS 230553
- 1.5.6 Pipe Insulation SS 230719
- 1.5.7 Chilled Water Monitoring Controls SS 230900
- 1.5.8 Hydronic Piping SS 232113
- 1.5.9 Chilled Water Flush & Chemical Treatment SS 232500
- 1.5.10 Heat Exchangers for HVAC SS 235700
- 1.5.11 Conductor & Cables SS 260519
- 1.5.12 Raceways SS 260533
- 1.5.13 AE Details M20 through M29

1.6. QUALIFICATIONS

- 1.6.1 The Manufacturer shall have in place a Quality Management System which meets ISO 9001 requirements.
- 1.6.2 Manufacturer shall have at a minimum five years in design, manufacturing, and application experience with heat exchanger skid systems, district cooling systems, or other similar type systems.

- 1.6.3 Manufacturer shall have a professionally licensed Structural Engineer (structural supports and base design) and a skid design Engineer (for design of all components not part of structural design) at their disposal.
- 1.6.4 All pressure piping welders shall be qualified to B31.1 for the welding on piping components.
- 1.6.5 All structural welders shall be qualified to AWS D1.1 for welding on structural base and supports.

1.7. QUALITY ASSURANCE

- 1.7.1 All structural welds shall be visually inspected
 - 1.7.1.1 Record of visual inspection by person other than welder who performed the welding shall be kept, reviewed during site visit and provided with final submittal
- 1.7.2 All piping welds shall be compliant with AE Specification Hydronic Piping SS 232113 quality requirements

1.8. AUDITS AND INSPECTIONS

- 1.8.1 Virtual Inspections
 - 1.8.1.1 Manufacturer shall accommodate for at least three virtual inspections: virtual inspections may include but not limited to the following:
 - 1.8.1.1.1 Raw (not cut or welded) Piping Inspections
 - 1.8.1.1.2 Pressure Testing
 - 1.8.1.1.3 Shipping split flange alignment inspection
- 1.8.2 Skid Checkout
 - 1.8.2.1 Manufacturer shall facilitate an on-site visit by two (2) representatives from Austin Energy
 - 1.8.2.1.1 All costs associated with travel: transportation, lodging, and food shall be at the manufacturer's expense
 - 1.8.2.1.2 Length of trip will be two full days on-site, with travel in on the day before the first day on-site and travel out after 6 pm on the last day or the morning after the second day.
 - 1.8.2.2 Manufacturer shall provide estimated date of Skid Checkout (skid fabrication is at least 75% complete) with a minimum of 4 weeks' notice.
 - 1.8.2.3 AE Representatives will
 - 1.8.2.3.1 Verify skid complies with approved submittals and approved shop drawings
 - 1.8.2.3.2 Review records made during Quality Assurance practices
- 1.8.3 On-Site Acceptance Testing
 - 1.8.3.1 Once skid is on-site at its final destination, all loose components are installed and Installer has permanent power to the skid panel, AE will give two weeks' notice for requested On-Site Acceptance Testing (OAT).
 - 1.8.3.2 Manufacturer or Manufacturer's representative shall be available during OAT.

1.8.3.2.1 If any component fails or does not function according to design requirements, Manufacturer shall at Manufacturer's expense correct any deficiencies.

1.8.4 AE Inspector shall witness the removal or partial removal of the protective wrap.

1.8.4.1 Manufacturer shall not disturb or otherwise enter the skid protective wrap or area inside protective wrap until AE Inspector is on-site.

1.9. WARRANTY

1.9.1 Manufacturer shall provide 12 month warranty from the date of Substantial Completion for all components of the skid.

1.10. SUBMITTALS

1.10.1 GENERAL

1.10.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include

1.10.1.1.1 A title page with Project name, Location, and Submittal name

1.10.1.1.2 Table of Contents page

1.10.1.1.3 Dividing pages with Equipment title

1.10.1.2 Submittals must be tailored to each project, generic submittals will not be accepted

1.10.1.3 It is mandatory that the *Submittal with Quotation* documents be submitted with the Quote

1.10.1.3.1 Quotes which do not include all of *Submittal with Quotation* documents will be considered incomplete and therefore rejected

1.10.1.4 *Submittal after award* documents shall be submitted no later than 10 business days after Award

1.10.1.5 Fabrication may not begin until the *Submittal after Award* documents are received and approved.

1.10.1.6 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.

1.10.1.6.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.10.2 SUBMITTAL WITH QUOTATION

1.10.2.1 The Manufacturer's Quality Manual describing the company's Quality Management System shall be compliant with ISO 9001

1.10.2.2 Piping and Structural Welder qualifications

1.10.2.3 Piping and Structural Welding procedures

1.10.2.4 Piping and Structural Welding Procedure qualifications

1.10.2.5 Set of "Not for Construction" arrangement design drawings

- 1.10.2.6 System design information sheet detailing pipe sizes, instrumentation sizes and heat exchanger utilized

1.10.3 SUBMITTAL AFTER AWARD

- 1.10.3.1 Structural Steel base design calculations and drawings developed, signed and stamped by professionally licensed Structural Engineer to show at minimum the following
 - 1.10.3.1.1 Structural member type and size
 - 1.10.3.1.2 Center to center distances
 - 1.10.3.1.3 HX nozzle loading
 - 1.10.3.1.4 Each flange open end connection loading
 - 1.10.3.1.5 Load and deflection calculations
 - 1.10.3.1.5.1 For full WET load plus 10%
 - 1.10.3.1.5.2 For DRY load with half of the dry weight loading the back footing
 - 1.10.3.1.6 Weld symbol details for base beam attachment to diamond/smooth plate connections
 - 1.10.3.1.7 Base depth
 - 1.10.3.1.8 Overlay of structural base drawings with structural pipe supports locations and heat exchanger footing locations.
- 1.10.3.2 "For construction" shop Drawings and piping schematics and in isometric form providing at minimum the following information
 - 1.10.3.2.1 End piping connections X, Y, and Z dimensions with 1/4" tolerance
 - 1.10.3.2.2 End piping connections for piping and fittings size with class information
 - 1.10.3.2.3 End to end and side to side dimensions of base
 - 1.10.3.2.4 Piping layout including X, Y, and Z dimensions
 - 1.10.3.2.5 Pipe sizes
 - 1.10.3.2.6 Base support structure dimensions with member details and center to center spacing
 - 1.10.3.2.7 Suggested pipe support design and locations
 - 1.10.3.2.8 Location of reducers, instrumentation, valves, and specialties
- 1.10.3.3 Catalog information on valves, strainers, and control components.
- 1.10.3.4 Piping Hydraulic model detailed in section 2.2.5. in non-compressed AFT Fathom format and pdf format.
- 1.10.3.5 Welding documentation
 - 1.10.3.5.1 Weld map of piping welds in isometric view as described in hydronic piping spec SS 232113
 - 1.10.3.5.2 Pipe welding documentation as described in hydronic piping spec SS 232113

1.10.4 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.10.4.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.10.4.1.1 System design information sheet
 - 1.10.4.1.2 Description of system operation
 - 1.10.4.1.3 Skid dimensions and as-built drawings
 - 1.10.4.1.4 Piping schematic of packaged system components and specialties
 - 1.10.4.1.5 Control panel drawing with list of operator interfaces see SS 230900
 - 1.10.4.1.6 Control-wiring diagram
 - 1.10.4.1.7 Bill of material
 - 1.10.4.1.8 Record of structural welding inspection
 - 1.10.4.1.9 All approved submittals
 - 1.10.4.1.10 Pressure Test Results
 - 1.10.4.1.11 Cleaning and Flushing Acceptance and Pictures see SS 232500

2. DESIGN

2.1. GENERAL

- 2.1.1 Manufacturer shall review all standards/specifications listed in sections 1.4 and 1.5, and the Design Data Packet received from AE engineer.
 - 2.1.1.1 Manufacturer shall receive the Design Data Packet at least 15 days prior to quotation deadline.
- 2.1.2 Manufacturer shall design the skid to meet the requirements referenced in 2.1.1.
- 2.1.3 System will require
 - 2.1.3.1 Supply and return pipe flange end connections for both the AE side and customer side piping
 - 2.1.3.2 Necessary terminal contacts to the various field mounted devices and PLC control system
- 2.1.4 List of Manufacturers:
 - 2.1.4.1 Canaris
 - 2.1.4.2 Envirosep
 - 2.1.4.3 Epsilon
 - 2.1.4.4 Stellar Energy
 - 2.1.4.5 Systecon Inc.
 - 2.1.4.6 Turbine Air Systems
 - 2.1.4.7 Or AE Approved Equal compliant with Sections 1.6 and 1.7

2.2. PIPING

- 2.2.1 Piping shall be designed to meet or exceed AE's design criteria for pressure, temperature, and flow as defined in the Design Data Packet.
- 2.2.2 Design piping such that the differential pressure is no more than 13 psi at design flow.

- 2.2.3 Branch piping shall be sized for the design capacity of each heat exchanger.
- 2.2.4 Piping shall be sized for a maximum velocity of 10 feet per second.
- 2.2.5 A hydraulic model shall be provided in *Submittal after Award* which indicates compliance to temperature, pressures and flow at
 - 2.2.5.1 Full load (100%)
 - 2.2.5.2 Half load (50%)
 - 2.2.5.3 Minimum load (10%)
- 2.2.6 Piping shall consist of fabricated welded steel headers using manufactured fittings conforming to ASME B31.1.
 - 2.2.6.1 Saddle welded or fish mouth joints shall not be acceptable.
 - 2.2.6.2 Header piping shall not terminate with end caps.

2.3. STRUCTURAL STEEL BASE

- 2.3.1 Base shall be designed to comply with AISC Manual of Steel Construction.
- 2.3.2 Base shall be designed to meet or exceed the following criteria
 - 2.3.2.1 Capable of supporting the full wet load plus 10% capacity of HX, piping, and components of the skid
 - 2.3.2.2 Capable of supporting the full dry load capacity of HX, piping, and components while in transit
- 2.3.3 Base shall be designed for lifting, shipping, and proper installation
- 2.3.4 Base shall be lifted with a maximum of 4 lifting lugs
- 2.3.5 Base shall be large enough to support all skid components
- 2.3.6 Base must be suitable for bolting to the floor and sealing to a concrete floor
- 2.3.7 Structural base shall not deflect more than the allowable strain at the allowable design stress or 1/360th of the length of the base, whichever is less
- 2.3.8 Base shall be covered with a minimum 3/16" thick diamond plate steel.
 - 2.3.8.1 Plate shall cover the total base (except under HX)and be welded to the substructure
 - 2.3.8.1.1 A smooth steel plate with a minimum thickness of 3/8" shall be placed underneath each heat exchanger and extend out at least 4 inches beyond the outermost points of the heat exchanger and support frame, or the outer measurements of the shroud whichever is greater.
 - 2.3.8.1.2 Smooth steel plate must be welded to support beams
 - 2.3.8.1.3 Heat exchanger shall be mounted plumb and level on a smooth surface.
 - 2.3.8.2 Any seams in the plate shall be continuously welded

2.4. HEAT EXCHANGER

- 2.4.1 Heat exchanger mounting "feet" shall be attached to 3/8" smooth steel baseplate.
- 2.4.2 Heat exchanger shrouds shall be provided and installed by the Manufacturer. (see Spec 235700)

2.5. SKID LAYOUT

- 2.5.1 Skid must be equal or less than the physical envelope shown on Design Drawing.
- 2.5.2 The base shall be large enough to support the skid's heat exchangers, piping, and control panel(s) while also providing the appropriate clearance zones as defined by AE Detail M-26, M-27, M-28 and M-29 for a walkway between components.
- 2.5.3 All major equipment shall be supported directly with full height structural steel members underneath the floor.
- 2.5.4 Middle aisle way shall be a minimum of 48" or the designated width required by HX Manufacturer, whichever is greater.
- 2.5.5 Piping shall be arranged such that there is a minimum 2" between insulated pipe and any other insulated pipe or other structure in all directions.
- 2.5.6 PLC cabinet edge shall be within 2" of the edge of the skid and not protrude into the walkway space around the skid.

2.6. MODULE SECTIONS

- 2.6.1 Module sections shall be provided with a means to pull sections together, as well as base bolts to fasten modules together.
- 2.6.2 Jacking bolts shall also be present on either side of base bolts on each module section

2.7. STRUCTURAL STEEL SUPPORTS

- 2.7.1 Structural steel supports shall be welded to the base structural members to support skid components
 - 2.7.1.1 Structural steel supports shall be designed to comply with AISC Manual of Steel Construction, Part 4, "Welded Joints."
 - 2.7.1.2 Piping shall be supported independently of heat exchanger connections.
 - 2.7.1.3 Supports welded directly to the pipe shall be unacceptable.
- 2.7.2 Base mounted supports shall be provided for at minimum
 - 2.7.2.1 The Supply header,
 - 2.7.2.2 The Supply and Return piping on each heat exchanger
 - 2.7.2.3 The Return header.
- 2.7.3 Pipe supports utilizing flange studs/bolting shall be unacceptable
- 2.7.4 Design structural supports in accordance with the heat exchanger manufacturer's nozzle maximum loading requirements.
- 2.7.5 All supports shall be arranged to permit field installation of 2" insulation.

2.8. ELECTRICAL WIRING

- 2.8.1 Conductors and Cables shall be designed in accordance with AE Specification SS 260519
- 2.8.2 Raceway and Boxes for Electrical system shall be designed in accordance with AE Specification SS 260533

- 2.8.3 Monitoring controls shall be designed in accordance with AE Specification SS 230900
- 2.8.4 Penetrations into PLC cabinet shall be in accordance with AE Spec SS 230900

3. PRODUCTS

3.1. NOT APPLICABLE

4. EXECUTION

4.1. TESTING

- 4.1.1 The skid piping shall be chemically cleaned in accordance with SS 232500
- 4.1.2 The skid piping shall be pressure tested as a complete unit and in accordance with SS 232113.
 - 4.1.2.1 AE Representatives shall either be present on-site or virtually for pressure test.

4.2. COATING

- 4.2.1 All heat exchangers, piping appurtenances, instrumentation, and non-steel surfaces shall be protected from the surface preparation and coating process.
- 4.2.2 All Steel surfaces on the entire skid shall be mechanically cleaned per SSPC SP2
- 4.2.3 All steel surfaces shall be degreased, primed, and painted with two-part epoxy of consistent approved color prior to insulation.

