SECTION 235700 - HEAT EXCHANGERS FOR HVAC

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section includes [**shell-and-tube**] [**brazed-plate**] [**and**] [**gasketed-plate**] heat exchangers.
      2. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. TEMA: Tubular Exchanger Manufacturers Association.
      1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer's installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.
      2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components, or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Equipment room plan or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

Retain "Seismic Qualification Data" Paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: Certificates, for heat exchanger, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Heat Exchanger: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of heat exchanger anchorage devices on which certification is based and their installation requirements.

Retain "Product Certificates" paragraph below to require submittal of product certificates from manufacturers.

* + - * 1. Product Certificates: For each type of shell-and-tube heat exchanger. Documentation that shell-and-tube heat exchangers comply with "TEMA Standards."
        2. Source quality-control reports.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
        2. Sample Warranty: For manufacturer's warranty.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
      2. WARRANTY

When warranties are required, verify with Director’s Representative's that special warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.

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

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

Faulty operation of controls.

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

Verify available warranties and warranty periods for units and components.

Warranty Periods: From date of Substantial Completion.

Shell-and-Tube Heat Exchangers:

Tube Coil: [**One**] <**Insert number**> year(s).

Other Components: [**One**] <**Insert number**> year(s).

Plate Heat Exchangers:

Brazed-Plate Type: [**One**] <**Insert number**> year(s).

Gasketed-Plate Type; [**One**] <**Insert number**> year(s).

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. PERFORMANCE REQUIREMENTS

Retain "Delegated Design" paragraph below if Contractor is required to assume responsibility for design.

* + - * 1. Delegated Design: Engage a qualified Professional Engineer to design seismic restraints for heat exchangers.

Retain "Seismic Performance" paragraph below with "Seismic Qualification Data" paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Heat exchangers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as components that contain hazardous content and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor is [**1.5**] [**1.0**].

See ASCE/SEI 7, "Coefficients for Architectural Component Table" and "Seismic Coefficients for Mechanical and Electrical Components Table," for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

* + - 1. SHELL-AND-TUBE HEAT EXCHANGERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3556) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

[Alfa Laval Inc](http://www.specagent.com/Lookup?uid=123457138843).

[API Heat Transfer Inc](http://www.specagent.com/Lookup?uid=123457138824).

[Armstrong Fluid Technology](http://www.specagent.com/Lookup?uid=123457138844).

[Bell & Gossett; a Xylem brand](http://www.specagent.com/Lookup?uid=123457138845).

[Delta T Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138846).

[Flo Fab Inc](http://www.specagent.com/Lookup?uid=123457138831).

[Kelvion, Inc](http://www.specagent.com/Lookup?uid=123457138847).

[Spirax Sarco Limited](http://www.specagent.com/Lookup?uid=123457138830).

[Taco Comfort Solutions](http://www.specagent.com/Lookup?uid=123457138826).

[Thermo Dynamics Ltd](http://www.specagent.com/Lookup?uid=123457138848).

[Thrush Co. Inc](http://www.specagent.com/Lookup?uid=123457138827).

[Wessels Company](http://www.specagent.com/Lookup?uid=123457138849).

Approved equivalent.

* + - * 1. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.
        2. Construction:

Use first subparagraph below when system pressures are greater than 15 psig.

Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

TEMA registration is an added quality assurance that the products comply with TEMA engineering and manufacturing criteria. Not all manufacturers listed are TEMA members. Contact TEMA for a current member listing.

Fabricate and label shell-and-tube heat exchangers to comply with "TEMA Standards."

First option in "Configuration" paragraph below is most common in HVAC applications.

* + - * 1. Configuration: [**U-tube with removable**] [**Straight tube with removable**] [**Straight tube with fixed**] bundle.
        2. Shell Materials: [**Steel**] [**Stainless steel**].
        3. Head:

In "Materials" subparagraph below, several metal types are listed as options. The first option is the most common in HVAC applications and is generally the least expensive. Other listed options are generally available and may be required for certain applications.

