SECTION 236413.13 - DIRECT-FIRED ABSORPTION WATER CHILLERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

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.

This Section may include provisions for LEED 2009, LEED v4, ASHRAE 189.1, IgCC, and Green Globes. Note that some sustainable design requirements are either mandatory or optional requirements that may be inserted in the Section Text using the hypertext links. Other requirements that are associated with sustainable design, and may be considered "best practice" or retained even if a sustainable design standard is not a project requirement, are discussed in the Evaluations.

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:

Packaged, water-cooled, direct-fired absorption water chillers.

Heat-exchanger, brush-cleaning system.

* + - 1. DEFINITIONS

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

* + - * 1. BAS: Building automation system.
				2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
				3. IPLV: Integrated part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by AHRI 560 and referenced to AHRI standard rating conditions.
				4. NPLV: Nonstandard part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by AHRI 560 and intended for operating conditions other than the AHRI standard rating conditions.
			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. Include rated capacities, operating characteristics, furnished specialties and accessories, and the following:

Performance at AHRI standard conditions and at conditions indicated.

Performance at AHRI standard unloading conditions.

Minimum evaporator flow rate.

Absorbent capacity of chiller.

Refrigerant capacity of chiller.

Liquid capacity of evaporator and condenser.

Liquid capacity of generator.

Characteristics of safety relief devices.

Minimum entering condenser-liquid temperature.

Performance at varying capacities with constant design condenser-liquid temperature. Repeat performance at varying capacities for different condenser-liquid temperatures from design to minimum in [**5 deg F**] <**Insert temperature**> increments.

If equipped, liquid capacity of dedicated hot-water heater exchanger.

Combustion-air flow.

Exhaust gas airflow.

Exhaust gas minimum and maximum operating temperature.

* + - * 1. Shop Drawings:

Include plans, elevations, sections, and attachment details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring.

Insulated Surface Diagrams: Indicating cold and hot surfaces requiring field-applied insulation with surface area tabulated for each.

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: Floor plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

Some manufacturers will not provide certification specified in "Seismic Qualification Data" paragraph below. Verify availability with manufacturers and retain below if required by seismic criteria applicable to Project. See "Seismic Considerations" Article in the Evaluations. Coordinate below 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 chillers, 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 Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

* + - * 1. Source quality-control reports.
				2. Startup service reports.
				3. Test and inspection startup 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 special warranty.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
			2. DELIVERY, STORAGE, AND HANDLING
				1. Ship chillers factory charged with nitrogen.

Retain one of first two paragraphs below. First paragraph is least restrictive; second paragraph is limiting. Verify availability with manufacturers.

* + - * 1. Ship absorbent and refrigerant in chillers or in containers separate from chillers.
				2. Ship [**absorbent**] [**and**] [**refrigerant**] in containers separate from chillers.

Retain paragraph below only for projects with special shipping requirements. Export shipping adds cost.

* + - * 1. Package chiller for export shipping in totally enclosed [**bagging**] [**crate**] [**crate with bagging**].
			1. COORDINATION

Retain first paragraph below for mounting chillers on concrete bases.

* + - * 1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

Retain paragraph below for mounting chillers on a structural-steel support structure.

* + - * 1. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.
			1. WARRANTY

When warranties are required, verify with Director’s Representative's that 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 chillers that fail in materials or workmanship within specified warranty period.

Consult Director’s Representative about need for extended warranties.

Extended warranties include, but are not limited to, the following:

Retain one of first three subparagraphs below.

Complete chiller.

[**Pumps and motors**] [**Purge unit**] [**Burner assembly**] <**Insert components**>.

[**Absorbent**] [**Absorbent and refrigerant**] only.

Parts [**only**] [**and labor**].

Loss of absorbent and refrigerant for any reason.

Verify available warranties and warranty periods with manufacturers listed in Part 2. The standard warranty offered by most manufacturers is one year. Longer warranties will increase the chiller cost.

Warranty Period: [**One**] [**Two**] [**Three**] [**Four**] [**Five**] <**Insert number**> year(s) from date of Substantial Completion.

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. MANUFACTURERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3765) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Dunham-Bush](http://www.specagent.com/Lookup?uid=123457139275).

[Trane / Thermax](http://www.specagent.com/Lookup?uid=123457139273).

[Yazaki Energy Systems](http://www.specagent.com/Lookup?uid=123457139274).

[YORK; brand of Johnson Controls International plc, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139272).

Approved equivalent.

* + - * 1. Source Limitations: Obtain chillers from single source from single manufacturer.
			1. PERFORMANCE REQUIREMENTS
				1. AHRI Rating: Rate chiller performance in accordance with requirements in AHRI 560.
				2. ASHRAE Compliance:

ASHRAE 15 and ASHRAE 34 for safety code for mechanical refrigeration.

"ASHRAE/IES 90.1" subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Sustainable design systems require compliance with requirements in ASHRAE/IES 90.1.

ASHRAE/IES 90.1.

* + - * 1. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.
				2. Comply with NFPA 70.
				3. UL Compliance:

Comply with requirements of UL and UL Canada, and include label by qualified testing agency showing compliance.

[**UL 726, "Oil-Fired Boiler Assemblies."**] [**UL 795, "Commercial-Industrial Gas Heating Equipment."**] [**UL 726, "Oil-Fired Boiler Assemblies"; and UL 795, "Commercial-Industrial Gas Heating Equipment."**]

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: Direct-fired absorption water chillers shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>.

Retain 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**]."