4.3. SHIPPING/LAY-UP

- 4.3.1 Preparation for shipment
 - 4.3.1.1 Skid shall be disassembled into sub-assembly form to allow for ease of transportation and installation at job site
 - 4.3.1.1.1 Reassembly at the job site is the responsibility of the Installer under the direction of the Manufacturer or Manufacturer's representative.
 - 4.3.1.2 Blind flanges shall be installed on all open piping ends.
 - 4.3.1.3 Manufacturer shall install 2 pressure gauges (range 0-50 psi) on two existing ball valves: one on the AE side and another on the Customer side piping and will be left installed until commissioning.
 - 4.3.1.4 Skid piping shall be charged with 10 – 15 psig of nitrogen before shipment
 - 4.3.1.4.1 The nitrogen charge shall remain above 10 pounds until skid reaches the job site.
 - 4.3.1.5 Shock indicators capable of indicating 5.0 G force shall be placed on the pressure plate for both heat exchangers on skid package prior to shipment.
 - 4.3.1.5.1 If the skid experiences more than 5.0 G of shock, the heat exchanger skid manufacturer is required to replace any component that the AE Engineer

has determined as adversely affected by the shock condition at no cost to AE.

- 4.3.1.6 Manufacturer shall review the HX Manufacturer requirements for rigging and transportation and comply with those requirements.
- 4.3.1.7 Skid shall have a protective weatherproof wrap around its entirety.
- 4.3.2 Touch up paint shall be included with shipment
- 4.3.3 HX Shrouds shall be included with shipment.

4.4. INSTALLATION

- 4.4.1 Skids shall be rigged and connected according to the Manufacturer's written procedure or in-person instruction.
- 4.4.2 After the skid piping is connected, the system shall be re-charged with 10 psig of nitrogen until either the customer piping is connected, or the AE Right of Way piping is connected, whichever is first.
- 4.4.3 If the nitrogen purge drops below 7 psig, nitrogen shall be added to bring the pressure back to 10 psig.
- 4.4.4 Installation of HX shrouds shall be after skid is verified functional.
- 4.4.5 Skid to concrete floor joint shall be caulked or otherwise sealed from water entry.
- 4.4.6 Installer must sign off on the Manufacturer's rigging and connection procedure request form.
 - 4.4.6.1 Final form shall communicate that all hook-ups, tie-ins, and terminations have been completed.

4.5. COMMISSIONING

- 4.5.1 Manufacturer shall provide one representative to attend an on-site job visit for AE commissioning the water management system.
- 4.5.2 AE commissioning shall occur after installation steps in section 3.4 are complete
- 4.5.3 AE commissioning shall include
 - 4.5.3.1 Preliminary check to verify proper installation
 - 4.5.3.2 Final checkout
 - 4.5.3.2.1 Panel and Instrumentation checks
 - 4.5.3.2.2 Pressure checks
 - 4.5.3.2.3 Flow checks
 - 4.5.3.3 Any deficiencies identified during the commissioning process shall be corrected by the Manufacturer or Manufacturer's representative at no cost to AE.
 - 4.5.3.4 Startup

4.6. ADDITIONAL PRICING OPTIONS

- 4.6.1 As an line item option, provide pricing for the following:
 - 4.6.1.1 Incorporate a drain trough for 2" copper tubing by either use of an I-beam or boxed in frame.

- 4.6.1.1.1 Provide a 3" knock out hole in top of base platform within one (1) foot of the strainer location to allow 2" copper pipe to enter trough.
- 4.6.1.1.2 Provide a 3" knock out hole in side of base platform to allow for drain pipe to connect to 2" copper pipe once off the skid.
- 4.6.1.1.3 Insulate 2" copper tubing - 3" from the point of entry to the trough to 3" after exiting trough.
- 4.6.1.1.4 Trough sizing shall be sized to accommodate the 2" copper tubing with insulation.
- 4.6.1.1.5 Provide a perforated removable cover into base to allow for access to drain pipe.
 - 4.6.1.1.5.1 Cover shall encompass entire trough opening.

END of SECTION

HYDRONIC PIPING

SECTION SS 232113

10/12/2020

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for pipe and fittings, joining methods, special-duty valves, and specialties for the following:
 - 1.1.1.1 Hydronic piping.
 - 1.1.1.2 Joining materials.
 - 1.1.1.3 Dielectric fittings.
 - 1.1.1.4 Air control assemblies
 - 1.1.1.5 Strainers.
- 1.1.2 An independent third party inspection firm shall be contracted for all weld testing and inspection.
- 1.1.3 If any deviations are found to occur by the AE Engineer, the Contractor shall bring it back into compliance at Contractor's expense.
- 1.1.4 Welds which Failed Volumetric Tests:
 - 1.1.4.1 The cost for repair, additional inspection, and testing shall be borne by Contractor at no additional cost or schedule impact to Owner.
 - 1.1.4.1.1 Should Owner incur fees for any additional testing costs will be deduct from Contractor's payment.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the design pressure ratings for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project

- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after Substantial Completion of Project
- 1.2.13 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 Pressure Test Documentation – A set of documents containing the pressure test procedure and the pressure test record form.
- 1.2.15 Project - the design and construction of pipe and piping specialties for AE plant or AE mechanical room.
- 1.2.16 Required Test Pressure – The test pressure as defined in the Design Data Packet for hydrostatic or pneumatic pressure test.
- 1.2.17 Shop Drawings – detailed drawings used for shop personnel to fabricate Project
- 1.2.18 Specification – the Specification is defined as this document, titled Hydronic Piping SS 232113.
- 1.2.19 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.20 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected.
- 1.2.21 Submittal before Fabrication – Group of documents reviewed and AE approved before fabrication can begin.
- 1.2.22 Submittal before Pressure Test – Group of documents reviewed and AE approved before pressure test can begin.
- 1.2.23 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.24 Volumetric Testing – Project specific ultrasonic testing or radiographic testing both shall require a record of test results.
- 1.2.25 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 AFF Above finished floor
- 1.3.3 ASME American Society of Mechanical Engineers

1.3.4	ASNT	American Society for Nondestructive Testing
1.3.5	ASTM	American Society of Testing and Materials
1.3.6	AWS	American Welding Society
1.3.7	BPVC	ASME Boiler Pressure Vessel Code
1.3.8	CWI	Certified Welding Inspector
1.3.9	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
1.3.10	MTR	Mill Test Report
1.3.11	NDE	Nondestructive Evaluation
1.3.12	NDT	Nondestructive Testing
1.3.13	NPS	Nominal Pipe Size
1.3.14	PFI	Piping Fabricators Institute
1.3.15	PQR	Procedure Qualification Records
1.3.16	QA/QC	Quality Assurance/Quality Control
1.3.17	RT	Radiographic Testing
1.3.18	UT	Ultrasonic Testing
1.3.19	VT	Visual Inspection
1.3.20	WPQ	Welder's Performance Qualifications
1.3.21	WPS	Welder's Procedure Specifications

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Contractor shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The contractor is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 SNT – TC-1A
- 1.4.3 ASME B1.20.1, B16.3, B16.5, B16.21, B18.2.1, SA-182F
- 1.4.4 ASME B31 Pressure Piping Code
- 1.4.5 ASME BPVC Section IX
- 1.4.6 ASTM A53, A105, A106, A126, A193, A194, A234, A312, B32, B88, B813, F36
- 1.4.7 MSS SP-58
- 1.4.8 PFI ES-03

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Project design and manufacture
- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 General Duty Valves for HVAC Piping SS 230523
- 1.5.4 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.5 HVAC Pipe Identification SS 230553
- 1.5.6 Pipe Insulation SS 230719

- 1.5.7 Chilled Water Monitoring Controls SS 230900
- 1.5.8 Hydronic Piping SS 232113
- 1.5.9 Chilled/Condenser Water Flush & Chemical Treatment SS 232500
- 1.5.10 AE Details M16 through M29

1.6. QUALIFICATIONS

- 1.6.1 Welders:
 - 1.6.1.1 Welders shall be qualified to ASME Section IX.
 - 1.6.1.2 WPQ shall be provided for all welders on the project
 - 1.6.1.2.1 WPQ shall be certified by signature of current employer.
 - 1.6.1.2.1.1 Austin Energy will not accept welders WPQ from previous employer or other organization.
 - 1.6.1.2.2 Welder's WPQ shall be no more than 6 months old unless accompanied by a continuity log.
 - 1.6.1.2.2.1 Continuity log shall clearly demonstrate that the welders has had no lapse greater than 6 months in welding in the process they are qualified for.
- 1.6.2 Welding Procedure and Procedure Qualifications
 - 1.6.2.1 All piping WPSs proposed for use on the project shall be qualified to ASME Section IX by the agency performing the Work.
 - 1.6.2.2 All PQRs shall include the tensile testing results.
- 1.6.3 Third Party Inspections
 - 1.6.3.1 Firms hired to provide third party inspections shall have the following capabilities and certifications.
 - 1.6.3.1.1 A written practice compliant with SNT-TC-1A. Describing certifications of NDE personnel.
 - 1.6.3.1.2 AWS CWI with valid AWS certification number
 - 1.6.3.2 An ASNT level III inspector certified for the type of additional NDE selected for the project (i.e.; magnetic testing, radiographic, and ultrasonic testing methods).
 - 1.6.3.3 Inspectors performing all types of NDE other than VT shall be qualified as an ASNT level II inspector for the type of NDE selected for the Project.
 - 1.6.3.4 A written procedure for the NDE testing method for the Project.
- 1.6.4 Specialty Tools
 - 1.6.4.1 Torqueing tools shall have current traceable to the tool via serial number calibration certificate.
 - 1.6.4.2 Personnel utilizing specialty tools shall be knowledgeable and trained on the tool being used.

1.7. QUALITY ASSURANCE

- 1.7.1 Contractor shall provide their own quality assurance inspector. The inspector To verify the following:
 - 1.7.1.1 All dimensions as indicated on the Design Drawings
 - 1.7.1.2 Minimum of 10% of all dimensions on Shop Drawings
 - 1.7.1.2.1 Check piping connection tolerances
 - 1.7.1.3 All pipe and pipe fitting heat codes match MTRs submitted and approved.
 - 1.7.1.3.1 Heat numbers are properly transferred according to Section 4.2.1.1.
 - 1.7.1.4 All welding meets B31.1 visual acceptance criteria.
 - 1.7.1.5 Records of these inspections shall be maintained and signed by the QA inspector and submitted with the Submittal before Pressure Test.

1.8. AUDITS AND INSPECTIONS

- 1.8.1 Third party CWI shall inspect the first 2 butt welds from each welder on the Project from start to finish.
 - 1.8.1.1 CWI shall inspect at minimum the following:
 - 1.8.1.1.1 Heat numbers properly transferred to cut sections.
 - 1.8.1.1.2 Bevel angle
 - 1.8.1.1.3 Fit-up
 - 1.8.1.1.4 Root gap
 - 1.8.1.1.5 Root pass
 - 1.8.1.1.6 Welding parameters during welding
 - 1.8.1.1.7 Weld meets B31.1 visual acceptance criteria
 - 1.8.1.2 CWI shall create a record of this inspection with the weld numbers inspected corresponding to the weld map provides with Submittal after Award.
 - 1.8.1.3 CWI shall VT 100% of finished welds and provide signed final record results.
- 1.8.2 Austin Energy will audit the welding facility and review all documentation, quality assurance practices, and record keeping.
- 1.8.3 Austin Energy or its representative will spot check and inspect torqueing of any bolts and threaded connections on Project.
- 1.8.4 Reference 2.6.1 and 4.6

1.9. SUBMITTALS

1.9.1 GENERAL

- 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.9.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.9.1.1.2 Table of Contents page
 - 1.9.1.1.3 Dividing pages with Material title

- 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.9.1.3 It is mandatory that the *Submittal with Quotation* documents be submitted with the Quote
 - 1.9.1.3.1 Quotes which do not include all of *Submittal with Quotation* documents will be considered incomplete and therefore rejected
- 1.9.1.4 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.9.1.5 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.9.1.6 Pressure test shall not begin until the *Submittal before Pressure Test* documents are received and approved.
- 1.9.1.7 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.9.1.7.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL WITH QUOTATION

- 1.9.2.1 Welding Documents:
 - 1.9.2.1.1 Welding Procedures (WPS)
 - 1.9.2.1.2 PQR for each submitted WPS
 - 1.9.2.1.3 Welding Performance Qualifications for each welder.
 - 1.9.2.1.3.1 Continuity log if applicable.
 - 1.9.2.1.4 Set of "Not for Construction" arrangement design drawings.
 - 1.9.2.1.5 NDE third party inspection firm written practice.
 - 1.9.2.1.6 NDE procedures for MT, PT, UT, LPA, and RT.
 - 1.9.2.1.7 NDE personnel certifications
 - 1.9.2.1.8 CWI certifications
 - 1.9.2.1.9 System design information sheet detailing pipe sizes, instrumentation sizes and heat exchanger utilized, if applicable.

1.9.3 SUBMITTAL AFTER AWARD

- 1.9.3.1 Product Data:
 - 1.9.3.1.1 Contractor shall submit exact manufacturer's product data sheet for the product that will be installed. If a product does not have a manufacturer's product data sheet, prior AE approval is required before contractor purchases product.
 - 1.9.3.1.2 For each type of the following, provide manufacturer's catalog and additional supporting information as required to show compliance with specifications and standards.
 - 1.9.3.1.2.1 Pressure-seal fittings

- 1.9.3.1.2.2 Air control devices
- 1.9.3.1.2.3 Hydronic specialties
- 1.9.3.1.2.4 Pipe Material and Fittings – Additionally, include certified copies of mill tests and, in catalog data, mark specific model, type, sizes, etc. as applicable.
- 1.9.3.2 Design Drawings:
 - 1.9.3.2.1 Detail at 1/2" scale or larger, indicating piping, all pipe fittings valve, drain piping and specialties layout, fabrication of pipe anchors, hangers, chain wheels, all appurtenances, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure; provide isometric drawings of installation as well.
 - 1.9.3.2.2 Design Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings.
 - 1.9.3.2.3 Indicate distances, measurements and elevations in Design Drawings, including mechanical room floor-ceiling heights, to ensure adequate vertical clearance.
 - 1.9.3.2.4 Pipe Expansion:
 - 1.9.3.2.4.1 The piping for the Project is within the stress limits of the ASME Code for Pressure Piping.
 - 1.9.3.2.4.1.1. Changes in piping configuration resulting from the Contractor's selection of equipment or variation in pipe routing will require detailed stress and expansion calculations by the Contractor.
 - 1.9.3.2.4.1.1.1. These calculations shall be presented on Design Drawings for review.
- 1.9.3.3 Shop Drawings:
 - 1.9.3.3.1 Complete and dimensional working drawings of all pipe layouts.
 - 1.9.3.3.2 Shop Drawings shall include but not limited to these types of drawings:
 - 1.9.3.3.2.1 Fabrication/Spool Piece Drawings
 - 1.9.3.3.2.2 Installation Drawings or Diagrams
 - 1.9.3.3.2.3 Flow diagrams
 - 1.9.3.3.2.4 Pipe, Valve and Equipment Schedules
 - 1.9.3.3.2.5 Pipe Pattern Development Drawings
 - 1.9.3.3.2.6 Detail Drawings
 - 1.9.3.3.2.7 Other similar type drawings.
 - 1.9.3.3.3 Submit Shop Drawings showing in-plan view of all piping and systems of pipe two inches and larger.
 - 1.9.3.3.3.1 Shop Drawings shall show the actual equipment furnished, equipment location by dimension and connections.

