SECTION 223500 – DOMESTIC AND LABORATORY WATER HEAT EXCHANGERS

Latest Edition 08-10-2024

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes the requirements for domestic and laboratory water heaters as follows:

<Edit for Project>

1. Packaged steam to water hot water heaters with shell and tube heat exchanger and storage tank.

2. Commercial electric hot water heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heat exchanger indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of shell-and-tube, domestic-water heat exchanger, from manufacturer.

B. Domestic-Water, Heat-Exchanger Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic-water heat exchangers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. LEED-NC Prerequisite EA 2 requires that domestic-water heat exchangers comply with ASHRAE/IESNA 90.1, including equipment efficiency indicated in table titled "Performance Requirements for Water Heating Equipment."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete housekeeping pads with actual equipment provided. At a minimum the house keeping pads should extend six (6) inches beyond the footprint of the equipment to be installed.

1.8 WARRANTY AND GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including heat exchanger, storage tank, and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Verify available warranties for units and components with manufacturers listed in Part 2 articles.

3. Warranty Periods: From date of Substantial Completion.

a. Shell-and-Tube, Domestic-Water Heat Exchangers:

1) Tube Coil: Two (2) year(s).

2) Controls and Other Components: Two (2) year(s).

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Domestic and Laboratory Hot Water Heating equipment shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Basis of Design: The basis of design for Domestic and Laboratory Water Heating equipment shall be as follows: <Edit required for project>

1. PVI Industries LLC. – Packaged Shell and Tube Water Heaters
2. PVI Industries LLC. – Semi-instantaneous Water Heaters
3. AO Smith Inc.– Commercial Electric Water Heaters

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide Domestic and Laboratory Water Heating equipment by one (1) of the following: <Edit required for project>

1. Patterson Kelly
2. AERCO International, Inc.
3. ThermaFlo Engineering Inc.
4. AO Smith Inc.

2.2 PACKAGED SHELL AND TUBE DOMESTIC WATER HEATERS

A. Shell-and-Tube, Heating-Fluid-in-Coil, Domestic-Water Heat Exchangers:

1. Description: Packaged assembly of tank, heat-exchanger coils, controls, and specialties for heating domestic water with steam in coils.

2. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel shell with 150-psig minimum working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

b. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.

3. Heat-Exchanger Coils: Stainless-steel, vertical, U-tube, double-wall helix-wound coils for heating fluid. Include pressure rating equal to or greater than heating-fluid supply pressure. The heat exchanger shall be UL listed as acceptable for use heating potable water in commercial installations.

4. Temperature Control: Adjustable thermostat that operates control valve and is capable of maintaining outlet-water temperature within 4ºF of setting.

5. Safety Control: Automatic, high-temperature-limit cutoff device or system.

6. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger.

7. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.

a. Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.

8. Stand: Factory fabricated for floor mounting.

B. Capacity and Characteristics:

1. See Equipment Schedules for performance characteristics.

2.3 SEMI-INSTANTANEOUS WATER HEATERS

A. General: The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for stand-by heat losses as established for indirect fired water heaters incorporating storage tanks.

B. Construction:

1. Water heater shall be a, semi-instantaneous design indirectly heated by steam through a copper u-tube bundle.

2. The water heater vessel shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.

3. All vessel connections/ fittings shall be nonferrous. Vessel shall be equipped with a ball-type drain valve.

4. The vessel shall be an unlined and constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."

5. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

6. All internal and external vessel surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

7. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% postconsumer recycled materials and be 100% recyclable.

8. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.

9. Lined, clad or plated storage tanks will not be acceptable.

10. The water heater will not require anode rods and none will be used. Vessels that employ anodes will not be acceptable.

11. The heat exchanger shall be a SINGLE-WALL copper u-tube bundle ASME stamped to section VIII. Heat exchanger's tube sheet, tie rods and baffles will be non-ferrous. The heat exchanger shall be a DOUBLE-WALL copper u-tube bundle

ASME stamped to section VIII. Heat exchanger's tube sheet, tie rods and baffles will be non-ferrous.