* + - * 1. Condenser-Liquid Temperature Performance:

Startup Condenser-Liquid Temperature: Provide chiller capable of starting with entering condenser-liquid temperature of [**60 deg F**] <**Insert temperature**> and providing stable operation until system temperature is elevated to manufacturer's recommended minimum operating entering condenser-liquid temperature.

Minimum Operating Condenser-Liquid Temperature: Provide chiller capable of continuous operation over entire capacity range indicated with entering condenser-liquid temperature of [**70 deg F**] <**Insert temperature**>.

Make factory modifications to standard chiller design if necessary to comply with performance indicated.

* + - * 1. Site Altitude: Provide chiller suitable for altitude at which it is installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

Retain "Performance Tolerance" paragraph below if Project requires more stringent tolerances than allowed by AHRI 560.

* + - * 1. Performance Tolerance: Comply with the following in lieu of AHRI 560:

Allowable Capacity Tolerance: [**Zero**] <**Insert number**> percent.

Allowable IPLV/NPLV Performance Tolerance: [**Zero**] <**Insert number**> percent.

* + - 1. CAPACITIES AND CHARACTERISTICS

If Project has more than one type or configuration of direct-fired absorption water chiller, delete this article and schedule chillers on Drawings.

* + - * 1. Capacity: <**Insert tons**>.

Sustainable design systems require minimum efficiency equal to requirements in ASHRAE/IES 90.1.

* + - * 1. Full-Load Efficiency (COP): <**Insert number**>.

Retain first option in "Part-Load Efficiency" paragraph below if operating conditions reference AHRI standard rating conditions; retain second option if operating conditions are other than AHRI standard rating conditions.

* + - * 1. Part-Load Efficiency [**(IPLV)**] [**(NPLV)**]: <**Insert number**>.
				2. Evaporator:

Pressure Rating: [**150 psig**] [**300 psig**] <**Insert number**>.

Number of Passes: [**Two**] [**Three**] [**Four**] <**Insert number**>.

Liquid Type: [**Water**] <**Insert liquid type**>.

Design Liquid Flow Rate: <**Insert gpm**>.

Minimum Liquid Flow Rate: <**Insert gpm**>.

Entering-Liquid Temperature: <**Insert deg F**>.

Leaving-Liquid Temperature: <**Insert deg F**>.

Liquid Pressure Drop: <**Insert feet of head**>.

Liquid Velocity: <**Insert fps**>.

Fouling-factor units in "Fouling Factor" subparagraph below are consistent with AHRI 560; first option is based on AHRI 560 standard rating.

Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu**] [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] <**Insert value**>.

* + - * 1. Absorber/Condenser:

Pressure Rating: [**150 psig**] [**300 psig**] <**Insert number**>.

Number of Passes: [**One**] [**Two**] [**Three**].

Liquid Type: [**Water**] <**Insert liquid type**>.

Design Liquid Flow Rate: <**Insert gpm**>.

Entering-Liquid Temperature: <**Insert deg F**>.

Leaving-Liquid Temperature: <**Insert deg F**>.

Liquid Pressure Drop: <**Insert feet of head**>.

Liquid Velocity: <**Insert fps**>.

Fouling-factor units in "Fouling Factor" subparagraph below are consistent with AHRI 560; first option is based on AHRI 560 standard rating.

Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] [**0.001 sq. ft. x h x deg F/Btu**] <**Insert value**>.

Retain "Dedicated Hot-Water Heat Exchanger" paragraph below for chillers equipped with dedicated hot-water heat exchanger.

* + - * 1. Dedicated Hot-Water Heat Exchanger:

Capacity: <**Insert MBtu/h**>.

Pressure Rating: [**150 psig**] [**300 psig**] <**Insert number**>.

Number of Passes: [**One**] [**Two**] [**Three**] [**Four**].

Liquid Type: [**Water**] <**Insert liquid type**>.

Design Liquid Flow Rate: <**Insert gpm**>.

Entering-Liquid Temperature: <**Insert deg F**>.

Leaving-Liquid Temperature: <**Insert deg F**>.

Liquid Pressure Drop: <**Insert feet of head**>.

Liquid Velocity: <**Insert fps**>.

Fouling-factor units in "Fouling Factor" subparagraph below are consistent with AHRI 560; first option is based on AHRI 560 standard rating.

Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu**] [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] <**Insert value**>.

Consider impact of site altitude on fan and motor.

* + - * 1. Burner Blower:

Motor Horsepower: <**Insert number**>.

RPM: <**Insert number**>.

* + - * 1. Pump Horsepower:

Purge: <**Insert number**>.

Refrigerant: <**Insert number**>.

Solution: <**Insert number**>.

* + - * 1. Chiller Control Electrical Requirements:

Power Input: <**Insert kilowatts**>.

Minimum Circuit Ampacity: <**Insert value**> A.

Maximum Overcurrent Protection Device: <**Insert value**> A.

Characteristics: [**120**] <**Insert number**> V ac, single phase, 60 Hz.

* + - * 1. Chiller Electrical Requirements:

Power Input: <**Insert kilowatts**>.

Minimum Circuit Ampacity: <**Insert value**> A.

Maximum Overcurrent Protection Device: <**Insert value**> A.

Characteristics: [**208**] [**240**] [**480**] <**Insert number**> V ac, three phase, 60 Hz.

Consider actual heating value of fuel source if retaining "Natural-Gas Heating Value" paragraph below. Contact fuel supplier and chiller manufacturers to determine impact. Insert text indicating heating value of fuel if applicable.

* + - * 1. Natural-Gas Heating Value: <**Insert Btu/cu. ft.**>.
				2. Natural Gas Input, Full-Fire: <**Insert cfh**>.