- 1.9.3.3.3.2 Pipelines shall be dimensioned in plan view and located in elevation on the Shop Drawings.
- 1.9.3.3.4 Submit additional Shop Drawings showing pipelines or systems of pipe two inches and larger in isometric view for all prefabricated pipe and where required to show the piping system in complete detail including specials, valves, drains and vent valves, and instrumentation connections.
- 1.9.3.3.5 Submit newly prepared information drawing accurately to scale. Highlight, circle, or otherwise indicate deviations from the Contract Documents.
 - 1.9.3.3.5.1 Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings.
 - 1.9.3.3.5.2 Standard information prepared without specific reference to the Project is not a Shop Drawing.
 - 1.9.3.3.5.3 Pipelines and equipment shall be located in plan and elevation as near to the arrangement indicated on the Contract Drawings as possible.
- 1.9.3.3.6 Shop Drawings shall include the following information:
 - 1.9.3.3.6.1 Detail at 1/2" scale or larger
 - 1.9.3.3.6.2 Grade of material
 - 1.9.3.3.6.3 Size
 - 1.9.3.3.6.4 Wall thickness of pipe and fittings
 - 1.9.3.3.6.5 Type and location of fittings
 - 1.9.3.3.6.6 Type and limits of the lining and coating systems of the pipe and fittings.
 - 1.9.3.3.6.7 Dimensions
 - 1.9.3.3.6.8 Tolerances compliant with PFI ES-03 detail
 - 1.9.3.3.6.9 Identification of products and material include by sheet and detail number
 - 1.9.3.3.6.10 Compliance with specified standards
 - 1.9.3.3.6.11 Notation of coordination requirements
 - 1.9.3.3.6.12 Notation of dimensions established by field measurement
 - 1.9.3.3.6.13 If pipe is insulated, show pipe insulation
 - 1.9.3.3.6.14 Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 24 inches by 36 inches.
 - 1.9.3.3.6.15 Only use Shop Drawings with an appropriate stamp indicating "For Construction".
 - 1.9.3.3.6.16 Coordinate with building-side contractor to determine final building-side piping layout so that shop drawings submitted represent actual installation.

1.9.3.4 Weld Map Drawings:

- 1.9.3.4.1 Drawings shall be isometric and indicate all welds to be performed.
- 1.9.3.4.2 Each weld shall have a unique number.
- 1.9.3.4.3 Included on drawing a table of weld number and its corresponding welding procedure to be performed for that weld.

1.9.3.5 Torque setting table: For each flange and valve

- 1.9.3.5.1 Table shall include for each bolted connection manufacturer's recommended torque adjustment range for bolt tightening.
- 1.9.3.5.2 Provide calibration certificate of all torqueing tools used.

1.9.4 SUBMITTALS BEFORE FABRICATION

1.9.4.1 Mill Test Reports:

- 1.9.4.1.1 MTRs for all pipe and pipe fittings shall be submitted and approved before pipe and pipe fittings are brought to the construction site from Contractor's service yard.
- 1.9.4.1.2 Certified copies of mill tests confirming the type of material used in steel plates, mill pipe flanges and bolts and nuts to show compliance with the requirements of the applicable standards.

1.9.5 SUBMITTALS BEFORE PRESSURE TESTING

- 1.9.5.1 Submittals Before Pressure Test are due 5 business days before pressure test
- 1.9.5.2 Contractor to provide updated torque table with actual values applied to the bolted connections.
- 1.9.5.3 Pressure Test Procedure
- 1.9.5.4 Welding test reports applicable to the Project
 - 1.9.5.4.1 Contractor QA records of inspections outlined in Section 1.7
 - 1.9.5.4.2 Third party NDE records with UT image or RT film and reports.
 - 1.9.5.4.3 CWI inspection report
- 1.9.5.5 Contractor shall not proceed with pressure test until Cleaning and Flushing submittal as described in Chilled/Condenser Water Flush & Chemical Treatment SS 232500 has been AE approved and scheduled.

1.9.6 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.9.6.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.9.6.1.1 All approved submittals
 - 1.9.6.1.2 Pressure Test Results
 - 1.9.6.1.3 Operation and Maintenance Data:
 - 1.9.6.1.3.1 For air control devices, hydronic specialties, and special-duty valves shall include emergency, operation, and maintenance manuals.
 - 1.9.6.1.4 As-Built Drawings

- 1.9.6.1.5 Final Torque Table
- 1.9.6.1.6 Welding Test Reports
- 1.9.6.1.7 Mill Test Reports for all pipes and fittings

1.10. COORDINATION

- 1.10.1 After fabrication and before instrumentation installation a meeting shall be scheduled to coordinate installation of instrumentation location and orientation.
 - 1.10.1.1 All control devices and piping specialties (including sensors, pressure-temperature test ports, drains, drain piping, air releases, flow meter, pressure transmitters, control valves, control panel, fiber panel. etc.).
 - 1.10.1.2 Contractor shall provide a full set Shop Drawings to AE Representative prior to meeting.

2. DESIGN

2.1. GENERAL

- 2.1.1 All design data is referenced in Design Data Packet.
 - 2.1.1.1 Select system components with pressure rating equal to or greater than system operating pressure.
- 2.1.2 If Contractor is intending to use the SMAW welding process, Contractor shall utilize the low hydrogen rods for the cap.
- 2.1.3 Dielectric fittings usage shall conform to MIL-STD-1250A.
- 2.1.4 Dielectric fittings shall be used if the galvanic potential of the dissimilar metals is greater than 0.45 V
- 2.1.5 Tubing screwed joints for connecting to instrument equipment shall be made with connectors with compression tubing connector on one end and I.P.S. thread on the other end.
- 2.1.6 The tubing design basis shall be 125 psig unless otherwise state in Design Data Packet.

2.2. WELDING

- 2.2.1 All pipe welding on the Project shall comply with ASME Boiler and Pressure Vessel Code, Section IX.
- 2.2.2 If Contractor is intending to use SMAW welding process, Contractor shall utilize low hydrogen rods for the fill and cap.
- 2.2.3 Contractor shall properly store low hydrogen rods.
- 2.2.4 All repairs required to correct deficiencies found during testing Section 4.6 shall be welded and retested in accordance with ASME B31.1 section 127.4.11

2.3. VALVE APPLICATION

- 2.3.1 Isolation/shutoff valves at each branch connection to supply mains, and at supply connection to each piece of equipment, and as indicated in drawings.

2.3.2 Valve placement shall be according to SS230523 "General-Duty Valves for HVAC Piping."

2.3.3 See AE Details M19, M19A, M22 and M24

2.4. GENERAL LAYOUT DESIGN:

2.4.1 Piping:

2.4.1.1 Design all piping at right angles or parallel to building walls unless specifically indicated otherwise.

2.4.1.2 Design piping to permit valve servicing.

2.4.1.2.1 Shutoff valves shall be installed at elevations reachable from floor level without a ladder. Indicate elevation of shutoff valves on Shop Drawings.

2.4.1.2.2 For valves higher than 78 inches AFF, provide chain operator; reference specifications SS 230523 GENERAL-DUTY VALVES FOR HVAC PIPING.

2.4.1.3 Design fittings for changes in direction and branch connections.

2.4.1.4 Design piping with adequate clearances to allow application of insulation.

2.4.1.5 Design groups of pipes parallel to each other, spaced to permit applying insulation, and operation and servicing of valves.

2.4.1.6 Design branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe.

2.4.1.7 For up-feed risers, connect the branch to the top of the main pipe.

2.4.2 Y-Strainer:

2.4.2.1 Design Y-Strainer vertically and for ease of access, removal and maintenance.

2.4.2.2 Removal of Y-Strainer shall not cause piping to have to be supported temporarily.

2.4.2.3 See AE Detail M19 and M19A

2.4.3 Drains:

2.4.3.1 Design drains at heat exchangers, strainers, and elsewhere as required for system drainage.

2.4.3.2 See AE Detail M18, M19 and M19A

2.4.4 Air Vents:

2.4.4.1 Design automatic and manual air vents at high points in piping system and as indicated.

2.4.4.2 See AE Detail M16, M17, M19 and M19A

2.5. HANGERS AND SUPPORTS

2.5.1 Hanger, support, and anchor devices are specified in SS230529 "Hangers and Supports for HVAC Piping and Equipment."

2.6. PIPE JOINT DESIGN

2.6.1 Welded Joints:

2.6.1.1 Pipe weld joint design shall comply with ASME B31.1.

- 2.6.2 Flanged Joints:
 - 2.6.2.1 Select appropriate gasket material, size, type, and thickness for service application.
- 2.6.3 Threaded Joints:
 - 2.6.3.1 Threaded pipe shall be no larger than 2" unless otherwise approved by AE Engineer.

2.7. HYDRONIC SPECIALITIES DESIGN

- 2.7.1 Automatic air vents:
 - 2.7.1.1 Design at high points of system piping inside mechanical equipment rooms as indicated in Shop Drawings.
 - 2.7.1.2 Provide the following, in order from connection at main process water pipe (reference AE detail M16 and M22):
 - 2.7.1.2.1 ¾" Threadolet.
 - 2.7.1.2.2 Between 2" to 4" long (longer if needed to allow extension beyond insulation and allow for valve connection), threaded, ¾" NPT, schedule 80, 316 stainless steel nipple;
 - 2.7.1.2.3 Shutoff valve: Apollo ball valve, ¾"; reference SS230523 GENERAL-DUTY VALVES FOR HVAC PIPING.
 - 2.7.1.2.4 Vent Outlet:
 - 2.7.1.2.4.1 3/8" diameter 316 stainless steel tubing.
 - 2.7.1.2.4.2 Provide stainless steel transition fittings as required.
 - 2.7.1.2.4.3 Route to nearest floor drain.
- 2.7.2 Manual air vents:
 - 2.7.2.1 Design at high points in piping, at heat-exchangers, and elsewhere as required for system air venting as indicated in Shop Drawings.
 - 2.7.2.2 Provide the following, in order from connection at main process water pipe (reference AE detail M17, M19 and M19A)
 - 2.7.2.3 1" Threadolet.
 - 2.7.2.4 Between 2" to 4" long (longer if needed to allow extension beyond insulation and allow for valve connection), threaded, 1" NPT, schedule 80, 316 stainless steel nipple.
 - 2.7.2.5 Shutoff valve: Apollo ball valve, 1"; reference SS230523 GENERAL-DUTY VALVES FOR HVAC PIPING.
 - 2.7.2.6 Stainless Steel Plug for shutoff valve.
- 2.7.3 Strainer:
 - 2.7.3.1 Design strainers in vertical pipe at inlet of each heat exchanger as indicated in Shop Drawings.
 - 2.7.3.2 Ensure strainers are oriented to allow easy removal of strainer baskets and easy access to drain piping and shutoff valve.

- 2.7.3.3 Strainers shall be mounted so that the bottom flange of strainer is at least 48" off floor unless otherwise designated and approved by AE Engineer.
- 2.7.3.4 Drain outlet of strainer: Provide the following, in order from outlet of strainer (reference AE Detail M19, M19A and M22).
 - 2.7.3.4.1 Between 2" to 4" long, threaded, schedule 80, 316 stainless steel nipple at outlet of strainer, equal in size to strainer drain connection.
 - 2.7.3.4.2 Shutoff valve: Ball valve, equal in size to strainer drain connection; reference SS230523 GENERAL-DUTY VALVES FOR HVAC PIPING.
 - 2.7.3.4.3 Line-size dielectric union.
 - 2.7.3.4.4 Drain pipe:
 - 2.7.3.4.4.1 Copper equal in size to strainer drain connection.
 - 2.7.3.4.4.2 Route pipe to nearest floor drain.
 - 2.7.3.4.4.3 Provide copper union fitting for copper pipe disconnection.
 - 2.7.3.4.4.4 Anchor pipe to walls, base, floor, with Unistrut piece or other manufactured fittings.
- 2.7.4 Low Point Drains:
 - 2.7.4.1 Design at low point in piping near each heat exchanger, other location(s) in piping if lower than heat exchanger drain, and as indicated in Shop Drawings.
 - 2.7.4.2 Ensure drain and valve are oriented to allow valve to be accessible and opened and closed fully.
 - 2.7.4.3 Design drain angled off dead center bottom of main pipe.
 - 2.7.4.4 Reference AE Detail M18, M19 and M19A.
 - 2.7.4.5 Provide the following, in order from connection at main process water pipe.
 - 2.7.4.5.1 1" Threadolet.
 - 2.7.4.5.2 Between 2" to 4" long (longer if needed to allow extension beyond insulation and allow for valve connection), 1" NPT, threaded, schedule 80, 316 stainless steel nipple.
 - 2.7.4.5.3 Shutoff valve: Ball valve, equal in size to strainer drain connection; reference SS230523 GENERAL-DUTY VALVES FOR HVAC PIPING.
 - 2.7.4.5.4 Drain pipe: 1" NPT, 316 stainless steel, schedule 80.
 - 2.7.4.5.5 Stainless Steel Plug for shutoff valve.

2.8. PIPING APPLICATIONS

- 2.8.1 Chilled-water, aboveground, NPS 2.5 and larger
 - 2.8.1.1 See Section 3.2 Chilled Water Pipe.
- 2.8.2 Condenser Water, above ground, NPS 2.5 and larger
 - 2.8.2.1 See Section 3.3 Condenser Water Pipe
- 2.8.3 Process Air and Drain piping, NPS 2 and smaller
 - 2.8.3.1 See Section 3.4.1 Copper Tubing
 - 2.8.3.2 See Section 3.4.3 Steel Pipe

- 2.8.4 Air and Process Tubing
 - 2.8.4.1 See Section 3.4.2 Stainless Steel Tubing
 - 2.8.4.2 See Section 3.4.1.2 Copper Tubing
- 2.8.5 Pipe Nipples
 - 2.8.5.1 See Section 3.4.3 Steel Pipe
 - 2.8.5.2 See Section 3.4.4 Stainless Steel Pipe

3. PRODUCTS

3.1. GENERAL

- 3.1.1 Material for the Project shall be chosen from the products identified in this Section.
- 3.1.2 All pipe shall be melted and manufactured in the USA.
 - 3.1.2.1 If Contractor establishes a need for foreign material, request for use of foreign material shall be submitted with Submittal After Award for written AE Engineer approval prior to purchase.
 - 3.1.2.2 Documentation shall clearly define the need for using foreign material.
- 3.1.3 Product datasheet submitted shall indicate compliance to all requirements listed for all pipe, couplings, supports, fittings, coatings and related items as applicable to the Project.