12. Steam will be controlled through one or more pilot operated solenoid steam valves.

C. Performance:

1. Vessel will meet the tank insulation requirements of ASHRAE 90.1-2010

D. Water Heater Trim:

1. As a minimum, the heater will be equipped with the following:

a. Electronic operating thermostat
b. Temperature limiting device
c. ASME- or AGA-rated temperature and pressure relief valve
d. Options as selected on form PV 8146

2. Operating and safety controls shall meet the requirements of [ETL] [MASS Code]

3. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection via Ethernet using one (1) of the following protocols:

a. BACnet IP
b. ModBus TCP

2.4 COMMERCIAL ELECTRIC HOT WATER HEATER <Edit for Project or Delete if not required>

A. General: The heater shall be a glass-lined Custom Xi™ commercial electric heater Model DSE - X with [X] gallons storage, as manufactured by A.O. Smith or approved equal.

B. Heater: Heater should be rated at [X] kW, [X] volts, [X] phase, 60 cycle AC and constructed in accordance with ASME Code, shall bear appropriate symbol and be listed with the National Board as required. Heater shall be listed with Underwriters' Laboratories and classified to The National Sanitation Foundation Standard No. 5.

C. Tank: All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1,600°F. Tank shall be cathodically protected with a combination of sacrificial and powered anodes. The entire vessel is to be enclosed in a round steel enclosure with baked enamel finish.

D. Insulation: Foam insulation shall meet the thermal efficiency and/or standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1.

E. Controls: Water heater shall have an electronic control with large LCD displaying current water heater status; provide real time element status and sensing, low water cutoff and economy mode operation.

1. Provide a 120 volt control circuit transformer, transformer fusing, magnetic contactor(s), element fusing per N.E.C., and commercial grade Incoloy elements.
2. Temperature controls include limiting switch which will require resetting manually in the event the temperature reaches 202°F.
3. The Operating Set Point shall be adjustable from 90°F/42°C to 190°F/88°C. The factory setting is 120°F/49°C.

F. Relief and Drain Valves: Heater shall include a CSA Certified and ASME Rated T&P relief valve and a drain valve.

G. BAS Interface: Water heater units(s) shall be compatible with building management systems using [Modbus] or [BACnet] with optional ICC interface.

2.5 POINT OF USE HOT WATER HEATER <Delete if not required>

A. General: Point of Use Electric Water Heater shall be Model TRONIC ES4 electric mini-tank water heaters as distributed by Bosch Thermotechnology Corp. and 98% thermal efficiency. Supply voltage shall be 110 - 120VAC with a heating capacity of 1440 Watts. The electric mini-tank water heaters shall be UL listed for the US and UPC certified. The electric mini-tank water heaters shall be Massachusetts Plumbing Board approved and Wisconsin Plumbing Board approved.

B. Construction: Water heater shall be electrically powered with compact mini-tank design for point-of-use operation and an efficiency rating of 98%. Tank shall be glass-lined and insulated for thermal retention. Unit shall be protected by a tough plastic housing. Tank shall be rated for maximum working pressure not less than 150 psig. Water heater shall be equipped with a pressure relief valve and a magnesium anode rod for protection against tank corrosion. Water connections for inlet and outlet shall be one half (1/2) inch NPT male for Model ES4.

C. Controls: The controls shall be a wired thermostat with temperature selector and a high temperature safety cut-out. A red light shall indicate when the unit is powering the heating element.

D. Mode of Operation: The heater shall include integral factory wired thermostat to control all operation and energy input. Control of outlet water temperature shall be set through an internal set point with a field adjustment of 65°F to 145°F. Heater shall be capable of maintaining the temperature set point +/- 3°F by supplying power to the 1440 Watt heating element.