Consider actual heating value of fuel source if retaining "Fuel-Oil Heating Value" paragraph below. Contact fuel supplier and chiller manufacturers to determine impact. Insert text indicating heating value of fuel if applicable.

* + - * 1. Fuel-Oil Heating Value: <**Insert Btu/gal.**>.
				2. Fuel-Oil Input, Full Fire: <**Insert gph**>.
				3. Sound Power Level Rating: [**80**] [**85**] <**Insert dBA**> sound power level when measured in accordance with AHRI 575. Provide factory-installed sound attenuation treatment if necessary to achieve performance indicated.
			1. MANUFACTURED UNIT
				1. Description: Factory-assembled and -tested, hermetic-design chiller, complete with absorber, evaporator, condenser, generator, solution heat exchanger, controls, absorbent solution pump with motor, refrigerant pump with motor, purge unit with motor, burner assembly, motor controllers, rupture disk, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

Retain subparagraph below if limited space is available for installation.

Disassemble chiller into major assemblies, as required for installation, after factory testing and before packaging for shipment.

* + - * 1. Absorbent and Refrigerant:

Absorbent: Lithium bromide solution with corrosion inhibitor.

Refrigerant: Deionized [**or**] [**distilled**] water.

Performance Enhancer: Heat and mass transfer enhancer to improve performance.

Retain "Seismic Fabrication Requirements" paragraph below for projects in seismic areas. If retaining, also retain "Seismic Performance" paragraph in "Performance Requirements" Article and "Seismic Qualification Data" paragraph in "Informational Submittals" Article.

* + - * 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to chiller, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.
			1. PUMPS
				1. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating, tapered carbon bearings.
				2. Pump motor assembly shall be designed to operate for not less than 50,000 hours between inspections.
				3. Pump motors shall be cooled and bearings lubricated, by fluid being pumped.
				4. Provide isolation valves at pump suction and discharge.
				5. Provide separate pumps for absorbent solution and refrigerant.

Provide chiller manufacturer's recommended absorbent solution and refrigerant flow-control method, to comply with operating requirements indicated.

* + - * 1. Purge System: Unit mounted and factory wired, equipped with controls and pump to automatically remove noncondensable vapors.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Purge Pump Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Retain first or third option in "Enclosure" subparagraph below to restrict enclosure type; retain all three options to allow Contractor the choice. If retaining first or third option, verify availability of enclosure types with manufacturers.

Enclosure: [**Open dripproof**] [**or**] [**totally enclosed**].

* + - 1. HEAT-EXCHANGER SHELLS
				1. Configuration: Two shells; one shell consists of absorber/evaporator, low-stage generator/condenser; and one shell consists of high-stage generator. Where indicated, equip chiller with dedicated hot-water heat exchanger.
				2. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.
				3. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.
				4. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between liquid in tubes and refrigerant in shell.
				5. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid tube contact resulting in abrasion and wear.
				6. Generator/Condenser Shell Pressure Relief Device: Manufacturer's standard rupture disk complying with requirements in ASHRAE 15 and ASHRAE 34, and in applicable portions of ASME Boiler and Pressure Vessel Code.
			2. ABSORBER
				1. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes; constructed of brass, stainless steel, or another material that will not corrode.
				2. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.

Tube materials for all heat exchangers can be independently selected; the choice can be different for each heat exchanger. Tube materials vary among manufacturers and chiller models; verify availability with manufacturer. First option in "Material" subparagraph below is current standard of listed manufacturers.

Copper-nickel alloys available include 95/5 and 06/11. The higher nickel content in 06/11 provides better resistance to corrosion. If required by Project, insert specific alloy.

Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; other options limit thickness. Second option is current standard of listed manufacturers but is subject to change. Third and fourth options are upgrades. If using materials other than copper, wall thickness may vary. See the Evaluations.

Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch**] [**0.028 inch**] [**0.035 inch**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

First option in "Internal Finish" subparagraph below is standard of most manufacturers. Third option is for applications with dirty fluids that require frequent tube cleaning. Retain all three options to give manufacturer the choice.

Internal Finish: [**Enhanced**] [**or**] [**smooth**].

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from each end without disturbing refrigerant in shell.

Retain one of first two subparagraphs below. If retaining first subparagraph, verify availability of second option with manufacturers.

[**Standard**] [**Marine-type**] water box with piping connections.

Water boxes [**and marine-type water-box covers**]with lifting lugs or eyebolts.

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine-type water-box covers.

Standard water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain first subparagraph below for special applications.

Hinged water boxes.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

Retain "Additional Corrosion Protection" paragraph below for special applications. Verify availability with manufacturers.

* + - * 1. Additional Corrosion Protection:

Electrolytic corrosion-inhibitor anode.

Retain one of two subparagraphs below.

Coat wetted surfaces with corrosion-resistant finish.

Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with corrosion-resistant finish.

Retain "Absorber/Condenser Crossover Piping" paragraph below for factory involvement with crossover pipe between absorber and condenser. Verify availability with manufacturers.

* + - * 1. Absorber/Condenser Crossover Piping: Factory-furnished and -installed piping connecting liquid connection of absorber discharge to inlet connection of condenser.
			1. EVAPORATOR
				1. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes; constructed of brass, stainless steel, or another material that will not corrode when exposed to absorbent.
				2. Refrigerant Holding Pan: Steel or stainless steel.
				3. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets, other tubes, and integrity of tube-tube sheet connections.

Tube materials for all heat exchangers can be independently selected; the choice can be different for each heat exchanger. Tube materials vary among manufacturers and chiller models; verify availability with manufacturers.