3.2. CHILLED WATER PIPE

- 3.2.1 Steel Pipe, up to and including 10"; ASTM A53, Type S, seamless, Grade B or ASTM A106, Grade B; Schedule 40 Weight; and plain ends, unless otherwise indicated.
- 3.2.2 Steel Pipe, greater than 10" to 26"; ASTM A53, Type S, seamless, Grade B or ASTM A106, Grade B; Standard Weight; and plain ends, unless otherwise indicated.
- 3.2.3 Steel Pipe, larger than 26"; API 5L, PSL2, SSAW, spiral submerged arc welded, Grade B/X42; Standard Weight; and plain ends, unless otherwise indicated.

3.3. CONDENSER WATER PIPE

- 3.3.1 Steel Pipe, up to and including 10"; ASTM A53, Type S, seamless, Grade B; Schedule 40 Weight; and plain ends, unless otherwise indicated.
- 3.3.2 Steel Pipe, greater than 10" to 26"; ASTM A53, Type S, seamless, Grade B; Standard Weight; and plain ends, unless otherwise indicated.
- 3.3.3 Steel Pipe, larger than 26"; API 5L, PSL1, SSAW, spiral submerged arc welded, Grade B/X42; Standard Weight; and plain ends, unless otherwise indicated.

3.4. SPECIALTY PIPE

- 3.4.1 Copper Tubing:
 - 3.4.1.1 Size 1" to 4"
 - 3.4.1.1.1 Drawn-temper copper tubing, ASTM B 88, Type L (ASTM B 88M, Type B).

- 3.4.1.1.2 Copper tubing shall have the following diameters and wall thicknesses
 - 3.4.1.1.2.1 1" O.D. x 0.050" wall, plus or minus 0.005"
 - 3.4.1.1.2.2 2" O.D. x 0.070" wall, plus or minus 0.007"
 - 3.4.1.1.2.3 3" O.D. x 0.080" wall, plus or minus 0.009"
 - 3.4.1.1.2.4 4" O.D. x 0.114" wall, plus or minus 0.011"
- 3.4.1.2 Copper tubing less than 1"
 - 3.4.1.2.1 Soft annealed copper
 - 3.4.1.2.2 Seamless phosphor deoxidized copper, type DHP, with chemical and physical properties in accordance with ASTM Specification B-75. Dimensions, weights and tolerances shall be in accordance with ASTM Specification B-251
 - 3.4.1.2.3 Copper tubing shall have the following diameters and wall thicknesses
 - 3.4.1.2.3.1 1/4" O.D. x 0.030" wall, plus or minus 0.0025"
 - 3.4.1.2.3.2 3/8" O.D. x 0.030" wall, plus or minus 0.0025"
- 3.4.2 Stainless Steel Tubing:
 - 3.4.2.1 Seamless type 304 or type 316,
 - 3.4.2.2 Grade TP tubing cold drawn,
 - 3.4.2.3 Annealed and pickled, free from scale.
 - 3.4.2.4 The chemical and physical properties shall be in accordance with ASTM A269
 - 3.4.2.5 Stainless tubing shall have the following diameters and wall thicknesses:
 - 3.4.2.5.1 1/4" O.D. x 0.035" wall, plus or minus 0.0052"
 - 3.4.2.5.2 3/8" O.D. x 0.035" wall, plus or minus 0.0052"
 - 3.4.2.5.3 1/2" O.D. x 0.035" wall, plus or minus 0.0052"
 - 3.4.2.6 Connectors and fittings for stainless steel tubing shall be stainless steel fittings, with stainless steel collets, of the flareless type. Swagelok or AE Engineer approved equal.
- 3.4.3 Steel Pipe, 0.5" NPS to 2" NPS: ASTM A53, seamless, Schedule 80
- 3.4.4 Stainless Steel Pipe: ASTM A 312, Type 304 or 316 stainless steel, Schedule 80, NPT threaded
- 3.4.5 See Piping Application in Section 2.8.

3.5. PIPE FITTINGS

- 3.5.1 Steel Flanges: ASTM A105, ASME B16.5, steel Class shall be appropriate to the design system pressure; butt welded connection raised face
 - 3.5.1.1 Bolts: ASTM A193/A193M, Grade B7. Extend minimum of two full threads beyond nut with bolts tightened to required torque.
 - 3.5.1.2 Nuts: ASTM A194/194M, Grade 7, with Teflon coated threads.
 - 3.5.1.3 Washers: Stainless Steel flat circular washers under bolt heads and nuts.
- 3.5.2 Steel Welding Fittings: ASTM A234, forged steel.
 - 3.5.2.1 Tees

- 3.5.2.2 Reducers
- 3.5.2.3 Long Radius Elbows
- 3.5.2.4 Short radius elbows shall not be used unless prior approval by AE Engineer.
- 3.5.2.5 Reducing elbows shall not be used.
- 3.5.3 Fittings shall have the same weight schedule as pipe.
- 3.5.4 Field modified fittings shall not be allowed.
- 3.5.5 Threadolets: Class 3000, Schedule 80, ASTM / ASME SA 182 F.

3.6. JOINING MATERIALS

- 3.6.1 Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents, and type suitable for fluid to be handled and working temperatures and pressures.
 - 3.6.1.1 ASME B16.21, ASTM F36, nonmetallic, flat, asbestos free, 3/32-inch minimum thickness unless thickness or specific material is indicated.
 - 3.6.1.1.1 Full-Face Type: For flat-face or raised-face, Class 250.
 - 3.6.1.1.2 Factory cut gaskets shall be used unless noted otherwise.
 - 3.6.1.1.3 Manufacturers:
 - 3.6.1.1.3.1 Garlock
 - 3.6.1.1.3.2 Klinger Company
 - 3.6.1.1.3.3 or AE Engineer approved equal
- 3.6.2 Welding Filler Metals: Comply with AWS, ASME Section IX, and Section II Part C classifications for welding materials.
- 3.6.3 Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.
- 3.6.4 Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- 3.6.5 Flange Bolts and Nuts: ASTM A193 B7 and ASME B18.2.1, carbon steel, conform to 3.5.1.1 and 3.5.1.2 unless otherwise indicated.

3.7. DIELECTRIC FITTINGS

- 3.7.1 Description: Combination fitting dissimilar metals with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- 3.7.2 Insulating Material: Suitable for system fluid, pressure, and temperature.
- 3.7.3 Dielectric Unions:
 - 3.7.3.1 Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

3.8. COPPER FITTINGS

- 3.8.1 For drain piping, Contractor may provide either solder fittings or ProPress fittings or AE Engineer approved equal.

- 3.8.2 For process piping, Contractor shall provide only solder fittings unless otherwise approved by AE Engineer.
- 3.8.3 For process copper tubing, connection and fittings shall be brass fittings, with brass collets, of the flareless type, and shall be Swagelok tube fitting type or RE Approved equal.

3.9. HYDRONIC SPECIALITIES

- 3.9.1 Automatic Air Vents:
 - 3.9.1.1 Model: ITT Hoffman 792.
 - 3.9.1.2 Body: cast iron.
 - 3.9.1.3 Internal Parts: Stainless steel.
 - 3.9.1.4 Bottom Inlet Connection: 3/4" NPT.
 - 3.9.1.5 Discharge Connection: 1/2" NPT.
 - 3.9.1.6 Maximum operating pressure: 250 psi.
 - 3.9.1.7 10 cfm air discharge at 100 psi.
- 3.9.2 Y-Pattern Strainers:
 - 3.9.2.1 Pressure: 125-psig working pressure.
 - 3.9.2.2 Body material: Cast-iron body (ASTM A 126, Class B).
 - 3.9.2.3 Connection:
 - 3.9.2.3.1 Threaded connections for NPS 2 (DN 50) and smaller.
 - 3.9.2.3.2 Flanged ends for NPS 2-1/2 (DN 65) and larger.
 - 3.9.2.4 Cover: bolted.
 - 3.9.2.5 Drain connection: Bottom.
 - 3.9.2.6 Basket Material: Perforated 316 stainless-steel.
 - 3.9.2.7 Basket Sieve Opening: Maximum 1/8" opening size.

4. EXECUTION

4.1. GENERAL:

- 4.1.1 If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.

4.2. GENERAL PIPING INSTALLATIONS

- 4.2.1 Piping:
 - 4.2.1.1 All heat codes shall be marked on the interior of the pipe at both ends of cut pipe. All heat codes shall be marked on the interior of each pipe fitting unless permanently stamped on the fitting.
 - 4.2.1.2 Install piping as indicated unless deviations to layout are approved on Shop Drawing submittals.
 - 4.2.1.3 Install piping free of sags and bends.

- 4.2.1.4 Identify piping as specified in SS230553 "Identification for HVAC Piping and Equipment.
- 4.2.2 Tubing:
 - 4.2.2.1 Flareless and compression joints shall be assembled in accordance with manufacturer's recommendations.

4.3. HANGERS AND SUPPORTS

- 4.3.1 Comply with the following requirements for maximum spacing of supports.
 - 4.3.1.1 Install the following pipe attachments:
 - 4.3.1.1.1 Adjustable steel clevis hangers and spring hangers for individual horizontal piping less than 20 feet long.
 - 4.3.1.1.2 Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 4.3.1.1.3 Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4.3.1.1.4 Vertical runs: Floor stanchions.
 - 4.3.1.1.5 Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 4.3.2 Install hangers for steel piping with the following maximum spacing and minimum threaded rod sizes per MSS SP-58 Maximum Hanger and Support Spacing for Horizontal Pipe table.

4.4. PIPE JOINT CONSTRUCTION

- 4.4.1 Ream ends of tubes and remove burrs.
- 4.4.2 Bevel plain ends of steel pipe.
- 4.4.3 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- 4.4.4 Flanged Joints:
 - 4.4.4.1 Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 4.4.5 Threaded Joints:
 - 4.4.5.1 Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 4.4.5.2 Cut threads full and clean using sharp dies.
 - 4.4.5.3 Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 4.4.5.3.1 Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 4.4.5.3.2 Damaged Threads:
 - 4.4.5.3.2.1 Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - 4.4.5.3.2.2 Do not use pipe sections that have been previously been welded, have cracks or any abnormalities.

4.4.5.3.2.2.1. These pipes shall be discarded and not used for the Project.

4.4.6 Torque:

- 4.4.6.1 All flange bolts shall be torqued to recommended tightening pattern and applied torque recommendation per B31.1 and B31.3.
- 4.4.6.2 Threaded connections shall follow recommendation and ASME B1.20.1 for applied torque requirements.
- 4.4.6.3 Contractor shall record for each flange the torque applied. If applied torque is greater than torque range of valve, Contractor shall at Contractor's expense verify flange is not damaged.
- 4.4.6.4 If flange shows signs that damage has been done, Contractor shall replace damaged flange at Contractor's expense.

4.5. HYDRONIC SPECIALITIES INSTALLATION

4.5.1 Automatic air vents:

- 4.5.1.1 Install per Approved Shop Drawings
- 4.5.1.2 Insulate per Pipe Insulation SS 230719
- 4.5.1.3 Insulate nipple with 1/2" elastomeric insulation.

4.5.2 Manual air vents:

- 4.5.2.1 Install per Approved Shop Drawings
- 4.5.2.2 Insulate per Pipe Insulation SS 230719

4.5.3 Strainer:

- 4.5.3.1 Install per Approved Shop Drawings
- 4.5.3.2 Install 20#mesh strainer baskets for startup.
- 4.5.3.3 Provide no greater than 1/8 inch diameter mesh strainer baskets to AE field inspector.
- 4.5.3.4 Install final strainer as directed by AE field inspector and after Final Acceptance.
- 4.5.3.5 Provide insulating inserts as required to keep copper from contacting ferrous materials.
- 4.5.3.6 Insulate per Pipe Insulation SS 230719
- 4.5.3.7 Insulate nipple with 1/2" elastomeric insulation.

4.5.4 Low Point Drains:

- 4.5.4.1 Install per Approved Shop Drawings
- 4.5.4.2 Insulate per Pipe Insulation SS 230719
- 4.5.4.3 Insulate nipple with 1/2" elastomeric insulation.

4.6. TESTING

4.6.1 Third Party Inspection and Testing of Welds.

- 4.6.1.1 Testing shall be done prior to pressure testing and field application of sleeve or coating at joints.

- 4.6.1.2 Do not fill system with water nor pressure test until Owner and Engineer have approved results of welding tests.
- 4.6.1.3 The CWI shall perform VT on 100% of the completed welds.
- 4.6.1.4 The CWI shall perform in-process VT on the initial two (2) welds of each welder to verify they meet ASME B31.1 acceptance criteria.
- 4.6.1.5 Recordable Volumetric Testing for the Project shall be conducted on 10% of butt welds making sure to include a sample of each welder's work.
 - 4.6.1.5.1 If 1 weld fails volumetric inspection, 2 additional welds from that welder shall be volumetrically tested.
 - 4.6.1.5.2 If an additional weld fails volumetric inspection, all remaining butt welds from that welder shall be Volumetrically Tested.
- 4.6.1.6 All repairs shall be Volumetrically Tested by the initial testing method used to detect the defect.
- 4.6.1.7 If an individual welder fails 3 or more welds, they shall requalify before being allowed to weld on any AE Project.
- 4.6.2 Preparation for Pressure Testing:
 - 4.6.2.1 Prepare hydronic piping according to ASME B31.1 and as follows:
 - 4.6.2.1.1 Leave joints, including welds, uninsulated and exposed for examination during test.
 - 4.6.2.1.2 Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 4.6.2.1.3 If performing a hydrostatic pressure test,
 - 4.6.2.1.3.1 Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4.6.2.1.3.2 Fill system with ambient temperature city water.
 - 4.6.2.1.4 Isolate equipment from piping.
 - 4.6.2.1.5 Isolate AE identified equipment that will not participate in the pressure testing.
 - 4.6.2.1.6 Contractor shall provide and install a pressure relief valve in piping for pressure test.
 - 4.6.2.1.7 Contractor shall provide and install an additional pressure gauge in piping for pneumatic pressure test.
 - 4.6.2.1.8 Contractor shall provide a means to test the internal pipe temperature and pressure.
 - 4.6.2.1.9 Required Test Pressure shall be at least 1.5 times design pressure and shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.

