SECTION 236413.16 - INDIRECT-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, [**single-**] [**and**] [**double-**]effect 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.

* + - * 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.

* + - * 1. Insulated Surface Diagrams: Indicating cold and hot surfaces requiring field-applied insulation with 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 the "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**] <**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=3766) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457139276).

[Trane / Thermax](http://www.specagent.com/Lookup?uid=123457139279).

[Yazaki Energy Systems](http://www.specagent.com/Lookup?uid=123457139280).

[YORK; brand of Johnson Controls International plc, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139277).

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 a qualified testing agency showing compliance.

Retain "Seismic Performance" paragraph below with "Seismic Qualifications 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: Indirect-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:

Each manufacturer has different limits on minimum condenser water temperature. Verify the allowable condenser water temperature with the manufacturer's product data for each unit selected before selecting among the options in the following two subparagraphs.

Startup Condenser-Liquid Temperature: Provide chiller capable of starting with entering condenser-liquid temperature of [**64 deg F**] [**45 deg F**] <**Insert temperature**> and providing stable operation until system temperature is elevated to minimum operating entering condenser-liquid temperature.

Minimum Operating Condenser-Liquid Temperature: Provide chiller capable of continuous operation over entire capacity range indicated with an entering condenser-liquid temperature of [**65 deg F**] [**60 deg F**] [**55 deg F**].

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

* + - * 1. Site Altitude: Provide chiller suitable for altitude at which 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 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 indirect-fired, absorption water chillers, delete this article and schedule chillers on Drawings.

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

LEED Prerequisite EA 2 requires 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: [**One**] [**Two**] [**Three**] <**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**>.

* + - * 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.

Verify noise rating of selected chiller(s) with their manufacturers before selecting options in the following paragraph.

* + - * 1. Noise Rating: [**38**] [**51**] [**80**] <**Insert dBA**> sound power level when measured in accordance with AHRI 575. Provide factory-installed sound 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, 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. Provide pump motor assembly designed to operate for not less than [**25,000**] [**50,000**] hours between inspections.
				3. Pump motors cooled, and bearings lubricated, either by liquid being pumped.
				4. Provide isolation valves at pump suction and discharge.
				5. Provide separate and dedicated 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

Retain "Configuration for Single-Effect Chillers" or "Configuration for Double-Effect Chillers" paragraph below.

* + - * 1. Configuration for Single-Effect Chillers: Two shells; one shell consists of absorber/evaporator and other shell consists of condenser/generator.
				2. Configuration for Double-Effect Chillers: Two shells; one shell consists of absorber/evaporator, low-stage generator/condenser and other shell consists of high-stage generator.
				3. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.
				4. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.
				5. 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.
				6. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
				7. Generator/Condenser Shell Pressure Relief Device: Manufacturers standard rupture disk complying with requirements in ASHRAE 15 and ASHRAE 34 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
			1. 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 and 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.

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.

Stainless steel types available include Types 304L and 316L. The higher nickel content in Type 316L provides better resistance to corrosion. If required by Project, verify availability with manufacturers and insert specific type.

Material: [**Copper**] [**Copper-nickel alloy**] [**Stainless steel**] [**Titanium**] [**Copper, copper-nickel alloy, stainless steel, or titanium**] <**Insert material**>.

Retain one of four options in "Minimum Wall Thickness" subparagraph below. First option gives manufacturer the choice; second, third, and fourth options limit thickness. 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 liquids that require frequent tube cleaning. Second option gives 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**] for water box with piping connections.

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

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine water-box covers.

Standard water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain first subparagraphs 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 a 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 condenser inlet.
			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 and without damage to tube sheets and 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.

Stainless steel types available include Types 304L and 316L. The higher nickel content in Type 316L provides better resistance to corrosion. If required by Project, verify availability with manufacturers and insert specific type.

