SECTION 236413.13 - DIRECT-FIRED ABSORPTION WATER CHILLERS

TIPS:

To view non-printing **Editor's Notes** that provide guidance for editing, click on Masterworks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on Masterworks/Supporting Information.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, direct-fired absorption chillers.
2. Heat-exchanger, brush-cleaning system.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. 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.

C. IPLV: Integrated part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by ARI 560 and referenced to ARI standard rating conditions.

D. NPLV: Nonstandard part-load value. A single-number, part-load efficiency figure of merit calculated per the method defined by ARI 560 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Direct-fired absorption chillers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

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

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of [**60 deg F (16 deg C)**] <**Insert temperature**> and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of [**70 deg F (21 deg C)**] <**Insert temperature**>.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

C. Site Altitude: Chiller shall be suitable for altitude at which it is installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

D. Performance Tolerance: Comply with the following in lieu of ARI 560:

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

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties and accessories, and the following:

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Absorbent capacity of chiller.
5. Refrigerant capacity of chiller.
6. Fluid capacity of evaporator and condenser.
7. Fluid capacity of generator.
8. Characteristics of safety relief devices.
9. Minimum entering condenser-fluid temperature.
10. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in [**5 deg F (3 deg C)**] <**Insert temperature**> increments.
11. If equipped, fluid capacity of dedicated hot-water heater exchanger.
12. Combustion-air flow.
13. Exhaust gas airflow.
14. Exhaust gas minimum and maximum operating temperature.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
2. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.
3. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Insulated Surface Diagrams: Indicating cold and hot surfaces requiring field-applied insulation with area tabulated for each.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and clearances for tube pull and service.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Startup service reports.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. ARI Rating: Rate chiller performance according to requirements in ARI 560.

B. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE/IESNA 90.1.

C. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.

D. Comply with NFPA 70.

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

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

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers factory charged with nitrogen.

B. Ship absorbent and refrigerant in chillers or in containers separate from chillers.

C. Ship [**absorbent**] [**and**] [**refrigerant**] in containers separate from chillers.

D. Package chiller for export shipping in totally enclosed [**bagging**] [**crate**] [**crate with bagging**].

1.10 COORDINATION

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

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

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

a. Complete chiller.
b. [**Pumps and motors**] [**Purge unit**] [**Burner assembly**] <**Insert components**>.
c. [**Absorbent**] [**Absorbent and refrigerant**] only.

d. Parts [**only**] [**and labor**].
e. Loss of absorbent and refrigerant for any reason.

2. Warranty Period: [**Two**] [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.2 MANUFACTURED UNIT

A. 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.

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

B. Absorbent and Refrigerant:

1. Absorbent: Lithium bromide solution with corrosion inhibitor.
2. Refrigerant: Deionized [**or distilled**]water.
3. Performance Enhancer: Heat and mass transfer enhancer to improve performance.

C. 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.

2.3 PUMPS

A. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating, tapered carbon bearings.

B. Pump motor assembly shall be designed to operate for not less than 50,000 hours between inspections.

C. Pump motors shall be cooled and bearings lubricated, either by fluid being pumped or by a filtered supply of liquid refrigerant.

D. Pump suction and discharge shall be equipped with isolation valves.

E. Absorbent solution and refrigerant shall have separate and dedicated pumps.

1. Absorbent solution and refrigerant flow-control method shall be manufacturer's choice to comply with operating requirements indicated.

F. Purge System: Unit mounted and factory wired, equipped with controls and a pump to automatically remove noncondensable vapors.

1. 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."

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

2.4 HEAT-EXCHANGER SHELLS

A. Configuration: Two shells; one shell consists of the absorber/evaporator, low-stage generator/condenser and the other shell consists of the high-stage generator. Where indicated, equip chiller with a dedicated hot-water heat exchanger.

B. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.

C. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.

D. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.

E. 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.

F. Generator/Condenser Shell Pressure Relief Device: Manufacturer's standard rupture disk complying with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code.

2.5 ABSORBER

A. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes; constructed of brass, stainless steel, or another material that will not corrode.

B. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
2. Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch (0.6 mm)**] [**0.028 inch (0.7 mm)**] [**0.035 inch (0.9 mm)**] <**Insert dimension**>.
4. External Finish: Manufacturer's standard.
5. Internal Finish: [**Enhanced**] [**or**] [**smooth**].

C. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. [**Standard**] [**Marine-type**] water box with piping connections.

    a. Water boxes [**and marine-type water-box covers**]shall have lifting lugs or eyebolts.
    b. [**Hinged**] [**or**] [**davited**] water boxes.
    c. [**Hinged**] [**or**] [**davited**] marine-type water-box covers.

3. Standard water box without piping connections.

    a. Water boxes shall have lifting lugs or eyebolts.
    b. [**Hinged**] [**or**] [**davited**] water boxes.

4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

D. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

E. Absorber/Condenser Crossover Piping: Factory-furnished and -installed piping connecting fluid connection of absorber discharge to condenser inlet.

2.6 EVAPORATOR

A. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes; constructed of brass, stainless steel, or another material that will not corrode.

B. Refrigerant Holding Pan: Steel or stainless steel.

C. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
2. Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch (0.6 mm)**] [**0.028 inch (0.7 mm)**] [**0.035 inch (0.9 mm)**] <**Insert dimension**>.
4. External Finish: Manufacturer's standard.
5. Internal Finish: [**Enhanced**] [**or**] [**smooth**].

D. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. [**Standard**] [**Marine-type**] water box with piping connections.

    a. Water boxes [**and marine-type water-box covers**]shall have lifting lugs or eyebolts.
    b. [**Hinged**] [**or**] [**davited**] water boxes.
    c. [**Hinged**] [**or**] [**davited**] marine-type water-box covers.

3. Standard water box without piping connections.

    a. Water boxes shall have lifting lugs or eyebolts.
    b. [**Hinged**] [**or**] [**davited**] water boxes.

4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

2.7 CONDENSER

A. Refrigerant Holding Pan: Steel or stainless steel.

B. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
2. Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch (0.6 mm)**] [**0.028 inch (0.7 mm)**] [**0.035 inch (0.9 mm)**] <**Insert dimension**>.
4. External Finish: Manufacturer's standard.
5. Internal Finish: [**Enhanced**] [**or**] [**smooth**].

C. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. [**Standard**] [**Marine-type**] water box with piping connections.

    a. Water boxes [**and marine-type water-box covers**]shall have lifting lugs or eyebolts.
    b. [**Hinged**] [**or**] [**davited**] water boxes.
    c. [**Hinged**] [**or**] [**davited**] marine-type water-box covers.

3. Standard water box without piping connections.

a. Water boxes shall have lifting lugs or eyebolts.
b. [**Hinged**] [**or**] [**davited**] water boxes.

4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

D. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.8 FIRST-STAGE GENERATOR

A. Tubes:

1. [**Replaceable,**]straight, or U tubes expanded into tube sheets.
2. Material: [**Manufacturer's standard**] [**steel**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] <**Insert dimension**>.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Manufacturer's choice; enhanced or smooth.

B. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard water box.
3. Water boxes shall have lifting lugs or eyebolts.
4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

2.9 SECOND-STAGE GENERATOR

A. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
2. Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch (0.6 mm)**] [**0.028 inch (0.7 mm)**] [**0.035 inch (0.9 mm)**] <**Insert dimension**>.

4. External Finish: Manufacturer's standard.
5. Internal Finish: Manufacturer's standard.

B. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type.
3. Water boxes shall have lifting lugs or eyebolts.
4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

2.10 DEDICATED HOT-WATER HEAT EXCHANGER

A. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end without damage to tube sheets and other tubes.
2. Material: [**Copper**] [**or**] [**copper-nickel alloy**] <**Insert material**>.
3. Minimum Wall Thickness: [**Manufacturer's choice**] [**0.025 inch (0.6 mm)**] [**0.028 inch (0.7 mm)**] [**0.035 inch (0.9 mm)**] <**Insert dimension**>.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Manufacturer's standard.

B. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type.
3. Water boxes shall have lifting lugs or eyebolts.
4. 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**].
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with [**3/4-inch (19-mm)**] [**or**] [**1-inch (25-mm)**] <**Insert dimension**> drain connection at low point and vent connection at high point, each with threaded plug.

2.11 SOLUTION HEAT EXCHANGER

A. Description: Shell-and-tube or brazed-plate heat exchanger, an integral part of chiller, increases cycle efficiency by preheating the weak solution on its way to the generator while precooling the strong solution returning from the generator.

2.12 BURNER ASSEMBLY

A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser suitable for [**natural gas**] [**propane**] [**and**] [**fuel oil**].[**Mount burner on hinged access door to permit access to combustion chamber.**]

B. Blower: Centrifugal fan integral to burner, directly driven by motor; with adjustable damper assembly and locking quadrant to set air-fuel ratio.