4.6.2.1.10 Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping".

4.6.3 Perform pressure testing per Pressure Test Documentation.

4.6.4 Reference SS232500 CHILLED/CONDENSER WATER FLUSH & CHEMICAL TREATMENT

4.7. STARTUP

4.7.1 Perform the following before operating the system:

- 4.7.1.1 Inspect air vents at high points of system and determine if all are installed and operating appropriately; bleed air from system with manual air bleeds.
- 4.7.1.2 Clean strainer baskets.
- 4.7.1.3 Inspect drains and determine if all are installed and operating appropriately.
- 4.7.1.4 Inspect all flanges and pipe connection points and determine if all are installed properly and as per Approved Shop Drawings.

END of SECTION

CHILLED/CONDENSER WATER FLUSH & CHEMICAL TREATMENT

SECTION SS 232500

10/28/2020

Version 22.0

REVISION HISTORY			
DATE	VERSION	DESCRIPTION	AUTHOR
10/28/2020	21.0	Re-format specification	
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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for the flushing and cleaning of the hydronic piping.
- 1.1.2 The design, installation, operation, and removal, of a pump circulation system, and the disposal of treated water for purposes of flushing and passivation of chilled and condenser water lines prior to service shall be the sole responsibility of the Contractor.
- 1.1.3 If pump(s) and/or hose(s) fail inspection, all project delay costs resulting from these failure(s) shall be assessed to the Contractor.
- 1.1.4 If flow rate physical measurement fails to achieve 5 fps, all project delay costs resulting from this failure shall be assessed to the Contractor.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidenced by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of Project

- 1.2.13 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 Project – the design and construction of pipe and piping specialties for AE plant or AE mechanical room.
- 1.2.15 Skid – Packaged heat exchanger system
- 1.2.16 Shop Drawings – detailed drawings used for shop personnel to fabricate the Project.
- 1.2.17 Specification – the Specification is defined as this document, titled Chilled/Condenser Water Flush & Chemical Treatment SS 232500.
- 1.2.18 Submittal before Cleaning and Flushing Activity – Body of documents required to be before cleaning and flushing equipment is delivered to the jobsite.
- 1.2.19 Submittal after Award – Body of documents required to be submitted after award of work to Contractor but before any Work commences.
- 1.2.20 Submittal with Quotation – body of documents required to be included with quote, absence of any of these documents from the quote will cause the quotation to be rejected
- 1.2.21 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.22 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. REFERENCE CODES AND STANDARDS

- 1.3.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.3.2 City of Austin Code Chapter 15-10 Wastewater Regulations

1.4. AUSTIN ENERGY SPECIFICATIONS

- 1.4.1 The following AE specifications shall be followed in their entirety during Project design and manufacture
- 1.4.2 Hydronic Piping SS 232113
- 1.4.3 Chilled/Condenser Water Flush & Chemical Treatment SS 232500
- 1.4.4 Heat Exchangers for HVAC SS 235700

1.5. QUALIFICATIONS

- 1.5.1 The Contractor shall demonstrate or employ the services of a Vendor who shall demonstrate to the AE Engineer and the Owner that he specializes in the design and operation of temporary pumping systems.
- 1.5.2 The Contractor or Vendor shall provide a minimum of five (5) references of projects of a similar size and complexity as this project performed by their firm within the past three years.

1.6. AUDITS AND INSPECTIONS

- 1.6.1 Prior to start of flushing process
 - 1.6.1.1 Inspection of pumps and hoses delivered shall be performed by AE Inspector before pumps and hoses are connected and placed into service.
 - 1.6.1.2 Owner may swab all pumps and hoses for determining cleanliness.
- 1.6.2 Before Chemical Addition
 - 1.6.2.1 AE Inspector shall verify water flowrate is at least 5 fps.
- 1.6.3 After completion of Cleaning process
 - 1.6.3.1 Traditional Cleaning Process
 - 1.6.3.1.1 AE Inspector shall inspect piping for cleanliness before connection to heat exchanger.
 - 1.6.3.2 Hand Cleaning Process
 - 1.6.3.2.1 AE Chemical Vendor Representative shall document via pictures that all pieces have been cleaned as described in Section 4.6

1.7. SUBMITTALS

- 1.7.1 GENERAL
 - 1.7.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.7.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.7.1.1.2 Table of Contents page
 - 1.7.1.1.3 Dividing pages with Equipment title
 - 1.7.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
 - 1.7.1.3 It is mandatory that the *Submittal with Quotation* documents be submitted with the Quote
 - 1.7.1.3.1 Quotes which do not include all of *Submittal with Quotation* documents will be considered incomplete and therefore rejected
 - 1.7.1.4 *Submittal after award* documents shall be submitted no later than 10 business days after Award
 - 1.7.1.5 Fabrication may not begin until the *Submittal after Award* documents are received and approved.

1.7.1.6 *Submittal before cleaning and flushing activities* documents shall be submitted 48 hours before cleaning and flushing equipment arrives at the jobsite.

1.7.1.7 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.

1.7.1.7.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.7.2 SUBMITTAL WITH QUOTATION

1.7.2.1 Submit references as described in Section 1.5

1.7.3 SUBMITTAL AFTER AWARD

1.7.3.1 Provide by Contractor:

1.7.3.1.1 Plans:

1.7.3.1.1.1 Pumping and Flushing Plan including:

1.7.3.1.1.1.1. Pump staging location,

1.7.3.1.1.1.2. Austin Water Utility water source location,

1.7.3.1.1.1.3. Water discharge location,

1.7.3.1.1.1.4. Pump size,

1.7.3.1.1.1.5. Pump capacity,

1.7.3.1.1.1.6. Number of pumps to be on-site.

1.7.3.1.1.2 Containment plan for isolating circulation system from discharges to storm sewer.

1.7.3.1.1.2.1. No discharges to storm sewer are allowed.

1.7.3.1.1.3 Capture plan for capturing accidental discharges of flushing water.

1.7.3.1.1.4 Disposal plan for water used in flushing.

1.7.3.1.1.5 A schematic drawing or sketch of the piping and the pump connections that will be cleaned, flushed and treated.

1.7.3.1.1.5.1. Number, size, material, and connection method of all suction and discharge piping, and suction and discharge manifolds.

1.7.3.1.2 Calculations:

1.7.3.1.2.1 Friction losses,

1.7.3.1.2.2 Discharge,

1.7.3.1.2.3 Flow velocity,

1.7.3.1.2.4 Pump curves,

1.7.3.1.2.5 Method of sampling discharge velocity in pumps and/or main piping.

1.7.3.1.2.6 Pump sizing calculations

1.7.3.1.2.7 System Volume

1.7.3.1.3 Schedule:

1.7.3.1.3.1 Detailed schedule for installation of circulation system.

1.7.3.2 Provided by Owner's Preferred Chemical Treatment vendor

1.7.3.2.1 Safety Data Sheets for all chemicals used and the quantity of chemical to be used.

1.7.3.2.2 Valid Austin Water Utility (AWU) Discharge permit number

1.7.4 SUBMITTAL BEFORE CLEANING AND FLUSHING ACTIVITY

1.7.4.1 Cleaning Certificates:

1.7.4.1.1 Pumps with serial numbers marked on the pump.

1.7.4.1.2 Hoses

1.7.4.1.3 Any other equipment utilized in the cleaning process.

1.7.4.2 If hand cleaning process is used, provide pictures of all pipe spool pieces that will be cleaned.

1.7.5 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

1.7.5.1 Operation and Maintenance Manuals shall include the following as a minimum

1.7.5.1.1 All submitted and Approved documents.

1.7.5.1.2 Document indicating acceptance of cleaning process by the Owner's Preferred Chemical Treatment vendor.

1.7.5.1.3 Traditional Cleaning Process

1.7.5.1.3.1 Final Iron report provide by the Owner's Preferred Chemical Treatment vendor

1.7.5.1.3.2 Metals analysis report by AE Engineer approved testing laboratory

1.7.5.1.4 Hand Cleaning Process

1.7.5.1.4.1 Provide report of all pipe spool pieces that were cleaned as defined in Section 4.6.2.6.

1.8. COORDINATION

1.8.1 The Contractor shall contract with the Owner's Preferred Chemical Treatment Vendor (as defined in Section 2.2) for all items associated with the Owner's Preferred Chemical Treatment Vendor's scope of work.

1.8.2 The Contractor shall coordinate circulation pump size and connection details, chemical pump size and connection details, administration of chemicals, testing locations and ports, sample acquisition, and recommendation of water discharge with the Owner's Preferred Chemical Treatment Vendor.

1.8.3 Contractor shall schedule and attend an on-site meeting with Owner, Owner's Engineer, Owner's Preferred Chemical Treatment Vendor, Contractor's Pump Vendor, and Developer's Representative to coordinate scheduling, logistics, piping connections, pump and hose placement, etc.

2. DESIGN

2.1. EQUIPMENT AND INSTRUMENTATION

- 2.1.1 System shall be 100% leak-proof and shall be pressure tested prior to operation at Required Test Pressure as defined in the Design Data Packet.
- 2.1.2 System shall feature a containment system to isolate pumps, pipes, fittings, hoses, equipment, etc. in the event of an unplanned discharge of circulation water.
- 2.1.3 System shall include a chemical pump and connection point for injection of chemicals by the Owner's Preferred Chemical Treatment Vendor.
- 2.1.4 Pumps shall be sized for a minimum of 5 fps in the largest pipe in the circulation loop.
- 2.1.5 Engine driven equipment or devices shall be sound attenuated to operate below 70dB or current city ordinance dB level whichever is lower.
- 2.1.6 The design shall include a method of measuring velocity in the system that can be directly related to the velocity in the main chilled or condenser water piping.
- 2.1.7 The use of PVC for interconnecting piping is prohibited for pipe sizes 2" and larger.
 - 2.1.7.1 If using PVC, PVC pipe and fittings shall be schedule 80.
- 2.1.8 Contractor shall bypass chillers, cooling towers, heat exchangers and any other large equipment not suitable for cleaning and flushing chemicals.

2.2. CHEMICAL REQUIREMENTS

- 2.2.1 Contract with Owner's Preferred Chemical Treatment vendor as defined in the Design Data Packet.

3. PRODUCTS

3.1. NOT APPLICABLE

4. EXECUTION

4.1. GENERAL

- 4.1.1 This section governs water and chemical circulation for Pre-Operation Cleaning and Flushing activities for chilled and condenser water system piping.
- 4.1.2 Adequate equipment and materials for capturing spills or releases of any kind shall be on hand and available for immediate use.
- 4.1.3 Contractor shall provide on-site 24-hour pump watch for the entirety of the flushing and passivation operation.
- 4.1.4 Pump Watch shall obtain water sample every 4 hours.
 - 4.1.4.1 Sample bottles will be provided to Contractor by Owner's Preferred Chemical Treatment Vendor representative.
 - 4.1.4.2 Pump Watch shall store sample bottles taken on-site for testing by Owner's Preferred Chemical Treatment Vendor.

- 4.1.4.3 Create a sample log that includes for each sample taken the sample bottle number, time, and date.
 - 4.1.4.3.1 Label bottle with time, date and sample number of each sample taken from the circulating water.
- 4.1.5 In case the water sample from the AE Engineer approved testing laboratory comes back noncompliant with Section 4.5.3, Owner shall determine best method for disposal and Contractor shall implement Owner's altered disposal plan.

4.2. PUMPS, HOSES and APPURTENANCES

- 4.2.1 Pumps and hoses shall be cleaned of all residues from previous jobs.
- 4.2.2 Hoses shall be in a bagged, wrapped and sealed package and kept sealed until assembly of hoses is performed.
- 4.2.3 Pumps exposed ends shall be bagged, wrapped and/or sealed from outside elements.
- 4.2.4 All pumps, piping, fittings, hoses, valves, manifolds, connections, and miscellaneous appurtenances in contact with circulation water shall be certified clean by steam cleaning methods prior to mobilization of equipment to the site.
 - 4.2.4.1 Equipment cleaned by methods other than steam shall be AE Engineer approved.
- 4.2.5 All pumps, piping, fittings, hoses, valves, manifolds, connections, and miscellaneous appurtenances shall be 100% leak proof.
- 4.2.6 Staging and testing of pumps and hoses shall be completed 24-hours prior to start of cleaning and passivation.
- 4.2.7 The use of non-leaking secondary containment for pumps and hose connections shall be used.

4.3. SERVICES PERFORMED BY OWNER'S PREFERRED CHEMICAL TREATMENT VENDOR

- 4.3.1 Chemical treatment will be provided by the Owner's Preferred Chemical Treatment Vendor.
- 4.3.2 The Owner's Preferred Chemical Treatment Vendor will provide the following:
 - 4.3.2.1 Chemicals and injection of chemicals after initial flushing and re-filling of pipe by Contractor.
 - 4.3.2.2 After 48 hours of chemical circulation and every 24 hours thereafter until the iron level have plateaued, an Iron level test shall be performed for each sample bottle.
 - 4.3.2.2.1 Iron levels have plateaued when there are at least 6 consecutive iron test sample readings within 0.2 ppm of each other.
 - 4.3.2.2.2 These field test results shall be sent to AE for Approval.
 - 4.3.2.3 Once the iron levels have plateaued and AE Approval has been given, take a new water sample and deliver to the AE Engineer approved testing laboratory.

- 4.3.2.3.1 For a next day turnaround, water samples shall be delivered to the laboratory before 10AM each morning between Monday and Thursday unless prior AE Approval has been given.
- 4.3.2.3.2 If delivered at any other time, turnaround is approximately 2-1/2 business days.
- 4.3.2.3.3 The testing laboratory shall provide the metals report for the water sample.
 - 4.3.2.3.3.1 The report shall include the five metals as defined in Section 4.5.3.
- 4.3.2.4 A recommendation to Austin Energy that the water used in the flushing operation is safe to discharge to the Austin Water Utility Waste Water System.
- 4.3.2.5 Addition of post-cleaning and final operational chemicals.
- 4.3.2.6 Written documentation of all cleaning and flushing procedures and results.