Material: [**Copper**] [**Copper-nickel alloy**] [**Stainless steel**] [**Titanium**] [**Copper, copper-nickel alloy, stainless steel, or titanium**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; second, third, and fourth options limit thickness. 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 liquids 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**] for water box with piping connections.

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

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine water-box covers.

Standard type for water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain one of first two subparagraphs 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 and 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 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.

Stainless steel types available include Types 304L and 316L. The higher nickel content in Type 316L provides better resistance to corrosion. If required by Project, verify availability with manufacturers and insert specific type.

Material: [**Copper**] [**Copper-nickel alloy**] [**Stainless steel**] [**Titanium**] [**Copper, copper-nickel alloy, stainless steel, or titanium**] <**Insert material**>.

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

External Finish: Manufacturer's standard.

First option in "Internal Finish" subparagraph below is standard of most manufacturers. Third option is for applications with dirty liquids that require frequent tube cleaning. Retain all three options to give the 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**] for water box with piping connections.

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

Retain one of first two subparagraphs below for special applications.

Hinged water boxes.

Hinged marine water-box covers.

Standard type for water box without piping connections.

Water boxes with lifting lugs or eyebolts.

Retain one of first two subparagraphs 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 a 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. GENERATOR FOR SINGLE-EFFECT CHILLERS
				1. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and 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 manufacturers.

Stainless steel types available include Types 316L and 409. The higher nickel content in Type 316L provides better resistance to corrosion. If required by Project, verify availability with manufacturers and insert specific type of stainless steel.

Material: [**06/11 copper-nickel alloy**] [**Stainless steel**] [**Titanium**] [**06/11 copper-nickel alloy, stainless steel, or titanium**] <**Insert material**>.

Retain one of two options in "Minimum Wall Thickness" subparagraph below. First option gives manufacturer the choice; second option limits thickness. Verify availability with manufacturers. If using materials other than 06/11 copper-nickel alloy, wall thickness may vary. See the Evaluations.

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

External Finish: Manufacturer's standard.

First option in "Internal Finish" subparagraph below is standard of most manufacturers. Third 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.

Standard type.

Provide 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.

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 a 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 a corrosion-resistant finish.

* + - 1. FIRST-STAGE GENERATOR FOR DOUBLE-EFFECT CHILLERS
				1. Tubes:

Replaceable, straight, or U tubes expanded into tube sheets.

Tube materials for all heat exchangers can be independently selected; the choice can be different for each heat exchanger. First option in "Material" subparagraph below gives manufacturer the choice; other options limit material choice. Tube materials vary among manufacturers and chiller models; verify availability with manufacturers.

Material: [**Manufacturer's standard**] [**06/11 copper-nickel alloy**] [**Type 409 stainless steel**] [**Titanium**] [**06/11 copper-nickel alloy, Type 409 stainless steel**] <**Insert material**>.

First option in "Minimum Wall Thickness" subparagraph below gives manufacturer the choice; other options limit thickness. Wall thicknesses vary among manufacturers; verify availability with manufacturers.

Minimum Wall Thickness: [**Manufacturer's choice**] [**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. Second option gives 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.

Standard type.

Provide 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**] [**1-inch**] [**3/4- 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 a 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 a corrosion-resistant finish.

* + - 1. SECOND-STAGE GENERATOR FOR DOUBLE-EFFECT CHILLERS
				1. Tubes:

Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and 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 manufacturers.

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

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

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. Second option gives 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.

Standard type.

Provide 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.

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 a 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 a corrosion-resistant finish.

* + - 1. SOLUTION HEAT EXCHANGER
				1. Description: Shell-and-tube or brazed-plate heat exchanger; integral part of chiller to increase cycle efficiency by preheating weak solution on its way to generator while precooling strong solution returning from generator.
			2. STEAM CONDENSATE DRAIN COOLER

Retain this article for factory-installed drain cooler on double-effect chillers served with steam. Consult manufacturers for availability.