Materials: [**Cast iron**] [**Cast stainless steel**] [**Fabricated steel**] [**Fabricated steel with removable cover**] [**Fabricated stainless steel**] [**Fabricated stainless steel with removable cover**].

Flanged and bolted to shell.

* + - * 1. Tube: [**Seamless copper**] [**Steel**] [**Cupronickel**] [**Stainless steel**] tubes.

Tube diameter is determined by manufacturer based on service.

* + - * 1. Tubesheet Materials: [**Steel**] [**Stainless steel**].
        2. Baffles: [**Steel**] [**Stainless steel**].
        3. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.

NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

* + - * 1. Support Saddles:

Fabricated of material similar to shell.

Fabricate foot mount with provision for anchoring to support.

If Project has more than one type or configuration of shell-and-tube heat exchanger, delete "Capacities and Characteristics" paragraph below and schedule on Drawings.

* + - * 1. Capacities and Characteristics:

General:

Shell Diameter: <**Insert inches**>.

Heat-Exchanger Length: <**Insert inches**>.

Heat-Exchanger Surface Area: <**Insert sq. ft.**>.

Number of Passes: <**Insert number**>.

Heat Exchanged: <**Insert Btu/h**>.

Operating Weight: <**Insert lb**>.

Shell Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraphs below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

Tube Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraphs below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

* + - 1. GASKETED-PLATE HEAT EXCHANGERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3557) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Alfa Laval Inc](http://www.specagent.com/Lookup?uid=123457138808).

[API Heat Transfer Inc](http://www.specagent.com/Lookup?uid=123457138809).

[Armstrong Fluid Technology](http://www.specagent.com/Lookup?uid=123457138852).

[Bell & Gossett; a Xylem brand](http://www.specagent.com/Lookup?uid=123457138850).

[Delta T Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138811).

[Flo Fab Inc](http://www.specagent.com/Lookup?uid=123457138822).

[Kelvion, Inc](http://www.specagent.com/Lookup?uid=123457138821).

[Polaris Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138813).

[SEC Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138814).

[Taco Comfort Solutions](http://www.specagent.com/Lookup?uid=123457138815).

[Tranter, Inc](http://www.specagent.com/Lookup?uid=123457138817).

[Weil-McLain](http://www.specagent.com/Lookup?uid=123457138851).

[Wessels Company](http://www.specagent.com/Lookup?uid=123457138823).

Approved equivalent.

* + - * 1. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.

Use "Construction" paragraph below when system pressures are greater than 15 psig.

* + - * 1. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
        2. Frame:

Capacity to accommodate [**20**] <**Insert number**> percent additional plates.

Painted carbon steel with provisions for anchoring to support.

* + - * 1. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

Retain subparagraph below for projects in seismic areas.

Fabricate attachment of heat-exchanger support bars and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger support bars and guide bars are anchored to building structure.

* + - * 1. End-Plate Material: Painted carbon steel.
        2. Tie Rods and Nuts: Steel or stainless steel.

In "Plate Material" paragraph below, 0.024-inch- thick, Type 304 stainless steel is standard for most manufacturers. It is acceptable for most HVAC applications and is generally the least expensive. Other listed options are generally available and may be required for certain applications.

* + - * 1. Plate Material: [**0.024 inch**] [**0.031 inch**] [**0.039 inch**] <**Insert thickness**> thick before stamping; [**Type 304**] [**Type 304L**] [**Type 316**] [**Type 316L**] stainless steel.

Glue-free gaskets are mechanically held in place by plates on both sides of each gasket.

* + - * 1. Gasket Materials: [**Glued**] [**Glue free**] [**Nitrile rubber**] [**EPDM rubber**] <**Insert material**>.

Retain "Glue" subparagraph below for glued gaskets.

Glue: Chlorine free.

* + - * 1. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.

NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

* + - * 1. Enclose plates in solid [**aluminum**] [**stainless steel**] removable shroud.

If Project has more than one type or configuration of gasketed-plate heat exchanger, delete "Capacities and Characteristics" paragraph below and schedule on Drawings.