4.4. SERVICES PERFORMED BY CONTRACTOR

- 4.4.1 Contractor shall provide or perform the following:
 - 4.4.1.1 Coordination with Owner's Preferred Chemical Treatment Vendor.
 - 4.4.1.1.1 Notify Owner's Preferred Chemical Treatment Vendor at least 2 weeks prior to start of cleaning and flushing.
 - 4.4.1.2 Install piping and valves per drawings and specifications in such a manner as to facilitate the addition of chemicals by the Owner's Preferred Chemical Treatment Vendor.
 - 4.4.1.3 Install, or temporarily remove flanges, valves, fittings, etc. as required to facilitate cleaning and flushing connections and activities.
 - 4.4.1.4 Deployment of equipment or material as needed to contain spills or releases of any kind.
 - 4.4.1.5 A piped source to Austin Water Utility water with shutoff valve, meter, and certified backflow preventer in location to allow filling of piping system by Contractor.
 - 4.4.1.6 Contractor shall flush hoses prior to connection to water piping system.
 - 4.4.1.7 Filling of piping system with Austin Water Utility water.
 - 4.4.1.8 Circulation of water through pipe for 2-4 hours or longer as needed until water flows clear to remove dirt, sand, silt, gravel, welding slag, construction debris, etc.
 - 4.4.1.8.1 Flow rate shall be sufficient to suspend any settled debris to discharge, and be a minimum of five feet per second.
 - 4.4.1.9 Discharge of initial circulation water directly to the Austin Water Utility Waste Water System at a rate not to exceed that specified by Austin Water.
 - 4.4.1.9.1 No testing is required for discharging of water used in the initial flushing of the facilities.
 - 4.4.1.10 Re-fill pipe with Austin Water Utility water.

- 4.4.1.11 After AE Inspector has verified flowrate requirements are met, coordinate with Owner's Preferred Chemical Treatment Vendor for injection of initial cleaning chemicals.
 - 4.4.1.11.1 Notify AE Inspector at least 24 hours prior to need of flowrate verification.
- 4.4.1.12 Circulate water for a minimum of 48-hours or iron plateau has occurred whichever is the greater time frame.
 - 4.4.1.12.1 The 48 hour circulation time duration is the amount of time once the chemicals have been added and before a sample is sent to the lab for analysis.
- 4.4.1.13 Once AE engineer gives Approval for sample to be taken to the lab for analysis, the circulation pumps shall continue to circulate until Approval for discharge is given.
- 4.4.1.14 Once lab results are received and City of Austin discharge parameters are verified by AE engineer (See Section 4.5), Owner's designated representative will indicate that the water is safe to discharge.
 - 4.4.1.14.1 Discharge water to Austin Water Utility Waste Water System at a rate not to exceed that specified by Austin Water.
- 4.4.1.15 Immediately following discharge of cleaning water, bleed and feed piping system with Austin Water Utility water.
 - 4.4.1.15.1 Bleed and feed until water returns to Austin Water conductivity.
 - 4.4.1.15.2 Flow rate shall be sufficient to suspend any settled debris to discharge.
- 4.4.1.16 Re-fill system with Austin Water Utility water and coordinate with Owner's Preferred Chemical Treatment Vendor for injection of final operational chemicals.
 - 4.4.1.16.1 Circulate final operational chemicals for at least 1 hour.
 - 4.4.1.16.1.1 Flow rate shall be a minimum of five feet per second.
- 4.4.1.17 No pumps or hoses shall be removed without the consent of the Owner and the Owner's Designated Representative.
- 4.4.1.18 Re-install flanges, valves, piping, etc. that were removed for flushing operation to the final condition as specified in the drawings and specifications.

4.5. PARAMETERS OF DISCHARGE WATER

- 4.5.1 Discharge of flushing water to the Austin Water Utility's sanitary system is subject to the prohibitions described in Chapter 15-10 of the Austin City Ordinance Code.
- 4.5.2 Owner's Preferred Treatment Vendor shall be required to acquire an Austin Water Utility (AWU) Discharge permit and shall provide the Owner with a valid permit number to Owner's Designated Representative.
- 4.5.3 Discharges must be approved by the Austin Water Utility's Special Services Division prior to any and all discharges related to the flushing operation. The

following parameters are required to be analyzed on all samples collected from the activities described herein:

PARAMETER	LIMIT
pH	6.0 – 11.5 std. units
Copper	1.1 mg/L
Lead	0.4 mg/L
Manganese	6.1 mg/L
Zinc	2.3 mg/L
Molybdenum	1.1 mg/L

4.6. HAND CLEANING (PRIOR AE ENGINEER APPROVAL REQUIRED)

- 4.6.1 Contractor shall request Approval for Hand cleaning for each Project that it will be used.
 - 4.6.1.1 Approval in one instance does not give blanket approval for every instance.
- 4.6.2 If utilizing this procedure, only two additional welds shall be welded in the field.
 - 4.6.2.1 If more than two welds are needed, this process is not acceptable.
- 4.6.3 Contractor shall hand clean the piping per the following procedure.
 - 4.6.3.1 Contractor to cleanse the spools and piping sections that will not be included in the traditional cleaning process with cleaning chemical as defined in the Design Data Packet.
 - 4.6.3.2 The cleaning chemical shall be mixed with clean city water in order to produce a diluted solution as defined in the Design Data Packet.
 - 4.6.3.3 Utilizing appropriate PPE as required by the cleaning chemical’s SDS Contractor shall clean the inside of each piece of pipe as indicated by Owner’s Preferred Chemical Treatment vendor.
 - 4.6.3.4 Each open end of the pipe shall be wrapped in plastic to prevent dust and debris from entering pipe.
 - 4.6.3.4.1 Wraps shall not be removed until pipe is ready to be used in the system.
 - 4.6.3.5 Contractor shall take photos of each pipe spool piece before and after cleaning.
 - 4.6.3.6 Owner’s Preferred Chemical Treatment vendor shall provide a report to AE that includes the before and after photos that indicates pipe is sufficiently cleaned by cleaning and flushing standards.

END of SECTION

HEAT EXCHANGERS FOR HVAC

SECTION SS 235700

10/14/2020

Version 22.0

REVISION HISTORY			
DATE	VERSION	DESCRIPTION	AUTHOR
10/14/2020	21.0	Re-format specification	
12/22/21	22.0	No Changes	

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for purchase of the plate and frame heat exchangers by the ASME authorized Manufacturer selected by Austin Energy.
- 1.1.2 Contractor shall purchase or design the heat exchanger shroud per this Specification.
- 1.1.3 Contractor shall transport and install heat exchanger and the heat exchanger shroud.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 HX Data Sheet – Final testing and verification data sheet of heat exchanger from heat exchanger manufacturer
- 1.2.12 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.13 Final Submittal (closeout) – body of documents due 20 business days after completion of Project
- 1.2.14 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting

through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.

- 1.2.15 Project – the design and construction of pipe and piping specialties for AE plant or AE mechanical room.
- 1.2.16 Skid – Packaged heat exchanger system
- 1.2.17 Shop Drawings – detailed drawings used for shop personnel to fabricate Project.
- 1.2.18 Specification – the Specification is defined as this document, titled Heat Exchanger for HVAC SS 235700.
- 1.2.19 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.20 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.21 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 AHRI Air-Conditioning, Heating & Refrigeration Institute
- 1.3.3 ANSI American National Standards Institute
- 1.3.4 ASME American Society of Mechanical Engineers
- 1.3.5 BPVC ASME Boiler Pressure Vessel Code
- 1.3.6 HX Heat Exchanger
- 1.3.7 NBR Nitrile Butadiene Rubber
- 1.3.8 SA Specification for Analysis

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Contractor shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 AHRI Standard 400
- 1.4.3 ANSI 16.5
- 1.4.4 ASME B31 Pressure Piping Code
- 1.4.5 ASME SA-193-B7, SA-516
- 1.4.6 ASME BPVC Section IX

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications shall be followed in their entirety during Project design and manufacture
- 1.5.2 Packaged Heat Exchanger System SS 232050
- 1.5.3 Hangers and Supports for HVAC Piping and Equipment SS 230529
- 1.5.4 HVAC Pipe Identification SS 230553
- 1.5.5 Pipe Insulation SS 230719
- 1.5.6 Hydronic Piping SS 232113
- 1.5.7 Chilled Water Flush & Chemical Treatment SS 232500
- 1.5.8 Heat Exchangers for HVAC SS 235700
- 1.5.9 AE Details M20 through M29

1.6. QUALIFICATIONS

- 1.6.1 HX Manufacturers shall have a minimum five (5) years of experience in the design and fabrication/manufacturing of plate and frame heat exchangers as specified in Section 3.0
- 1.6.2 HX Manufacturers shall be certified/qualified for the design and fabrication of heat exchangers pressure vessels in accordance with ASME, AHRI, and/or other applicable codes and standards.
 - 1.6.2.1 Provide certificate of authorization from ASME

1.7. QUALITY ASSURANCE

- 1.7.1 Manufacturer "general assembly" drawings and performance data sheets shall be stamped or labeled in accordance with the most current applicable ASME/AHRI codes and standards.

1.8. AUDITS AND INSPECTIONS

- 1.8.1 Contractor shall provide 48 hour written notification prior to delivering heat exchanger to its final designation for AE inspection.
- 1.8.2 AE will inspect the following but not limited to:
 - 1.8.2.1 Heat Exchanger components
 - 1.8.2.2 Heat Exchanger dimensions
 - 1.8.2.3 Heat exchanger plate pack dimensions
 - 1.8.2.4 Heat Exchanger nameplate information
 - 1.8.2.5 Heat Exchanger shock indicator, if applicable.
- 1.8.3 Contractor shall provide 48 hour written notification prior to installing heat exchanger shroud for AE inspection.

1.9. SUBMITTALS

1.9.1 GENERAL

- 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include

- 1.9.1.1.1 A title page with Project name, Location, and Submittal name
- 1.9.1.1.2 Table of Contents page
- 1.9.1.1.3 Dividing pages with Equipment title
- 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.9.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.9.1.4 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.9.1.5 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.9.1.5.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL AFTER AWARD

- 1.9.2.1 Product Data:
 - 1.9.2.1.1 Include rated capacities, operating characteristics, furnished specialties, and accessories as defined by Design Data Packet.
 - 1.9.2.1.2 Detail equipment assemblies and indicate dimensions, weights, loads, components, and location and size of each field connection.
 - 1.9.2.1.3 HX performance run.
- 1.9.2.2 HX Shroud design
- 1.9.2.3 ASME Certificate of Authorization

1.9.3 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

- 1.9.3.1 Operation and Maintenance Manuals shall include the following as a minimum
 - 1.9.3.1.1 All approved submittal(s)
 - 1.9.3.1.2 Installation and Maintenance Manual for HX
 - 1.9.3.1.3 HX performance run
 - 1.9.3.1.4 HX as-built drawing
 - 1.9.3.1.5 HX Shroud as-built drawings
 - 1.9.3.1.6 HX Data Sheet

2. DESIGN

2.1. SHROUD

- 2.1.1 Heat exchanger shroud reference guidelines are located in the design data packet.
- 2.1.2 Groove connection pieces for interlocking of shroud sides and front/back pieces for ease of locking pieces in place.
- 2.1.3 Shroud shall have a lip at the top so that the top shroud piece sits on the lip of the side and front/back pieces then lock in place.

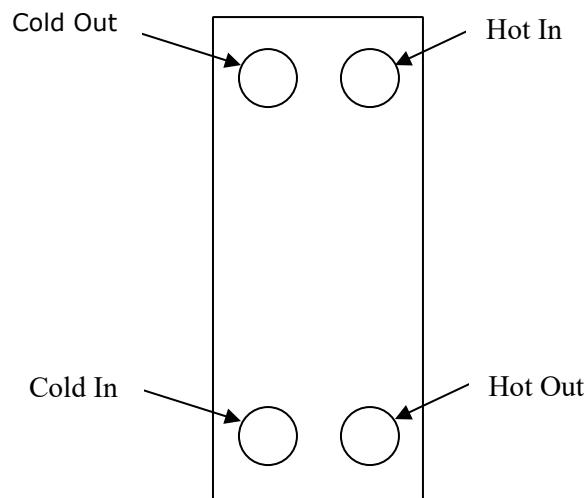
- 2.1.4 Rear Section shall have 2 vertical pieces cut down the middle.
 - 2.1.4.1 Holes shall be placed in each piece to accommodate the heat exchanger studs.
 - 2.1.4.1.1 Hole shall be no larger than 1" more than the outside diameter of heat exchanger stud.
- 2.1.5 Front Section shall have 4 pieces.
 - 2.1.5.1 All four pieces shall accommodate all pipe, flange and studs for ease of installation.
 - 2.1.5.2 Hole shall be no larger than 1" more than the outside diameter pipe.
- 2.1.6 1 mm external stucco aluminum sheet.
- 2.1.7 Insulation: 0.05 mm internal aluminum folio with minimum 60 mm thick polyurethane insulation.
- 2.1.8 Spring clips:
 - 2.1.8.1 See reference guidelines in Design Data Packet for spacing and quantity.

3. PRODUCTS

3.1. GASKETED PLATE HEAT EXCHANGERS

- 3.1.1 Manufacturers: Certified to AHRI Standard 400 in latest version with latest Addenda.
 - 3.1.1.1 Alfa Laval, AQ series
 - 3.1.1.2 Or AE Engineer approved equal.
- 3.1.2 Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, one-piece gaskets, insulated cover.
- 3.1.3 Frame: ASME SA-516-70 Carbon Steel.
 - 3.1.3.1 Capacity to accommodate 20 percent additional plates.
 - 3.1.3.2 Painted carbon steel with provisions for anchoring to support.
 - 3.1.3.3 Paint: Enamel.
- 3.1.4 End-Plate Material: Painted carbon steel.
- 3.1.5 Gaskets:
 - 3.1.5.1 Gasket Material: NBR.
 - 3.1.5.2 Gaskets shall be clipped on or glued and not taped nor free floating.
- 3.1.6 Capacity and Characteristics:
 - 3.1.6.1 See Design Data Packet for flowrate, temperature range, pressure and tonnage of heat exchanger.
 - 3.1.6.2 Single Pass Arrangement.
 - 3.1.6.3 All based upon Water with specific gravity of 1.0.
 - 3.1.6.4 Cold Side working pressure not to exceed 150 psig.
 - 3.1.6.5 Minimum Surface Margin of 20%.
 - 3.1.6.6 Maximum 5 psig pressure drop on both hot and cold sides.