Copper-nickel alloys available include 95/5 and 06/11. The higher nickel content in 06/11 provides better resistance to corrosion. If required by Project, verify availability with manufacturers and insert specific alloy.

Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; other options limit thickness. Second option is current standard of listed manufacturers but is subject to change. Third and fourth options are upgrades. If using materials other than copper, wall thickness may vary. See the Evaluations.

Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch**] [**0.028 inch**] [**0.035 inch**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

First option in "Internal Finish" subparagraph below is standard of most manufacturers. Third option is for applications with dirty fluids that require frequent tube cleaning. Retain all three options to give manufacturer the choice.

Internal Finish: [**Enhanced**] [**or**] [**smooth**].

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

Retain one of first two subparagraphs below. If retaining first subparagraph, verify availability of second option with manufacturers.

[**Standard**] [**Marine-type**] water box with piping connections.

Water boxes [**and marine-type water-box covers**]with lifting lugs or eyebolts.

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine-type water-box covers.

Standard water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain first subparagraph below for special applications.

Hinged water boxes.

Hinged marine water-box covers.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

* + - 1. CONDENSER
				1. Refrigerant Holding Pan: Steel or stainless steel.
				2. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; other options limit thickness. Verify availability with manufacturers. If using materials other than copper, wall thickness may vary. See the Evaluations.

Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch**] [**0.028 inch**] [**0.035 inch**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

First option in "Internal Finish" subparagraph below is standard of most manufacturers. Third option is for applications with dirty fluids that require frequent tube cleaning. Retain all three options to give manufacturer the choice.

Internal Finish: [**Enhanced**] [**or**] [**smooth**].

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

Retain one of first two subparagraphs below. If retaining first subparagraph, verify availability of marine-type water box with manufacturers.

[**Standard**] [**Marine-type**] water box with piping connections.

Water boxes [**and marine-type water-box covers**]with lifting lugs or eyebolts.

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine-type water-box covers.

Standard water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain first subparagraph below for special applications.

Hinged water boxes.

Hinged marine water-box covers.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

Retain "Additional Corrosion Protection" paragraph below for special applications. Verify availability with manufacturers.

* + - * 1. Additional Corrosion Protection:

Electrolytic corrosion-inhibitor anode.

Retain one of two subparagraphs below.

Coat wetted surfaces with corrosion-resistant finish.

Using same material as tubes, clad surfaces of end tube sheets in contact with liquid. Coat other wetted surfaces, including water boxes, with corrosion-resistant finish.

* + - 1. FIRST-STAGE GENERATOR
				1. Tubes:

[**Replaceable,**]straight, or U tubes expanded into tube sheets.

Material: [**Manufacturer's standard**] [**steel**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice. Consult manufacturers for available options.

Minimum Wall Thickness: [**Manufacturer's choice**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

Internal Finish: Manufacturer's choice; enhanced or smooth.

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to allow visual inspection and cleaning of tubes from each end without disturbing refrigerant in shell.

Standard water box.

Water boxes with lifting lugs or eyebolts.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

* + - 1. SECOND-STAGE GENERATOR
				1. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from each end without damage to tube sheets and other tubes.

First option in "Material" subparagraph below is standard of listed manufacturers. Verify availability of optional tube materials with manufacturers.

Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; other options limit thickness. Consult manufacturers for available options.

Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch**] [**0.028 inch**] [**0.035 inch**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

Internal Finish: Manufacturer's standard.

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to allow visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

Standard type.

Water boxes with lifting lugs or eyebolts.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

* + - 1. DEDICATED HOT-WATER HEAT EXCHANGER

Retain this article for individual chillers requiring simultaneous heating and cooling.

* + - * 1. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from each end without damage to tube sheets and other tubes.

First option in "Material" subparagraph below is standard of listed manufacturers. Verify availability of optional tube materials with manufacturers.

Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.

Minimum Wall Thickness: [**Manufacturer's choice**] <**Insert dimension**>.

External Finish: Manufacturer's standard.

Internal Finish: Manufacturer's standard.

* + - * 1. Water Boxes:

Carbon-steel construction; arranged to allow visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

Standard type.

Water boxes with lifting lugs or eyebolts.

Nozzle Pipe Connections: [**Welded, ASME B16.5, flat-face flange**] [**Welded, ASME B16.5, raised-face flange**] [**Grooved for mechanical-joint coupling**] [**Grooved with mechanical-joint coupling and flange adapter**].

Thermistor or RTD temperature sensor factory installed in each nozzle.

Fit each water box with [**3/4-inch**] [**or**] [**1-inch**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

* + - 1. SOLUTION HEAT EXCHANGER
				1. Description: Shell-and-tube or brazed-plate heat exchanger, integral to chiller, to increase cycle efficiency by preheating diluted solution on its way to generator while precooling concentrated solution returning from generator.
			2. BURNER ASSEMBLY
				1. Burner: Welded construction with multivane, stainless steel, flame-retention diffuser suitable for [**natural gas**] [**propane**] [**and**] [**No. 2 fuel oil**].[**Mount burner on hinged access door to permit access to combustion chamber.**]
				2. Combustion-Air Blower: Centrifugal fan integral to burner, directly driven by motor; with adjustable damper assembly and locking quadrant to set air-fuel ratio.

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, insert subparagraphs below to suit Project.

Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

Retain "Fuel-Oil Supply" and "Fuel-Oil Pilot" paragraphs below for fuel-oil burners. Verify availability of safety options with manufacturers.

* + - * 1. Fuel-Oil Supply: Control devices and modulating control sequence suitable to comply with requirements of [**ASME CSD-1**] [**FM Global**] [**UL**].