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

a. 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.

C. Oil Supply: Control devices and modulating control sequence shall comply with requirements of [**ASME CSD-1**] [**FMG**] [**IRI**] [**UL**].

1. Oil Pump: Two-stage, gear-type oil pump shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-in. Hg (50.7-kPa) vacuum.
2. Oil Piping Specialties:

a. Suction-line, manual, gate valve.
b. Removable-mesh oil strainer.
c. 0- to 30-in. Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
d. 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
e. Nozzle-line, solenoid-safety-shutoff oil valve.

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

E. Gas Train: Control devices and modulating control sequence shall comply with requirements of [**ASME CSD-1**] [**FMG**] [**IRI**] [**UL**].

F. Gas Pilot: [**Intermittent**] [**Interrupted**]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

G. Burner assembly shall be equipped to limit nitrogen oxide emissions to [**20**] [**30**] <**Insert value**> ppm.

2.13 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**]. Minimum withstand rating shall be as required by electrical power distribution system, but not less than [**42,000**] [**65,000**] <**Insert value**> A.

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

    a. NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
    b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2, Class A, full-voltage, nonreversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.
3. Control-circuit transformer with primary and secondary side fuses.

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

D. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than a 24-inch (610-mm) length of [**liquidtight**] [**or**] [**flexible metallic**] conduit.

2.14 CONTROLS

A. Chiller control panel shall be separate from burner control panel.

B. Burner Control Panel: Factory[**or field**] mounted. Maintains safe operating conditions, burner safety limits, burner operation, and interface with chiller controls; include the following components:

1. On-off switch.
2. Flame safeguard.
3. Contacts for remote monitoring of flame failure.
4. Contacts for proof of combustion air.
5. Exhaust gas temperature limit switch.
6. Control-circuit transformer.
7. Burner motor controls.
8. Fuel-oil pump controls, if chiller is equipped with fuel-oil pump.
9. Visual indication of on/off status of ignition, blower, and main fuel.
10. Alarm bell.

C. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

D. Enclosure: Unit mounted, NEMA 250, [**Type 1**] [**Type 4**] [**Type 4x**] <**Insert type**>, hinged or lockable.

E. 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 the following information in either imperial or metric units selectable through the interface:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outdoor-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Entering and leaving temperatures of chilled and condenser water.
7. Refrigerant temperature.
8. Solution concentration and temperature.
9. Indication of solution and purge-pump operation.
10. Generator shell pressure.
11. Number of starts.
12. Number of purge cycles.
13. Entering and leaving hot-water temperatures.
14. Burner firing rate displayed in percent.
15. <**Insert status display items**>.

F. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Automatic cycle to prevent crystallization.
3. Entering and leaving chilled-water temperatures and control set points. Chilled-water temperature shall be reset based on [**return-water**] [**outdoor-air**] [**space**] <**Insert condition**> temperature.
4. Entering and leaving hot-water temperatures and control set points. Hot-water temperature shall be reset based on [**return-water**] [**outdoor-air**] [**space**] <**Insert condition**> temperature.
5. Condenser-fluid temperature.
6. Cooling provided and heating energy used within programmable time periods, minimum monthly.
7. Heating provided and heating energy used within programmable time periods, minimum monthly.
8. <**Insert control functions**>.

G. 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.

H. Safety Shutdowns: Chiller shall automatically shut down and require manual restart. Display a message following each safety shutdown.

1. Crystallization.
2. Low refrigerant temperature.
3. Loss of chilled- or condenser-water flow.
4. Low leaving chilled-water temperature[**, 2 deg F (1 deg C) below set point**] <**Insert condition**>.
5. First-stage generator low-solution level.
6. First-stage generator high temperature or pressure.
7. Burner alarm or control malfunction.
8. Power failure.
9. Solution pump overloads.
10. External auxiliary safety shutdown.

11. High solution concentration.
12. Incomplete dilution cycle.
13. <**Insert conditions**>.

I. Warning Conditions: Chiller shall remain operational but inhibit burner firing rate to prevent safety shutdown. Control panel shall close warning contacts and generate a message when one of the following operating conditions is detected:

1. Low refrigerant temperature.
2. High generator temperature or pressure.
3. High or low entering condenser-water temperature.
4. Solution temperature sensor failure.
5. Low chilled-water flow.
6. Purge-pump current overload.
7. <**Insert warning conditions**>.