- 3.1.7 Top and Bottom Carrying and Guide Bars:
 - 3.1.7.1 Painted carbon steel, except the portion of the upper and lower guide bars that contact the plates shall be Stainless Steel.
 - 3.1.7.2 Top guide bar shall mate with plates to allow plates to hang from the guide bar during service.
- 3.1.8 Tightening Bolts, Nuts and Washers: SA-193-B7 Carbon Steel, Zinc Plated 8/2H tie nuts. Washers shall not deform under compression force.
- 3.1.9 Heat exchanger locking nuts shall be in such a location that only the bolt side of the heat exchanger is necessary to access to remove the plate pack.
- 3.1.10 Pressure vessel code ASME.
- 3.1.11 150 PSIG HX – Design pressure as defined in Design Data Packet.
 - 3.1.11.1 Plate Material: 316 stainless steel, 0.5 mm minimum thickness
 - 3.1.11.2 Test Pressure: 195 psig
 - 3.1.11.3 Piping Connections:
 - 3.1.11.3.1 End-plate port with ANSI 16.5 150# 316 stainless studs suitable for flanged connection. Not smaller than Plate port diameter.
 - 3.1.11.3.2 Sleeve the frame port with welded 316 SS liner to isolate process water from contacting frame.
- 3.1.12 300 PSIG HX – Design pressure as defined in Design Data Packet.
 - 3.1.12.1 Plate Material: 316 stainless steel, 0.5 mm minimum thickness
 - 3.1.12.2 Test Pressure: 390 psig
 - 3.1.12.3 Piping Connections:
 - 3.1.12.3.1 Flanged, with 316 nozzle, not smaller than Plate port diameter.
 - 3.1.12.3.2 Sleeved with 316 SS to isolate process water from contacting frame.
- 3.1.13 Piping Connection Pattern-Facing stationary end from connection side.



3.2. HEAT EXCHANGER SHROUDS

- 3.2.1 Spring Clips:

- 3.2.1.1 Galvanized or stainless steel material
- 3.2.1.2 Locking latches
- 3.2.1.3 Retention capacity: a minimum of 220 lb
- 3.2.1.4 Plastic cover for handle protection
- 3.2.1.5 Manufacturers:
 - 3.2.1.5.1 Renyiao Model GH-4001
 - 3.2.1.5.2 Or AE Approved equal

4. EXECUTION

4.1. HEAT EXCHANGERS

- 4.1.1 Install heat exchanger per Heat Exchanger Manufacturer's installation instructions.
- 4.1.2 If heat exchanger is on a skid, refer to Specification 232050 section 2.4 for additional installation instructions.

4.2. SHROUD

- 4.2.1 Enclose all 5 chilled surfaces of heat exchanger with an insulated aluminum removable shroud.
- 4.2.2 Weather strip panels to provide vapor tight seal.
- 4.2.3 Elastomeric insulation shall be placed on the pipe connection in front of heat exchanger, on the upper and lower frame rails and around all the back bolts of each heat exchanger.
- 4.2.4 Install silver mastic type covering over the polyurethane insulation and seal or glue to aluminum edges.
- 4.2.5 Seal with caulk and glue to jacket around all bolt connections and seal at bolt ends.
- 4.2.6 Caulk around the elastomeric on the frame rails and pipe connections.
- 4.2.7 Caulk all 4 sides where the heat exchanger shroud touches the plate or concrete underneath the heat exchanger.

4.3. SHIPPING

- 4.3.1 Preparation for shipment
 - 4.3.1.1 If Contractor is required to transport heat exchangers that are not part of a skid, Contractor shall provide and activate shock indicator(s) before heat exchanger(s) are transported.
 - 4.3.1.1.1 Temporary support(s) shall be placed such that the plate pack and rear plate of each heat exchanger deflects vibration either vertically or horizontally.
 - 4.3.1.1.2 Review and follow manufacturer's recommended transport requirements.
 - 4.3.1.2 If heat exchangers are part of a skid, transportation of heat exchangers is defined in SS 232050 Packaged Heat Exchanger System.

END of SECTION

CONTROLS CONDUCTORS AND CABLES

SECTION SS 260519

11/4/2020

Version 22.0

REVISION HISTORY			
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11/4/2020	21.0	Re-format specification	
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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for all control wire and cables and associated connectors, splices, and terminations for wiring systems rated 120 V or less.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project layout.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of Project
- 1.2.13 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 PLC Drawings – a set of drawings indicating the Programmable Logic Controller (PLC) cabinet and its components as defined in the Design Data Packet.
- 1.2.15 Project – the design and construction of pipe and piping specialties for AE plant or AE mechanical room.

- 1.2.16 Shop Drawings – detailed drawings used for shop personnel to fabricate the Project
- 1.2.17 Specification – the Specification is defined as this document, titled Conductors and Cables SS 260519.
- 1.2.18 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.19 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.20 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 ATS Acceptance Testing Specifications
- 1.3.3 NECA National Electrical Contractors Association
- 1.3.4 NEMA National Electrical Manufacturer Association
- 1.3.5 NETA InterNational Electrical Testing Association
- 1.3.6 NFPA National Fire Protection Association
- 1.3.7 UL Underwriter Laboratories

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 NFPA 70: National Electric Code (NEC)
- 1.4.3 NFPA 80
- 1.4.4 NEMA WC 3, WC 5, WC 7, WC 8, WC 26
- 1.4.5 UL 486A, 486B
- 1.4.6 NECA "Standard of Installation"

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications/details shall be followed in their entirety during conductor and cable selection and installation
- 1.5.2 Chilled Water Monitoring Controls SS 230900
- 1.5.3 Conductor & Cables SS 260519

1.6. QUALIFICATIONS

- 1.6.1 Controls Contractor:

- 1.6.1.1 Manufacturer shall be a company specializing in manufacturing products specified in this section with minimum three years' experience.
- 1.6.1.2 Installer shall specialize in performing Work of this section with minimum three years documented experience.
- 1.6.2 Electrical Contractor:
 - 1.6.2.1 Manufacturer shall be a company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - 1.6.2.2 Installer shall be a Texas licensed electrician with documented experience installing all equipment specified here and shall directly supervise all work.
 - 1.6.2.2.1 Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.7. QUALITY ASSURANCE

- 1.7.1 Verify all cables are labeled in accordance with NFPA 70, Article 100.
- 1.7.2 Before electrical circuitry has been energized, perform visual and mechanical inspection for each conductor and cable.
 - 1.7.2.1 Replace damaged or rejected conductors and cables as directed by AE Engineer.

1.8. AUDITS AND INSPECTIONS

- 1.8.1 AE Inspector may inspect conductors and cables that have been installed and/or terminated for compliance to Specification.

1.9. SUBMITTALS

1.9.1 GENERAL

- 1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include
 - 1.9.1.1.1 A title page with Project name, Location, and Submittal name
 - 1.9.1.1.2 Table of Contents page
 - 1.9.1.1.3 Dividing pages with Equipment title
- 1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted
- 1.9.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award
- 1.9.1.4 Fabrication may not begin until the *Submittal after Award* documents are received and approved.
- 1.9.1.5 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.
 - 1.9.1.5.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL AFTER AWARD

1.9.2.1 Product Data: For each type of conductor and cable indicated.

1.9.3 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

1.9.3.1 Operation and Maintenance Manuals shall include the following as a minimum

1.9.3.1.1 Approved Submittal for all conductors and cables.

1.10. COORDINATION

1.10.1 Coordinate layout and installation of cables with other installations.

1.10.2 Revise locations and elevations from those indicated, as required to suit field conditions and as approved by AE Engineer.

2. DESIGN

2.1. GENERAL REQUIREMENTS

2.1.1 All electrical control wiring shall be furnished and installed in accordance with this section.

2.1.2 Indicate location of all control panels requiring power on submittal shop drawings for coordination with Electrical Contractor during pre-installation meeting

2.1.3 All network cabling shall be installed with J-hooks and D-rings.

2.1.3.1 Tie wraps shall not be used.

2.1.3.2 Velcro straps for cable management are acceptable.

2.1.4 In the case of factory mounted controls the manufacturer doing the mounting shall provide control transformers and coordinate the voltages.

2.1.5 Electrical Contractor:

2.1.5.1 All 120 volt and higher power wiring associated with the control system shall be provided.

2.1.5.2 Provide 120VAC and higher power to all control panels under the direction of the controls contractor when required.

2.1.6 Controls Contractor:

2.1.6.1 Provide 120VAC to all field instrumentation from PLC control panel as required.

2.1.6.2 Provide all transformers with secondary voltages of 24 volts or less.

2.2. WIRE AND INSULATION APPLICATIONS

2.2.1 Branch Circuits: Type THHN/THWN, in raceway.

2.2.2 Class 1 Control Circuits: Type THHN/THWN, in raceway.

2.2.3 Class 2 Control Circuits: Type THHN/THWN, in raceway.

3. PRODUCTS

3.1. GENERAL

3.1.1 This item shall govern the conductors and cables furnished and installed as indicated on the PLC Drawings.

3.2. CONTROL WIRES AND CABLES

- 3.2.1 UL-listed wires and cables with conductor material, insulation type, cable construction, and rating as specified in Section 2.1 and Specification SS 230900 AE Monitoring and Controls.
- 3.2.2 Rubber Insulation Material: Comply with NEMA WC 3.
- 3.2.3 Thermoplastic Insulation Material: Comply with NEMA WC 5.
- 3.2.4 Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- 3.2.5 Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- 3.2.6 Conductor Material: Copper.
- 3.2.7 Stranding: Stranded conductor for all gauge wires.
- 3.2.8 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.2.8.1 Alpha Wire
 - 3.2.8.2 Belden Inc.
 - 3.2.8.3 Encore Wire
 - 3.2.8.4 Houston Wire and Cable
 - 3.2.8.5 Southwire Company
 - 3.2.8.6 Or AE Engineer approved equal

3.3. CONNECTORS

- 3.3.1 UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated.
- 3.3.2 Comply with Project's installation requirements and as specified in Section 2.1.
- 3.3.3 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.3.3.1 TE Connectivity; AMP Incorporated
 - 3.3.3.2 Panduit
 - 3.3.3.3 Schneider Electric
 - 3.3.3.4 Square D Co.; Anderson.
 - 3.3.3.5 Thomas & Betts
 - 3.3.3.6 3M Company; Electrical Products Division.
 - 3.3.3.7 Or AE Engineer approved equal

4. EXECUTION

4.1. EXAMINATION

- 4.1.1 Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting

performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

4.2. INSTALLATION

- 4.2.1 Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation".
- 4.2.2 Contractor may need to remove existing wires from raceway before pulling in new wires and cables at the direction of AE Engineer.
- 4.2.3 Pull Conductors:
 - 4.2.3.1 Use manufacturer-approved pulling compound or lubricant where necessary.
 - 4.2.3.1.1 Compound used must not deteriorate conductor or insulation.
 - 4.2.3.2 Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 4.2.3.3 Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- 4.2.4 Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- 4.2.5 Support cables according to NFPA 70, NEC 300.4, and 300.11.
- 4.2.6 Seal around cables penetrating fire-rated elements according NFPA 70, NEC 300.21 and NFPA 80 code.
- 4.2.7 Identify wires and cables according to NFPA 70, NEC 310.6 and 310.8, and NEMA WC-57.

4.3. CONNECTIONS

- 4.3.1 Conductor Splices: Do not splice conductors.
- 4.3.2 Wiring at Outlets/Device:
 - 4.3.2.1 If end device is an instrument, install conductor with enough slack to wrap conductor at least once around inside of instrument.
 - 4.3.2.2 If end device is a panel/junction box, install conductor with enough slack to reach the top and bottom portion of the terminal strip the conductor is attached.
- 4.3.3 Contractor shall use the manufacturer's recommended tool for installing connectors to cables, conductors and components.
- 4.3.4 Connect outlets/device and components to wiring and to ground as indicated and instructed by manufacturer.
- 4.3.5 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
 - 4.3.5.1 If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END of SECTION

RACEWAYS AND BOXES

SECTION SS 260533

8/22/2020

Version 22.0

REVISION HISTORY			
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8/22/2020	21.0	Re-format specification	
12/22/21	22.0	No Changes	

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1. GENERAL REQUIREMENTS

1.1. SCOPE

- 1.1.1 This specification defines the requirements for all raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2. DEFINED TERMS

- 1.2.1 As used in this specification, each of the following terms shall have the meaning as set forth below
- 1.2.2 AE - defined as the City of Austin Electric Utility Department, dba Austin Energy
- 1.2.3 Approval/Approved – Written approval of document(s) by AE Engineer.
- 1.2.4 Contract – The binding legal agreement between the Owner and the Contractor. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidence by the Contract Documents.
- 1.2.5 Contract Documents – Project Manual, Drawings, Addenda and Change Orders.
- 1.2.6 Contractor – The individual, firm, corporation or other business entity with whom Owner has entered into the Contract for performance of the Work.
- 1.2.7 Design Data Packet – A document that AE engineer provides that indicates the piping sizes, instrumentation sizes, heat load, and heat exchanger performance and dimensions for the Project.
- 1.2.8 Design Drawings – AE Approved for Construction drawings of Project layout.
- 1.2.9 General Arrangement Drawing – AE Approved not for construction drawings of Project layout.
- 1.2.10 Hold Point – The point at which the Manufacturer shall not proceed until given the AE written approval to move forward in the project
- 1.2.11 Engineer – the Austin Energy District Energy and Cooling Engineer over each Project
- 1.2.12 Final Submittal (closeout) – body of documents due 20 business days after completion of Project
- 1.2.13 Owner – City of Austin, Texas, a municipal corporation, home rule city and political subdivision organized and existing under the laws of the State of Texas, acting through the City Manager or his/her designee, officers, agents or employees to administer design and construction of the Project.
- 1.2.14 PLC Drawings – a set of drawings indicating the Programmable Logic Controller (PLC) cabinet and its components as supplied by AE engineer.
- 1.2.15 Project – the design and construction of a specific building’s mechanical room’s chilled water system delivery
- 1.2.16 Shop Drawings – detailed drawings used for shop personnel to fabricate the Project

- 1.2.17 Specification – the Specification is defined as this document, titled Raceways and Boxes SS 260533.
- 1.2.18 Submittal after Award – Body of documents required to be submitted after award of work to Manufacturer but before any fabrication commences.
- 1.2.19 Substantial Completion – The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so AE can occupy or utilize the Work for its intended use, as evidence by a Certificate of Substantial Completion approved by AE.
- 1.2.20 Work – The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.