Fuel-Oil Pump: Two-stage, gear-type oil pump capable of producing 300-psig discharge pressure and 15-in. Hg vacuum.

Fuel-Oil Piping Specialties:

Suction-line, manual, gate valve.

Removable-mesh oil strainer.

0- to 30-in. Hg vacuum; 0- to 30-psig vacuum-pressure gauge.

0- to 300-psig oil-nozzle pressure gauge.

Nozzle-line, solenoid-safety-shutoff oil valve.

* + - * 1. Fuel-Oil Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with [**cadmium sulfide**] [**UV scanner**] [**Optical**] flame-safety control.

Retain "Gas Train" and "Gas Pilot" paragraphs below for fuel-gas burners. Verify availability of safety options with manufacturers.

* + - * 1. Gas Train: Control devices and modulating control sequence to comply with requirements of [**ASME CSD-1**] [**FM Global**] [**UL**].
				2. Gas Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

Retain paragraph below to limit exhaust gas emissions. Verify availability with manufacturers.

* + - * 1. Equip burner assembly to limit nitrogen oxide emissions to [**20**] [**30**] <**Insert value**> ppm.
			1. ELECTRICAL
				1. Factory installed and wired, and functionally tested at factory before shipment.

Retain first paragraph below for single-point, field-power connection. Requirement is limited to chillers equipped with factory-mounted motor controllers. Coordinate selection of options with electrical system requirements.

* + - * 1. Single-point, field-power connection to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**]. Provide electrical devices with minimum withstand rating as required by electrical power distribution system, but not less than [**42,000**] [**65,000**] <**Insert number**> A.

Branch power circuit to each motor, dedicated electrical load, and to controls[**with disconnect switch or circuit breaker**].

If retaining option in subparagraph above, retain first two subparagraphs below.

NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.

NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

NEMA ICS 2, Class A, full-voltage, non-reversing motor controller, with hand-off-auto switch, and overcurrent protection for each motor.

Control-circuit transformer with primary and secondary side fuses.

* + - * 1. Terminal blocks with numbered [**and color-coded**]wiring to match wiring diagram. Include spare wiring terminal block for connection to external controls or equipment.

Retain "Wiring Outside of Enclosures" paragraph below to enclose wiring. Chiller manufacturers do not normally enclose all wiring. Consult manufacturers for availability.

* + - * 1. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than 24-inch length of [**liquid tight**] [**or**] [**flexible metallic**] conduit. Coordinate conduit requirements with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
			1. CONTROLS

Coordinate this article with Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Provide chiller control panel separate from burner control panel.
				2. Burner Control Panel: Factory[**or field**] mounted. Maintains safe operating conditions, burner safety limits, burner operation, and interface with chiller controls; include following components:

On-off switch.

Flame safeguard.

Contacts for remote monitoring of flame failure.

Contacts for proof of combustion-air flow.

Exhaust gas temperature limit switch.

Control-circuit transformer.

Burner motor controls.

Retain first subparagraph below for chillers equipped with fuel-oil burners.

Fuel-oil pump controls, if chiller is equipped with fuel-oil pump.

Visual indication of on/off status of ignition, blower, and main fuel.

Alarm bell.

* + - * 1. Control: Standalone and microprocessor based, with programs and configuration settings stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
				2. Enclosure: Unit mounted, NEMA 250, [**Type 1**] [**Type 3R**] [**Type 4**] [**Type 4x**] <**Insert type**>, with [**hinged**] [**or**] [**lockable**] cover.
				3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. Display following information in either imperial or metric units selectable through interface:

Verify, with manufacturers, availability of requirements in subparagraphs below.

Date and time.

Operating or alarm status.

Cumulative operating hours.

Outdoor-air temperature if required for chilled-water temperature reset.

Operating set points for temperature and pressure.

Entering and leaving temperatures of chilled and condenser water.

Refrigerant temperature.

Solution concentration and temperature.

Indication of solution and purge-pump operation.

Generator shell pressure.

Number of starts.

Number of purge cycles.

Entering and leaving hot-water temperatures.

Burner firing rate displayed in percent.

<**Insert status display items**>.

* + - * 1. Control Functions:

Verify, with manufacturers, availability of requirements in subparagraphs below.

Manual or automatic startup and shutdown time schedule.

Automatic cycle to prevent crystallization.

Entering and leaving chilled-water temperatures and control set points. Reset chilled-water temperature set point based on [**return-water**] [**outdoor-air**] [**space**] <**Insert condition**> temperature.

Entering and leaving hot-water temperatures and control set points. Reset hot-water temperature based on [**return-water**] [**outdoor-air**] [**space**] <**Insert condition**> temperature.

Condenser-liquid temperature.

LEED 2009 EA Credit 5 and LEED v4 EA Prerequisite "Building-Level Energy Metering" requires measurement of performance in accordance with International Performance Measurement and Verification Protocol. If pursuing LEED 2009 EA Credit 5 or LEED v4 EA Prerequisite "Building-Level Energy Metering," retain first two subparagraphs below along with satisfying other requirements. See the Evaluations.

Measure and record cooling provided and heating energy consumed within programmable time periods, minimum monthly.

Measure and record heating provided and heating energy consumed within programmable time periods, minimum monthly.

<**Insert control functions**>.

* + - * 1. Capacity Control: Automatically controls burner firing rate to maintain chilled-water temperature set point for cooling loads and heating-water temperature set point for heating loads ranging from [**30**] <**Insert number**> to 100 percent.
				2. Safety Shutdowns: To automatically shut down chiller and require manual reset before restart. Display message following each safety shutdown.