* + - * 1. Capacities and Characteristics:

General:

Heat-Exchanger Surface Area: <**Insert sq. ft.**>.

Number of Plates: <**Insert number**>.

Number of Passes: [**One**] <**Insert number**>.

Heat Exchanged: <**Insert Btu/h**>.

Operating Weight: <**Insert lb**>.

Hot Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraphs below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

Cold Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraph below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

* + - 1. BRAZED-PLATE HEAT EXCHANGERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3558) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Alfa Laval Inc](http://www.specagent.com/Lookup?uid=123457138832).

[API Heat Transfer Inc](http://www.specagent.com/Lookup?uid=123457138833).

[Armstrong Fluid Technology](http://www.specagent.com/Lookup?uid=123457138853).

[Bell & Gossett; a Xylem brand](http://www.specagent.com/Lookup?uid=123457138854).

[Delta T Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138855).

[Flo Fab Inc](http://www.specagent.com/Lookup?uid=123457138842).

[Kelvion, Inc](http://www.specagent.com/Lookup?uid=123457138835).

[Polaris Heat Exchangers](http://www.specagent.com/Lookup?uid=123457138837).

[Tranter, Inc](http://www.specagent.com/Lookup?uid=123457138838).

[Weil-McLain](http://www.specagent.com/Lookup?uid=123457138856).

[Wessels Company](http://www.specagent.com/Lookup?uid=123457138857).

Approved equivalent.

* + - * 1. Configuration: Brazed assembly, consisting of embossed or pressed stainless steel plates brazed together and two end plates, one with threaded nozzles and one with pattern-embossed plates. Floor-mounted heat exchangers must have factory-furnished integral legs with mounting feet.

Use "Construction" paragraph below when system pressures are greater than 15 psig.

* + - * 1. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
        2. End-Plate Material: Type 316 stainless steel.
        3. Threaded Nozzles: Type 316 stainless steel.
        4. Plate Material: Type 316 stainless steel.

Retain one option in "Brazing Material" paragraph below. Copper is most common.

* + - * 1. Brazing Material: [**Copper**] [**or**] [**nickel**].

If Project has more than one type or configuration of brazed-plate heat exchanger, delete "Capacities and Characteristics" paragraph below and schedule on Drawings.

* + - * 1. Capacities and Characteristics:

General:

Heat-Exchanger Surface Area: <**Insert sq. ft.**>.

Heat Exchanged: <**Insert Btu/h**>.

Operating Weight: <**Insert lb**>.

Hot Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraphs below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

Cold Side:

Fluid: [**Water**] [**Steam**] <**Insert type**>.

Working Pressure: <**Insert psig**>.

Retain "Supply Pressure" and "Steam-Flow Rate" subparagraphs below for steam-to-water or steam-to-steam heat exchangers.

Supply Pressure: <**Insert psig**>.

Steam-Flow Rate: <**Insert lb/h**>.

Retain "Water-Flow Rate," "Pressure Drop," "Inlet Temperature," "Outlet Temperature," and "Fouling Factor" subparagraphs below for steam-to-water or water-to-water heat exchangers. Retain "Inlet Size" and "Outlet Size" subparagraphs for all.

Water-Flow Rate: <**Insert gpm**>.

Pressure Drop: <**Insert psig**>.

Inlet Temperature: <**Insert deg F**>.

Outlet Temperature: <**Insert deg F**>.

Fouling Factor: <**Insert value**>.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

* + - 1. ACCESSORIES
         1. Hangers and Supports:

Custom-built steel supports and saddles for mounting on [**floor**] [**wall**] [**structural steel**].

Minimum Number of Saddles: <**Insert number**>.

See manufacturer's recommendations for the number of vertical and horizontal supports required to both support and stabilize heat exchangers.

Supports and saddles to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

Retain "Shroud" paragraph below for gasketed-plate heat exchangers.

* + - * 1. Shroud: [**Steel**] [**Stainless steel**] [**Aluminum**] sheet.

Retain "Miscellaneous Components for ( High-Temperature,) Hot-Water Unit" paragraph below for water-to-water heat exchangers to require factory-mounted valves and specialties. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230923.11 "Control Valves."