1.3. ACRONYMS

- 1.3.1 As used in this specification, each of the following acronyms shall have the meaning as set forth below
- 1.3.2 ANSI American National Standards Institute
- 1.3.3 ATS Acceptance Testing Specifications
- 1.3.4 EMT Electrical metallic tubing
- 1.3.5 ENT Electrical nonmetallic tubing
- 1.3.6 FMC Flexible metal conduit
- 1.3.7 IMC Intermediate metal conduit
- 1.3.8 LFMC Liquidtight flexible metal conduit
- 1.3.9 LFNC Liquidtight flexible nonmetallic conduit
- 1.3.10 NECA National Electrical Contractors Association
- 1.3.11 NEMA National Electrical Manufacturer Association
- 1.3.12 NFPA National Fire Protection Association
- 1.3.13 RMC Rigid metal conduit
- 1.3.14 RNC Rigid nonmetallic conduit

1.4. REFERENCE CODES AND STANDARDS

- 1.4.1 Manufacturer shall meet or exceed the latest version of applicable standards listed below. This list is not comprehensive and may not include all standards applicable to Project components. The manufacturer is responsible for meeting any applicable standards, even if they are not listed below.
- 1.4.2 ANSI C80
- 1.4.3 NFPA 70: National Electric Code (NEC)
- 1.4.4 NEMA FB, OS, 250
- 1.4.5 NECA “Standard of Installation”

1.5. AUSTIN ENERGY SPECIFICATIONS

- 1.5.1 The following AE specifications/details shall be followed in their entirety during conductor and cable selection and installation
- 1.5.2 Chilled Water Monitoring Controls SS 230900

1.5.3 Raceways and Boxes SS 260533

1.6. QUALIFICATIONS

1.6.1 Controls Contractor:

1.6.1.1 Manufacturer shall be a company specializing in manufacturing products specified in this section with minimum three years' experience.

1.6.1.2 Installer shall specialize in performing Work of this section with minimum three years documented experience.

1.6.2 Electrical Contractor:

1.6.2.1 Manufacturer shall be a company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6.2.2 Installer shall be a Texas licensed electrician with documented experience installing all equipment specified here and shall directly supervise all work.

1.6.2.2.1 Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.7. QUALITY ASSURANCE

1.7.1 Verify all raceways and boxes are labeled in accordance with NFPA 70, Article 100

1.7.2 Comply with NEC (NFPA 70) Chapter 3.

1.7.3 Perform visual and mechanical inspection for each raceway and box.

1.7.3.1 Replace damaged or rejected conductors and cables as directed by AE Engineer.

1.8. AUDITS AND INSPECTIONS

1.8.1 AE Inspector may inspect raceways and boxes that have been installed for compliance to Specification.

1.9. SUBMITTALS

1.9.1 GENERAL

1.9.1.1 All submittals shall be provided in electronic copy in pdf format, assembled in a neat, orderly manner and include

1.9.1.1.1 A title page with Project name, Location, and Submittal name

1.9.1.1.2 Table of Contents page

1.9.1.1.3 Dividing pages with Equipment title

1.9.1.2 Submittals must be tailored to each project, generic submittals will not be accepted

1.9.1.3 *Submittal after award* documents shall be submitted no later than 10 business days after Award

1.9.1.4 Fabrication may not begin until the *Submittal after Award* documents are received and approved.

1.9.1.5 *Final submittal* shall be submitted no later than 20 business days after Substantial Completion.

1.9.1.5.1 Final Submittals shall also be provided in a bound booklet form, assembled in a neat, orderly manner with section binder tabs.

1.9.2 SUBMITTAL AFTER AWARD

1.9.2.1 Product Data: For surface raceways, wireways and fittings, floor boxes, hinged cover enclosures, and cabinets.

1.9.3 FINAL SUBMITTALS (CLOSEOUT SUBMITTALS)

1.9.3.1 Operation and Maintenance Manuals shall include the following as a minimum

1.9.3.1.1 Approved Submittal for all raceways and boxes.

1.10. COORDINATION

1.10.1 Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access

1.10.2 Revise locations and elevations from those indicated, as required to suit field conditions and as approved by AE Engineer.

2. DESIGN

2.1. NOT APPLICABLE

3. PRODUCTS

3.1. GENERAL

3.1.1 This section shall govern the raceway and boxes furnished and installed as indicated on the Shop Drawings and PLC Drawings.

3.2. METAL CONDUIT AND TUBING

3.2.1 Rigid Steel Conduit and PVC Coated Rigid Steel Conduit: ANSI C80.1.

3.2.2 IMC: ANSI C80.6.

3.2.3 EMT and Fittings: ANSI C80.3.

3.2.3.1 Fittings: Compression type.

3.2.4 LFMC: Flexible steel conduit with PVC jacket..

3.2.5 FMC: Zinc-coated steel.

3.2.6 Aluminum: ANSI C80.5

3.2.7 Fittings: NEMA FB 1; compatible with conduit/tubing materials.

3.2.8 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3.2.8.1 Conduit:

3.2.8.1.1 AFC Cable Systems

3.2.8.1.2 Allied Tube & Conduit

3.2.8.1.3 Anixter

- 3.2.8.1.4 Calbrite
- 3.2.8.1.5 Electri-Flex Co.
- 3.2.8.1.6 Graybar Services, Inc.
- 3.2.8.1.7 Wheatland Tube Co.
- 3.2.8.1.8 Or AE Engineer approved Equal
- 3.2.8.2 Conduit Bodies or Fittings
 - 3.2.8.2.1 Carlon Electrical Products
 - 3.2.8.2.2 Crouse-Hinds; Div. of Eaton
 - 3.2.8.2.3 Hubbell Inc.
 - 3.2.8.2.4 Thomas & Betts
 - 3.2.8.2.5 Or AE Engineer approved equal

3.3. NON-METALLIC CONDUIT AND TUBING

- 3.3.1 Description:
 - 3.3.1.1 Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts.
 - 3.3.1.1.1 Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance.
 - 3.3.1.1.2 Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
 - 3.3.1.2 PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- 3.3.2 Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with conduits/tubing as required for complete system.
- 3.3.3 Select features as required to complete wiring system and to comply with NFPA 70.
- 3.3.4 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.3.4.1 AFC Cable Systems
 - 3.3.4.2 Calbrite
 - 3.3.4.3 Cantex Inc.
 - 3.3.4.4 Carlon Electrical Products
 - 3.3.4.5 Electri_Flex Co.
 - 3.3.4.6 Heritage Plastics
 - 3.3.4.7 Thomas & Betts
 - 3.3.4.8 Or AE Engineer approved equal

3.4. METAL WIREWAYS

- 3.4.1 Material: Sheet metal sized and shaped as indicated.

- 3.4.2 Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- 3.4.3 Select features as required to complete wiring system and to comply with NFPA 70.
- 3.4.4 Wireway Covers: Screw-cover type.
- 3.4.5 Finish shall be compatible with the environment the metal wireway is located.
- 3.4.6 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.4.6.1 Hammond Manufacturing Ltd.
 - 3.4.6.2 Hoffman Engineering Co.
 - 3.4.6.3 Square D Co.
 - 3.4.6.4 Or AE Engineer approved equal

3.5. SURFACE RACEWAYS

- 3.5.1 Surface Metal Raceways: Galvanized steel with snap-on covers.
- 3.5.2 Surface Nonmetallic Raceways: 2-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
- 3.5.3 Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- 3.5.4 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.5.4.1 Graybar Services, Inc.
 - 3.5.4.2 Hubbell Inc.
 - 3.5.4.3 Legrand North America, LLC
 - 3.5.4.4 Wiremold Co.
 - 3.5.4.5 Or AE Engineer approved equal

3.6. OUTLET AND DEVICE BOXES

- 3.6.1 Interior Sheet Metal Boxes: NEMA OS 1.
- 3.6.2 Exterior Metal Boxes: NEMA 4X.
- 3.6.3 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.6.3.1 Cantex
 - 3.6.3.2 Crouse-Hinds; Div. of Eaton
 - 3.6.3.3 Hubbell Inc.
 - 3.6.3.4 Molex
 - 3.6.3.5 RACO

- 3.6.3.6 Thomas & Betts
- 3.6.3.7 Or AE Engineer approved equal

3.7. PULL AND JUNCTION BOXES

- 3.7.1 Interior:
 - 3.7.1.1 Small Sheet Metal Boxes: NEMA OS 1.
- 3.7.2 Exterior:
 - 3.7.2.1 Small Metal Boxes: NEMA 4X
- 3.7.3 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.7.3.1 Crouse-Hinds; Div. of Eaton
 - 3.7.3.2 Hammond Manufacturing Ltd.
 - 3.7.3.3 Hubbell Inc.
 - 3.7.3.4 Hoffman Engineering Co.
 - 3.7.3.5 Thomas & Betts
 - 3.7.3.6 Or AE Engineer approved equal

3.8. ENCLOSURES AND CABINETS

- 3.8.1 Hinged-Cover Enclosures shall have a continuous hinge cover and flush latch.
 - 3.8.1.1 Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- 3.8.2 Interior Cabinets:
 - 3.8.2.1 NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge.
 - 3.8.2.2 Key latch to match panelboards.
 - 3.8.2.3 Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.
- 3.8.3 Exterior Cabinets:
 - 3.8.3.1 NEMA 4X stainless steel box with removable interior panel and removable front, finished inside with manufacturer's standard enamel.
 - 3.8.3.2 Key latch to match panelboards.
 - 3.8.3.3 Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.
- 3.8.4 Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3.8.4.1 Hammond Manufacturing Ltd.
 - 3.8.4.2 Hoffman Engineering Co.
 - 3.8.4.3 Or AE Engineer approved equal

4. EXECUTION

4.1. EXAMINATION

- 4.1.1 Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

4.2. WIRING METHODS

- 4.2.1 Outdoors: Use the following wiring methods:
 - 4.2.1.1 Exposed:
 - 4.2.1.1.1 Locations: Rigid steel or IMC.
 - 4.2.1.1.2 Under cooling tower:
 - 4.2.1.1.2.1 PVC Coated Rigid steel
 - 4.2.1.1.2.2 Aluminum (AE Approval Only on a case by case basis)
 - 4.2.1.2 Concealed: Rigid steel or IMC.
 - 4.2.1.3 Underground, Single Run or Grouped: RNC.
 - 4.2.1.4 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4.2.1.5 Boxes and Enclosures: NEMA 250, Type 3R or Type 4X.
- 4.2.2 Indoors: Use the following wiring methods:
 - 4.2.2.1 Exposed:
 - 4.2.2.1.1 Above 5 ft:
 - 4.2.2.1.1.1 EMT for circuits 480 V and less
 - 4.2.2.1.1.2 Rigid Steel for circuits greater than 480 V
 - 4.2.2.1.2 Below 5 ft:
 - 4.2.2.1.2.1 Rigid Steel
 - 4.2.2.1.2.2 EMT (AE Approval Only on a case by case basis)
 - 4.2.2.2 Concealed: EMT.
 - 4.2.2.3 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
 - 4.2.2.4 Boxes and Enclosures: NEMA 250, Type 1, except as follows.
 - 4.2.2.4.1 Outside, Damp or Wet Locations: NEMA 250, Type 4X, stainless steel.
- 4.2.3 Minimum Raceway Size:
 - 4.2.3.1 Power Circuits: 3/4-inch.
 - 4.2.3.2 Lighting Circuits: 3/4-Inch.
 - 4.2.3.3 Control Circuits: 3/4-inch.
- 4.2.4 Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 4.2.4.1 Intermediate Steel Conduit: Use threaded rigid steel conduit fittings.

- 4.2.4.2 PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material
 - 4.2.4.2.1 Patch all nicks and scrapes in PVC coating after installing conduits.
- 4.2.5 Do not install aluminum conduits embedded in, in contact with concrete, or where contact with softened water can occur.

4.3. INSTALLATION

- 4.3.1 Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- 4.3.2 In mechanical rooms, conduit and EMT may be surface mounted. In other areas, conceal conduit and EMT within finished walls, ceilings, and floors.
- 4.3.3 Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 4.3.3.1 Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 4.3.3.2 Space raceways laterally to prevent voids in concrete.
 - 4.3.3.3 Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement.
 - 4.3.3.3.1 Where at right angles to reinforcement, place conduit close to slab support.
 - 4.3.3.4 Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- 4.3.4 Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes.
 - 4.3.4.1 Install horizontal raceway runs above water and steam piping.
- 4.3.5 Install raceways level and square and at proper elevations.
 - 4.3.5.1 Provide adequate headroom.
- 4.3.6 Complete raceway installation before starting conductor installation.
- 4.3.7 Support raceways as specified defined in NEC Chapter 3
- 4.3.8 Use temporary closures to prevent foreign matter from entering raceways.
- 4.3.9 Protect stub-ups from damage where conduits rise through floor slabs.
 - 4.3.9.1 Arrange so curved portion of bends is not visible above the finished slab.
- 4.3.10 Make bends and offsets so conduit inner diameter is not reduced.
- 4.3.11 Keep legs of bends in the same plane and straight legs of offsets parallel.
- 4.3.12 Use raceway fittings compatible with raceways and suitable for use and location.
- 4.3.13 For intermediate steel conduit, use threaded rigid steel conduit fittings.
- 4.3.14 Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions.
- 4.3.15 Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

- 4.3.15.1 Run parallel or banked raceways together, on common supports where practical.
- 4.3.15.2 Make bends in parallel or banked runs from same centerline to make bends parallel.
- 4.3.15.3 Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- 4.3.16 Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 4.3.16.1 Make raceway terminations tight.
 - 4.3.16.2 Use bonding bushings or wedges at connections subject to vibration.
 - 4.3.16.3 Use bonding jumpers where joints cannot be made tight.
 - 4.3.16.4 Use insulating bushings to protect conductors.
- 4.3.17 Terminations:
 - 4.3.17.1 Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box.
 - 4.3.17.2 Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- 4.3.18 Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder.
 - 4.3.18.1 Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- 4.3.19 Install pull wires in empty raceways.
 - 4.3.19.1 Use monofilament plastic line with not less than 200-lb (90-kg) tensile strength.
 - 4.3.19.2 Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- 4.3.20 Flexible Connections:
 - 4.3.20.1 Use maximum of 3 feet of flexible conduit where indicated, and for equipment subject to vibration, noise transmission, or movement, for all motors and for recessed and semi-recessed lighting fixtures. Use liquid-tight flexible conduit in wet or damp locations.
 - 4.3.20.2 Install separate ground conductor across flexible connections.
- 4.3.21 Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.
 - 4.3.21.1 Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.
 - 4.3.21.2 Where a surface raceway is used to supply a lighting fixture having central-stem suspension with a backplate and a canopy (with or without extension ring), no separate outlet box is required.
 - 4.3.21.3 Provide surface metal raceway outlet box, and the backplate and canopy, at the feed-in location of each lighting fixture having end-stem suspension.

- 4.3.21.4 Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, no additional surface-mounted outlet box is required.
 - 4.3.21.4.1 Provide a backplate slightly smaller than the fixture canopy
- 4.3.22 Install hinged-cover enclosures and cabinets plumb.
 - 4.3.22.1 Support at each corner.
- 4.3.23 For all empty conduit or conduit that does not have conductors or cables within the conduit, Contractor shall leave a pull string for future use.

4.4. PROTECTION

- 4.4.1 Provide protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 4.4.1.1 Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4.4.1.2 Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

4.5. CLEANING

- 4.5.1 On completion of installation, including outlet fittings and devices, inspect exposed finish.
- 4.5.2 Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END of SECTION