Verify, with manufacturers, availability of requirements in subparagraphs below.

Crystallization.

Low refrigerant temperature.

Loss of chilled- or condenser-water flow.

Low leaving chilled-water temperature, [**2 deg F below set point**] <**Insert condition**>.

First-stage generator low-solution level.

First-stage generator high temperature or pressure.

Burner alarm or control malfunction.

Power failure.

Solution pump overloads.

External auxiliary safety shutdown.

High solution concentration.

Incomplete dilution cycle.

<**Insert conditions**>.

* + - * 1. Warning Conditions: Provide controls to keep chiller operational, but inhibit burner firing rate to prevent safety shutdown. Provide control panel with warning alarm contacts and display message when any of following operating conditions are detected:

Verify, with manufacturers, availability of requirements in subparagraphs below.

Low refrigerant temperature.

High generator temperature or pressure.

High or low entering condenser-water temperature.

Solution temperature sensor failure.

Low chilled-water flow.

Purge-pump current overload.

<**Insert warning conditions**>.

* + - * 1. Cycling Shutdowns: Permit automatic restart when preprogrammed limits are reached. Display message following each cycle shutdown.

Verify, with manufacturers, availability of requirements in subparagraphs below.

Cooling Mode:

Loss of condenser-water flow.

Low leaving chilled-water temperature.

Power failure.

<**Insert conditions**>.

Heating Mode:

Loss of hot-water flow.

High leaving hot-water temperature.

Power failure.

<**Insert conditions**>.

* + - * 1. Trending: Capability to trend analog data up to five parameters simultaneously over adjustable period and frequency of polling.
				2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of security: view only; view and operate; and view, operate, and service.
				3. Control Authority: At least four conditions: off, local manual control at chiller, local automatic control at chiller, and automatic control through remote source.
				4. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting printer [**or**] [**electronic monitoring device**].

Retain "BAS Interface" paragraph below if chiller controls interface with the BAS. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. BAS Interface: Factory-installed hardware and software to enable BAS to monitor, control, and display chiller status and alarms.

Retain "Hardwired Points" subparagraph below if interface with the BAS is through hardwired points and minimal interface is required.

Hardwired Points:

Monitoring: On-off status, [**common trouble alarm**] <**Insert monitoring point**>.

Control: On-off operation, [**chilled-water, discharge temperature set-point adjustment**] [**hot-water, discharge temperature set-point adjustment**] <**Insert control point**>.

Delete "Hardwired Points" subparagraph above and retain subparagraph below if extensive interface with the BAS is required and is beyond what hardwired points can provide. Requirement may exclude some manufacturers.

Provide [**ASHRAE 135 (BACnet)**] [**LonTalk**] [**Modbus**] <**Insert type of interface**> for communication interface with BAS to enable BAS operator to control and monitor chiller from remote operator workstation. Provide for control features and monitoring points displayed locally at chiller control panel to be available through BAS.

* + - 1. FINISH
				1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

Provide at least one coat of primer with total dry film thickness of at least 2 mils.

Provide at least two coats of [**alkyd-modified, vinyl enamel**] [**epoxy**] [**polyurethane**] finish with total dry film thickness of at least 4 mils.

Paint surfaces that are to be insulated before applying insulation.

Paint installed insulation to match adjacent uninsulated surfaces.

Color of finish coat to be [**manufacturer's standard**] [**custom color selected by Architect**] <**Insert color description**>.

* + - * 1. Furnish Director’s Representative with quart container of paint used in application of topcoat to use in touchup applications after Project closeout.
			1. ACCESSORIES
				1. Sight Glasses: Equip unit with sight glasses for visual inspection of absorbent solution and refrigerant levels. Provide at least one sight glass in absorber and evaporator sections.

Retain "Flow Switches" or "Vibration Isolation" paragraph below, or both, to add features furnished by chiller manufacturer.

* + - * 1. Flow Switches:

Furnish chiller-manufacturer-supplied flow switch for each [**condenser**] [**evaporator and condenser**] and verify field-mounting location before installation.

Retain "Paddle Flow Switches" or "Pressure Differential Switches" subparagraph below. Consult manufacturers for flow-switch requirements.

Paddle Flow Switches:

Vane operated to actuate double-pole, double-throw switch with one pole field wired to chiller control panel and other pole field wired to BAS.

Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with 10 A rating at 120 V ac.

Pressure rating equal to pressure rating of heat exchanger.

Construct body and wetted parts of Type 316 stainless steel.

House switch in NEMA 250, [**Type 4**] <**Insert type**> enclosure constructed of die-cast aluminum.

Vane length to suit installation.

Pressure Differential Switches:

Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.

Performance: Switch suitable to withstand, without damage, full-pressure rating of heat exchanger applied to either port and exhibit no set point shift due to variation in working pressure.

Set Point: Screw type, field adjustable.

Electrical Connections: Internally mounted, screw-type terminal blocks.

Switch Enclosure: NEMA 250, [**Type 4**] <**Insert type**>.

Switch Action: Double-pole, double-throw switch with one pole field wired to chiller control panel and other pole field wired to BAS.

* + - * 1. Vibration Isolation:

Chiller-manufacturer-furnished, neoprene-pad vibration isolation for each chiller.

Two layers of 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads separated by 16-gauge, stainless steel plate.

Fabricate pads from 40- to 50-durometer neoprene.

Provide stainless steel square bearing plate to load pad uniformly between 20 and 40 psi with 0.12- to 0.16-inch deflection.

* + - 1. HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

This article is for automatic tube cleaning systems that are generally not available as factory options, but they are available as aftermarket systems.