* + - * 1. Description: Shell-and-tube heat exchanger constructed of carbon-steel shell and copper-nickel-alloy or stainless steel tubes.
			1. FACTORY-APPLIED INSULATION

Not all manufacturers offer factory-applied insulation. Verify availability with manufacturers.

* + - * 1. Factory-Applied Insulation on Cold Surfaces:

Closed-cell, flexible elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tube and Type II for sheet materials.

Second option in "Thickness" subparagraph below may not be available from some manufacturers as a standard factory option. Consult manufacturers.

Thickness: [**3/4 inch**] [**1-1/2 inches**] <**Insert dimension**>.

Adhesive: As recommended by insulation manufacturer.

Factory apply insulation over all cold surfaces of chiller capable of forming condensation. Insulated components include, but are not limited to, evaporator shell and end tube sheets; evaporator water boxes including nozzles; refrigerant pump; cold surfaces of motor; and cold piping.

Apply adhesive to 100 percent of insulation contact surface.

Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.

Seal seams and joints to provide a vapor barrier.

After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

Not all manufacturers offer factory-applied insulation. Verify availability with manufacturers.

* + - * 1. Factory-Applied Insulation on Hot Surfaces:

Mineral-fiber board, pipe, or tank insulation complying with one of the following:

ASTM C547, Type I or Type II, Grade A.

ASTM C612, Type IB.

ASTM C1393, Type II or Type IIIA, Category 2.

Consult manufacturers for available thicknesses.

Thickness: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**>.

Adhesive: As recommended by insulation manufacturer.

Factory apply materials over all hot surfaces to provide smooth, straight, and even surfaces; free of voids.

Apply adhesive to insulation contact surface as recommended by insulation manufacturer.

Install insulation anchor pins and washers if required by insulation manufacturer to secure insulation to surfaces to be insulated.

Completely encapsulate insulation with metal jacket, leaving no exposed insulation. Provide removable jacket on components requiring access for service and inspection.

Paint exposed surfaces of metal jacket to match other painted parts unless jacket material is aluminum or stainless steel.

* + - 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 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 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, nonreversing motor controller, 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 a 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. 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**>, hinged or lockable.
				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.

Operating hours.

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

Temperature and pressure of operating set points.

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.

Retain first two subparagraphs below for chillers served with hot water.

Hot-water valve actuator potentiometer position (percentage).

Entering and leaving hot-water temperatures.

Retain first three subparagraphs below for chillers served with steam.

Steam demand limit.

Inlet steam pressure and temperature.

Steam valve actuator potentiometer position (percentage).

Retain first subparagraph below for double-effect chillers.

First-stage generator pressure and temperature.

<**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 based on [**return-water**] [**outdoor-air**] [**space**] 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 subparagraph below along with satisfying other requirements.

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

<**Insert control functions**>.

* + - * 1. Capacity Control: Automatically controls input flow rate of heat source to maintain chilled-water temperature set point for cooling loads ranging from 10 to 100 percent.
				2. Control Valve Package: [**Factory-furnished, for field installation,**] [**Factory-installed**] control valve package suitable for energy source indicated.

Body: Cast-iron, carbon-steel, or stainless steel body with flanged connections.

Type: [**Manufacturer's choice**] [**V-notch ball**] [**Butterfly**] [**Globe style with cage-guide plug**] <**Insert type**> constructed of stainless steel.

Rating: Pressure and temperature rating to match heat exchanger.

Shutoff: Capable of bubble-tight shutoff against maximum system pressure.

Size: Determined by chiller manufacturer.

Modulation: [**Two**] [**Three**] way.

Turndown: As required to achieve stable control through indicated operating range.

Actuator: Electric powered from chiller control panel and installed on valve.

* + - * 1. 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**].

First-stage generator low-solution level.

First-stage generator high temperature or pressure.

Power failure.

Solution pump overloads.

External auxiliary safety shutdown.

High solution concentration.

Incomplete dilution cycle.

Retain first subparagraph below for chillers served with hot water.

High entering-water temperature.