E. Warranty: The inner tank shall carry a six (6) year limited warranty. All other parts and components shall carry a two (2) year limited warranty against defects in materials or workmanship.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half (1-1/2) times pressure rating before shipment.

C. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER, HEAT-EXCHANGER INSTALLATION

A. Domestic-Water, Heat-Exchanger Mounting: Install domestic-water heat exchangers on concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Anchor heat exchangers to substrate.

B. Install domestic-water heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to heat exchangers and on domestic-hot-water outlet piping.

2. Install shutoff valves on steam and condensate piping to heat exchangers. Comply with requirements for shutoff valves specified in Division 23, Specification Section "Valves for HVAC Piping Systems".

C. Install temperature and pressure relief valves in top portion of storage-tank shells of domestic-water heat exchangers with domestic-water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature-and-pressure relief valves in water piping for domestic-water heat exchangers without storage. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heat exchangers that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22, Specification Section "Valves for Plumbing Piping Systems."

F. Install thermometer on each domestic-water, heat-exchanger, inlet and outlet piping, and install thermometer on each domestic-water, heat-exchanger, heating-fluid outlet piping. Comply with the requirements for thermometers as specified in Division 22, Specification Section "Thermometers and Gauges for Plumbing Piping."

G. Install pressure gages on domestic-water, heat-exchanger, heating-fluid piping. Comply with requirements for pressure gages specified in Division 22, Specification Section "Thermometers and Gauges for Plumbing Piping."

H. Fill domestic-water heat exchangers with water.

I. Charge domestic-water compression tanks with air.

3.2 SEMI-INSTANTANEOUS WATER HEATERS

A. Finishing: The vessel and heating sections shall be completely factory packaged on a single skid, requiring only job site hookup to utilities, venting, and plumbing. The heater shall be insulated to ASHRAE 90.1-2010 requirements, jacketed with enameled steel panels, and mounted on heavy-duty channel skids. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

B. Start-up: Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.

3.3 COMMERCIAL ELECTRIC HOT WATER HEATERS <Delete if not Required>

A. Hot water heater installation shall comply with the requirements of the latest edition of the Plumbing Code adapted by the State of Maryland.

B. The water heaters shall be installed level and plumb and securely anchored.

C. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

D. Water heaters shall be installed on concrete housekeeping pads unless elevated above the floor. See Detail and Division 22 for housekeeping pad requirements

E. The water heaters shall be installed and connected in accordance with manufacturer's written instructions with manufacturer's recommended clearances.

F. All pressure and temperature relief valves discharge shall be piped to nearby floor drains with air gap.

G. Dielectric unions shall be provided if there are dissimilar metals between the water heater connections and the attached piping.

H. Shutoff valves and unions shall be installed on the domestic water supply piping to the water heater and on the domestic hot water outlet piping.

I. A combination temperature and pressure relief valve shall be installed at the top portion of the storage tank in accordance with manufacturer's recommendations. The sensing element shall extend into the tank. The relief valve outlet drain piping shall discharge by air gap into a floor drain.

J. Where hot water is recirculated, see details and diagrams on drawings for the pump and piping requirements.

3.4 POINT OF USE HOT WATER HEATER <Delete if not required>

A. All aspects of installation of electric mini-tank water heater shall be in strict accordance with manufacturer's instructions. Materials shall conform to all manufacturer's recommendations including electrical connections and wiring. Water heater piping shall be fi eld constructed of materials as specified. Water heater shall be installed with water shutoff valves for service and maintenance.

3.5 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Comply with requirements for piping specified in Division 22, Specification Section "Domestic and Laboratory Water Piping Systems and Specialties."

C. Comply with requirements for steam and condensate piping specified in Division 23, Specification Section “HVAC Piping Systems and Specialties”.

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to domestic-water heat exchangers, allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of domestic-water heat exchangers.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22, Specification Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain shell-and-tube domestic-water heat exchangers.

END OF SECTION 223500