* + - * 1. Provide brush-cleaning system for field installation on each chiller [**condenser**] <**Insert heat exchanger**> for tube cleaning and improved heat transfer.
				2. Cleaning system to maintain tube fouling at or below design conditions without interrupting normal equipment operation.
				3. System consisting of brush inserted in each tube and catch basket attached to each end of tube. Four-way valve that operates to reverse direction of water flow to push brush through tube while removing tube deposits. Control four-way reversing valve actuator by preset time cycle that provides regular tube brushing during equipment operation. Program frequency of brushing cycle to match Project requirements.
				4. Components:

Brush: Each brush to have nylon bristles, titanium wires, and polypropylene tips. Select brush diameter for interference fit with ID of tube not exceeding 0.025 inch.

Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design to allow for insertion of eddy current probe or removal of brush without removing basket from valve.

Four-Way Valve:

Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.

Configure valve with parallel flow connections to minimize field installation piping.

Construct valve to comply with ASME Boiler and Pressure Vessel Code, at system working pressure equal to condenser.

Provide flanged pipe connections.

Valve manufacturer to test and certify maximum leakage rate of 0.05 percent of design flow rate at operating conditions with maximum differential pressure.

Hydrostatically test valve to 1.5 times design working pressure.

Design valve to cause no more than 0.5-psig pressure drop at design flow conditions.

Provide valve with valve-mounted indicating/warning light, that energizes before valve begins rotation.

Retain one of two "Valve Actuator" subparagraphs below. If retaining second subparagraph, verify that a source of instrument-grade, clean, dry compressed air is available.

Valve Actuator: Provide actuator to operate valve. Coordinate actuator power and signal requirements with control system and valve operating requirements.

A limited number of manufacturers offer pneumatic valve actuators; consult manufacturers.

Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator is suitable for operation with field-supplied air pressure.

Position Switches: Factory mount limit switches on valve to indicate complete rotation of valve in both normal and reverse flow.

Control Panel: Factory or field mount control panel including the following features on chiller:

NEMA 250, [**Type 1**] [**Type 4**] [**Type 4x**] [**Type 12**] enclosure.

Timer to automatically initiate cleaning cycle over 24-hour period.

Manual override of preset cleaning cycle.

Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction," indicating slow or incomplete valve turn.

For pneumatic actuators, mount four-way solenoid valve in control panel for control valve actuator operation.

Flow-switch bypass.

Unloading signal to chiller.

* + - 1. SOURCE QUALITY CONTROL

Not all manufacturers "run test" chillers. Verify availability of run tests with manufacturers.

Retain first paragraph below if factory test is required. Independent certification may be acceptable to authorities having jurisdiction without further monitoring of plant's quality-control and testing program by Director’s Representative.

* + - * 1. Perform functional [**run**]tests of chillers before shipping.
				2. Factory test and inspect absorber, generator, evaporator, and condenser in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times rated pressure. Vacuum and pressure test shells for leaks.

Retain "Burner Test" paragraph below for factory testing of factory-assembled chillers.

* + - * 1. Burner Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion requirements indicated.

Retain first paragraph below for factory performance testing. Factory performance tests are an added cost. Verify requirement with Director’s Representative.

* + - * 1. Factory performance test chillers, before shipping, in accordance with AHRI 560.

Test the following conditions:

Design conditions indicated.

Retain one of three subparagraphs below for part-load performance testing.

Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> percent with condenser liquid at design conditions.

Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> percent with varying entering condenser-liquid temperature from design to minimum conditions in [**5 deg F**] <**Insert temperature**> increments.

At [**one**] [**two**] [**three**] [**four**] [**five**] [**10**] <**Insert number**> point(s) of varying part-load performance to be selected by Director’s Representative at time of test.

Retain first paragraph below for factory sound testing. Factory sound tests are an added cost and may not be available from some manufacturers. Verify requirement with Director’s Representative.

* + - * 1. Factory sound test chillers, before shipping, in accordance with AHRI 575.

Test the following conditions:

Design conditions indicated.

Chiller operating at calculated worst-case sound condition.

At [**one**] [**two**] [**three**] [**four**] [**five**] <**Insert number**> point(s) of full and varying part-load performance to be selected by Director’s Representative at time of test.

Retain first paragraph below to witness testing.

* + - * 1. Allow [**Director’s Representative**] <**Insert entity**> access to place where chillers are being tested. Notify Director’s Representative [**14**] <**Insert number**> days in advance of testing.
				2. Prepare and submit test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
1. EXECUTION
	* + 1. EXAMINATION
				1. Examine chillers before installation. Reject chillers that are physically damaged.
				2. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. INSTALLATION OF CHILLER

Retain first paragraph below if chillers are to be installed on a support structure other than a concrete base. Indicate design of support structure on Drawings.

* + - * 1. Install chillers on support structure indicated.
				2. Equipment Mounting:

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

Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

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

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

* + - * 1. Maintain manufacturer's recommended clearances for service and maintenance.
				2. Charge chiller with absorbent and refrigerant if not factory charged.
				3. Install separate devices furnished by manufacturer and not factory installed.
				4. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated, and are not factory insulated. Comply with requirements in Section 230716 "HVAC Equipment Insulation."
			1. INSTALLATION OF HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

Retain this article for heat-exchanger, brush-cleaning system installation. Coordinate with "Heat-Exchanger, Brush-Cleaning System" Article.