Retain first subparagraph below for chillers served with steam.

High inlet steam pressure and temperature.

<**Insert conditions**>.

* + - * 1. Warning Conditions: Provide control panel that closes warning contacts and generates message when one of the following operating conditions is detected:

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

Low refrigerant temperature.

High generator temperature or pressure.

High entering generator-water temperature (single-stage generator only).

High or low entering condenser-water temperature.

Solution temperature sensor failure.

Low chilled-water flow.

<**Insert warning 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 access: 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 a 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**] [**generator heat source capacity limiting**] <**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**> 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 a total dry film thickness of at least 2 mils.

Provide at least two coats of [**alkyd-modified, vinyl enamel**] [**epoxy**] [**polyurethane**] finish with a 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 Director’s Representative**] <**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 hall 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 a rating of 10 A 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 a 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 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 to reverse direction of water flow to push brush through tube while removing tube deposits. Control four-way reversing valve's 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 with nylon bristles, titanium wires, and polypropylene tips. Select brush 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 brushes without removing baskets 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 to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.

Provide flanged pipe connections.

Valve manufacturer to test and certify maximum leakage rate of less than 0.05 percent of design flow rate at operation conditions of maximum differential pressure.

Hydrostatically test 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 "Valve Actuator, Electric" or "Valve Actuator, Pneumatic" subparagraph below. If retaining second subparagraph, verify that a source of instrument-grade clean, dry compressed air is available.

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

Position Switches: Factory mount microswitches on valve to indicate complete turn 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 a 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 turn or incomplete valve turn.

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

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 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 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**> with condenser liquid at design conditions.

Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> 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 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 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 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. Coordinate with "Heat-Exchanger, Brush-Cleaning System" Article.

* + - * 1. Install brush-cleaning system control panel adjacent to chiller control panel.
				2. Arrange piping to provide 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 to 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 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," Section 232116 "Hydronic Piping Specialties," Section 232213 "Steam and Condensate Heating Piping," and Section 232216 "Steam and Condensate Heating Piping Specialties." If Drawings are explicit enough, these requirements may be reduced or omitted.

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

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

Retain first paragraph for chillers served from a steam source.

* + - * 1. Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties" for steam and condensate piping. Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Where installing piping adjacent to chiller, allow space for service and maintenance.

Retain "Generator Steam Piping Connections" paragraph below for chillers served from a steam source.

* + - * 1. Generator Steam Piping Connections:

Connect steam piping with trapped drip leg, gate valve, strainer, control valve, and pressure gauge. Install pressure reducing valve and safety relief valve upstream from steam-control valve to protect control valve from excessive steam pressure. Make connections to chiller with [**flange**] [**or**] [**union**].

Connect steam condensate piping with vacuum breaker, trapped drip leg, gate valve, strainer, float and thermostatic trap(s), [**condensate cooler,**] [**condensate receiver,**] [**condensate receiver and pump,**] and check valve. Make connections to chiller with [**flange**] [**or**] [**union**].

Retain "Generator Hot-Water Connections" paragraph below for chillers served from a hot-water source.

* + - * 1. Generator Hot-Water Connections: Connect to generator inlet with shutoff valve, [**strainer,**] [**flexible connector,**] control valve, thermometer, and plugged tee with shutoff valve and pressure gauge. Connect to generator 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 a [**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 a [**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 a [**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**] to outdoors without valves or restrictions. Comply with ASHRAE 15. 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 outdoors. Comply with ASHRAE 15.
				3. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.
			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 inspection, and retain option to require Contractor to arrange for the assistance of a Company Field 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 a 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.

Operate chiller for run-in period.

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.

Operate chiller for run-in period.

Verify that refrigerant pressure relief device is vented outside.

Verify proper motor rotation.

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.

<**Insert startup steps if any**>.

* + - * 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**] Facility’s maintenance personnel to adjust, operate, and maintain chillers.[**Video record training sessions.**]

END OF SECTION 236413.16