J. Cycling Shutdowns: Permit automatic restart when preprogrammed limits are reached. Display a message following each cycle shutdown.

1. Cooling Mode:

a. Loss of condenser-water flow.
b. Low leaving chilled-water temperature.
c. Power failure.
d. <**Insert conditions**>.

2. Heating Mode:

a. Loss of hot-water flow.
b. High leaving hot-water temperature.
c. Power failure.
d. <**Insert conditions**>.

K. Trending: Capability to trend analog data up to five parameters simultaneously over an adjustable period and frequency of polling.

L. 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.

M. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

N. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer[**and a notebook computer**].

O. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1. Hardwired Points:

a. Monitoring: On-off status, [**common trouble alarm**] <**Insert monitoring point**>.
b. Control: On-off operation, [**chilled-water, discharge temperature set-point adjustment**] [**hot-water, discharge temperature set-point adjustment**] <**Insert control point**>.

2. [**ASHRAE 135 (BACnet)**] [**LonTalk**] [**Modbus**] [**Industry-accepted, open-protocol**] <**Insert type of interface**> communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

2.15 FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
2. Provide at least two coats of [**alkyd-modified, vinyl enamel**] [**epoxy**] [**polyurethane**] finish with a total dry film thickness of at least 4 mils (0.10 mm).
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be [**manufacturer's standard**] [**custom color selected by Architect**] <**Insert color description**>.

2.16 ACCESSORIES

A. 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.

B. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each [**condenser**] [**evaporator and condenser**] and shall verify field-mounting location before installation.
2. Paddle Flow Switches:

a. Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
b. Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
c. Pressure rating equal to pressure rating of heat exchanger.
d. Construct body and wetted parts of Type 316 stainless steel.
e. House switch in an NEMA 250, [**Type 4**] <**Insert type**> enclosure constructed of die-cast aluminum.
f. Vane length to suit installation.

3. Pressure Differential Switches:

a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set point shift due to variation in working pressure.
c. Set Point: Screw type, field adjustable.
d. Electrical Connections: Internally mounted, screw-type terminal blocks.
e. Switch Enclosure: NEMA 250, [**Type 4**] <**Insert type**>.
f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

C. Vibration Isolation:

1. Chiller manufacturer shall furnish neoprene-pad vibration isolation for each chiller.

a. Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
b. Fabricate pads from 40- to 50-durometer neoprene.
c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

2.17 CAPACITIES AND CHARACTERISTICS

A. Capacity: <**Insert tons (kW)**>.

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

C. Part-Load Efficiency [**(IPLV)**] [**(NPLV)**]: <**Insert number**>.

D. Evaporator:

1. Pressure Rating: [**150 psig (1035 kPa)**] [**300 psig (2070 kPa)**] <**Insert psig (kPa)**>.
2. Number of Passes: [**Two**] [**Three**] [**Four**].
3. Fluid Type: [**Water**] <**Insert fluid type**>.
4. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.
5. Minimum Fluid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Fluid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**] [**0.00025 sq. ft. x h x deg F/Btu (0.000045 sq. m x deg C/W)**] [**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**] <**Insert value**>.

E. Absorber/Condenser:

1. Pressure Rating: [**150 psig (1035 kPa)**] [**300 psig (2070 kPa)**] <**Insert psig (kPa)**>.
2. Number of Passes: [**One**] [**Two**] [**Three**].
3. Fluid Type: [**Water**] <**Insert fluid type**>.
4. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.

5. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
6. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
8. Fluid Velocity: <**Insert fps (m/s)**>.
9. Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu (0.000045 sq. m x deg C/W)**] [**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**] [**0.001 sq. ft. x h x deg F/Btu (0.00022 sq. m x deg C/W)**] <**Insert value**>.

F. Dedicated Hot-Water Heat Exchanger:

1. Capacity: <**Insert MBtu/h (kW)**>.
2. Pressure Rating: [**150 psig (1035 kPa)**] [**300 psig (2070 kPa)**] <**Insert psig (kPa)**>.
3. Number of Passes: [**One**] [**Two**] [**Three**] [**Four**].
4. Fluid Type: [**Water**] <**Insert fluid type**>.
5. Design Fluid Flow Rate: <**Insert gpm (L/s)**>.
6. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
7. Leaving-Fluid Temperature: <**Insert deg F (deg C)**>.
8. Fluid Pressure Drop: <**Insert feet of head (kPa)**>.
9. Fluid Velocity: <**Insert fps (m/s)**>.
10. Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W)**] [**0.00025 sq. ft. x h x deg F/Btu (0.000045 sq. m x deg C/W)**] [**0.0005 sq. ft. x h x deg F/Btu (0.00011 sq. m x deg C/W)**] <**Insert value**>.