* + - * 1. Install brush-cleaning system control panel adjacent to chiller control panel.
				2. Arrange piping to allow service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
				3. Provide field electric power, as required, to each system control panel and electric-actuated valve.
				4. Provide pneumatic piping with pressure regulator and isolation valve at each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.
				5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
				6. Functionally test entire brush-cleaning system, including control valve, control valve actuator, position indicator, and control panel, with chiller in operation.
			1. PIPING CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." If Drawings are explicit enough, these requirements may be reduced or omitted.

If using hot water as a heating source, verify that the water temperature used on Project is within the applicable temperature range of other Sections referenced. Otherwise, revise Sections to suit Project. This temperature range is of concern if water temperature is above 250 deg F (121 deg C).

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

Retain first three paragraphs below for chillers served with a fuel-gas source.

* + - * 1. Comply with requirements for gas piping in [**Section 231123 "Facility Natural-Gas Piping"**] [**or**] [**Section 231126 "Facility Liquefied-Petroleum Gas Piping."**] Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Connect fuel gas piping full size to gas-train inlet with shutoff valve and union.
				3. Extend burner fuel train vent to suitable outdoor location, away from operable windows and air intakes.
				4. Install gas-fired boilers in accordance with NFPA 54.

Retain first three paragraphs below for chillers served with a fuel-oil source.

* + - * 1. Comply with requirements for fuel-oil piping in Section 231113 "Facility Fuel-Oil Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Connect oil piping full size to burner inlet with shutoff valve and union.
				3. Install oil-fired chillers in accordance with NFPA 31.
				4. Where installing piping adjacent to chiller, allow space for service and maintenance.

Retain "Hot-Water Heat-Exchanger Connections" paragraph below for chillers equipped with a separate hot-water heat exchanger.

* + - * 1. Hot-Water Heat-Exchanger Connections: Connect to heat-exchanger inlet with shutoff valve, [**strainer,**] [**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to heat-exchanger outlet with shutoff valve, check valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with [**flange**] [**or**] [**mechanical coupling**].
				2. Evaporator-Liquid Connections: Connect to evaporator inlet with shutoff valve, [**strainer,**] [**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with [**flange**] [**or**] [**mechanical coupling**].
				3. Absorber/Condenser-Liquid Connections: Connect to inlet with shutoff valve, [**strainer,**] [**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gauge,[**flow meter,**] and drain connection with valve. Make connections to chiller with [**flange**] [**or**] [**mechanical coupling**].

If not factory furnished or installed, provide pipe connecting liquid connection of absorber discharge and condenser inlet.

* + - * 1. Refrigerant Pressure Relief Device Connections: Extend [**vent piping**] [**separate vent piping for each chiller**] without valves or restrictions to outdoor location. Comply with ASHRAE 15 and ASHRAE 34. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
				2. Extend [**purge vent piping**] [**separate purge vent piping for each chiller**] to outdoor location. Comply with ASHRAE 15 and ASHRAE 34.
				3. Connect each chiller drain connection with union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.
				4. Comply with requirements for chimney system in Section 235133 "Insulated Sectional Chimneys" and Section 235116 "Fabricated Breechings and Accessories." Drawings indicate general arrangement of pipe, fittings, and specialties. Connect chimney system to chiller burner outlet and extend to outdoor location.
				5. Connect fuel-fired burner assembly and blower and associated damper for combustion air.
			1. ELECTRICAL CONNECTIONS
				1. Install electrical devices furnished with chiller but not factory mounted.
				2. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				3. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
				4. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
				5. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

Retain one of two subparagraphs below. First subparagraph cross-references Section 260553 "Identification for Electrical Systems" and should be retained for consistent electrical identification. Second subparagraph is an abbreviated version of product specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

* + - 1. CONTROL CONNECTIONS
				1. Install control and electrical power wiring to field-mounted control devices.

Coordinate paragraphs below based on types of devices retained in Part 2.

* + - * 1. Connect control wiring between control devices.
				2. Connect control wiring in accordance with Section 260523 "Control Voltage Electrical Power Cables."
			1. FIELD QUALITY CONTROL

If model code requirements for types of work involved require special inspections, retain first "Testing Agency" paragraph below.

Retain one of first four paragraphs below. Retain first "Testing Agency" paragraph below if Director’s Representative will hire an independent testing agency.

* + - * 1. Testing Agency: Director’s Representative will engage a qualified testing agency to perform tests and inspections.

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

* + - * 1. Testing Agency: 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 "Tests and Inspections" paragraph 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.

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

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

* + - * 1. Absorption water chillers will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. STARTUP SERVICE

Factory startup can add a significant expense, but it is often required to coordinate with applicable Project commissioning and LEED requirements. Factory startup may also be advisable due to the complexity of absorption water chillers.

* + - * 1. [**Engage Company Field Advisor per OGS Spec Section 014216 to perform**] [**Perform**] startup service.

Complete installation and startup checks in accordance with manufacturer's written instructions.

Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.

Verify that pumps are installed and functional.

Verify that thermometers and gauges are installed.

Verify that refrigerant pressure relief device is vented to outdoors.

Verify proper motor rotation.

Operate chiller for run-in period.

Verify proper fuel supply. Adjust air-fuel ratio and combustion.

Verify proper combustion-air source.

Verify proper exhaust emissions.

Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.

Verify and record performance of liquid flow and low-temperature interlocks for evaporator and condenser.

Verify and record performance of chiller protection devices.

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

Retain "Burner Test" subparagraph below for field-assembled burners.

Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas.

* + - * 1. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
				2. Prepare test and inspection startup reports.
			1. DEMONSTRATION
				1. [**Engage a Company Field Advisor per OGS Spec Section 014216 to train**] [**Train**] Facilities maintenance personnel to adjust, operate, and maintain chillers.[**Video record training sessions.**]

END OF SECTION 236413.13