* + - * 1. Miscellaneous Components for[**High-Temperature,**] Hot-Water Unit: Control valve, valves, thermometers, and piping.[**Include components fitted for**] [**pneumatic control**] [**electric control**] [**electronic control**].

Retain "Miscellaneous Components for Steam Unit" paragraph below for steam-to-water heat exchangers to require factory-mounted valves and specialties. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230923.11 "Control Valves."

* + - * 1. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometers, and piping. [**Include components fitted for**] [**pneumatic control**] [**electric control**] [**electronic control**].

Retain "Pressure-Relief Valves" paragraph below if they are not included on adjacent equipment. If retaining, coordinate the pressure rating with heat-exchanger pressure rating.

* + - * 1. Pressure-Relief Valves: [**Cast iron**] [**Steel**] [**Bronze**] [**Brass**], <**Insert NPS**>, ASME rated and stamped.

Pressure-relief valve setting: <**Insert psig**>.

* + - 1. SOURCE QUALITY CONTROL

Retain "Factory Tests" paragraph below for factory-assembled heat exchangers. Factory tests are an added cost option and may not be available from some manufacturers. Verify requirement with Director’s Representative.

* + - * 1. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.
        2. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
        3. Heat exchangers will be considered defective if they do not pass tests and inspections.
        4. Prepare test and inspection reports.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
          2. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.
          3. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION OF HEAT EXCHANGER, GENERAL
          1. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain subparagraph below for projects in seismic areas.

Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

* + - 1. INSTALLATION OF SHELL-AND-TUBE HEAT EXCHANGER
         1. Install heat exchangers on saddle supports.
         2. Heat-Exchanger Supports: Mount heat exchanger on steel saddles and supports specifically designed for each heat exchanger.

Retain paragraph below for projects in seismic areas.

* + - * 1. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.
      1. INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER
         1. Install wall-mounted gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.
         2. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base, and fasten legs to base.
         3. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufacturer's written instructions.
      2. INSTALLATION OF BRAZED-PLATE HEAT EXCHANGER
         1. Install wall-mounted brazed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.
         2. Install floor-mounted brazed-plate heat exchangers on cast-in-place concrete equipment base and fasten legs to base.
      3. PIPING CONNECTIONS

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.

* + - * 1. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

Retain first paragraph below for steam heat exchangers.

* + - * 1. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
        2. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
        3. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
        4. Install shutoff valves at heat-exchanger inlet and outlet connections.
        5. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.
        6. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.
        7. Pipe pressure-relief valves, full size of valve connection, to floor drain.

Retain first paragraph below for steam heat exchangers.

* + - * 1. Install vacuum breaker at heat-exchanger steam inlet connection.

Retain first paragraph below for shell-and-tube heat exchangers.

* + - * 1. Install hose end valve to drain shell.
        2. Install thermometer on each heat-exchanger fluid [**inlet and**] outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."
        3. Install pressure gauges on each heat-exchanger fluid [**inlet and**] outlet piping [**and steam inlet piping**]. Comply with requirements for pressure gauges specified in Section 230519 "Meters and Gauges for HVAC Piping."
      1. CLEANING
         1. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
         2. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.
         3. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.
      2. FIELD QUALITY CONTROL

Retain "Testing Agency, Contractor" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a Company Field Advisor to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Field Advisor per OGS Spec Section 014216 to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspections, and retain option to require Contractor to arrange for the assistance of a Company Service Advisor.

* + - * 1. Perform tests and inspections [**with the assistance of a Company Field Advisor per OGS Spec Section 014216**]:

Retain test requirements below with any combination of paragraphs above.

* + - * 1. Tests and Inspections:

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

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

* + - * 1. Heat exchanger will be considered defective if it does not pass tests and inspections.
        2. Prepare test and inspection reports.
      1. DEMONSTRATION

Company Field Advisor is not usually required.

* + - * 1. [**Engage a Company Field Advisor per OGS Spec Section 014216 to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 235700