G. Burner Blower:

1. Motor Horsepower: <**Insert value**>.
2. RPM: <**Insert value**>.

H. Pump Horsepower:

1. Purge: <**Insert value**>.
2. Refrigerant: <**Insert value**>.
3. Solution: <**Insert value**>.

I. Chiller Control Electrical Requirements:

1. Power Input: <**Insert kilowatts**>.
2. Minimum Circuit Ampacity: <**Insert value**>.
3. Maximum Overcurrent Protection Device: <**Insert amperage**>.
4. Characteristics: [**120**] <**Insert value**>-V ac, single phase, 60 Hz.

J. Chiller Electrical Requirements:

1. Power Input: <**Insert kilowatts**>.
2. Minimum Circuit Ampacity: <**Insert value**>.
3. Maximum Overcurrent Protection Device: <**Insert amperage**>.
4. Characteristics: [**208**] [**240**] [**480**] <**Insert value**>-V ac, three phase, 60 Hz.

K. Natural-Gas Heating Value: <**Insert Btu/cu. ft. (kJ/L)**>.

L. Gas Input: <**Insert cfh (mL/s)**>.

M. Fuel-Oil Heating Value: <**Insert Btu/gal. (MJ/L)**>.

N. Oil Input: <**Insert gph (mL/s)**>.

O. Noise Rating: [**80**] [**85**] <**Insert dBA**> sound power level when measured according to ARI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.18 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Furnish for field installation a brush-cleaning system on each chiller [**condenser**] <**Insert heat exchanger**> for tube cleaning and improved heat transfer.

B. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.

C. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.

D. Components:

1. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
2. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
3. Four-Way Valve:

    a. Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
    b. Configure valve with parallel flow connections to minimize field installation piping.
    c. Construct valve to comply with ASME Boiler and Pressure Vessel Code , at a system working pressure equal to condenser.
    d. Pipe connections shall be flanged.
    e. Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
    f. Hydrostatically test valve to 1.5 times the design working pressure.
    g. Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
    h. Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.
    i. Valve Actuator: Mount electric actuator to operate valve.
    j. Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.

k. Position Switches: Factory mount microswitches on valve to indicate the complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:

a. NEMA 250, [**Type 1**] [**Type 4**] [**Type 4x**] [**Type 12**] enclosure.
b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
c. Manual override of preset cleaning cycle.
d. Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow or incomplete valve turn.
e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
f. Flow-switch bypass.
g. Unloading signal to chiller.

2.19 SOURCE QUALITY CONTROL

A. Perform functional [**run**]tests of chillers before shipping.

B. Factory test and inspect absorber, generator, evaporator, and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Vacuum and pressure test shells for leaks.

C. Rate sound power level according to ARI 575.

D. 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.

E. Factory performance test chillers, before shipping, according to ARI 560.

1. Test the following conditions:

a. Design conditions indicated.
b. Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with condenser fluid at design conditions.
c. Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with varying entering condenser-fluid temperature from design to minimum conditions in [**5 deg F (3 deg C)**] <**Insert temperature**> increments.
d. At [**one**] [**two**] [**three**] [**four**] [**five**] [**10**] <**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

F. Factory sound test chillers, before shipping, according to ARI 575.

1. Test the following conditions:

a. Design conditions indicated.
b. Chiller operating at calculated worst-case sound condition.

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

G. Allow [**Owner**] <**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**] <**Insert number**> days in advance of testing.

H. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. 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.

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

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting:

1. 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."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with absorbent and refrigerant if not factory charged.

E. Install separate devices furnished by manufacturer and not factory installed.

F. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated. Comply with requirements in Section 230716 "HVAC Equipment Insulation."

G. Install electrical devices furnished with chiller but not specified to be factory mounted.

H. Install control wiring to field-mounted electrical devices.

3.3 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM INSTALLATION

A. Install brush-cleaning system control panel adjacent to chiller control panel.

B. 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.

C. Provide field electric power, as required, to each system control panel and electric-actuated valve.

D. Provide pneumatic piping with pressure regulator and an isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.

E. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.

F. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

3.4 CONNECTIONS

A. 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.

B. 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.

C. Connect gas piping full size to gas-train inlet with shutoff valve and union.

D. Install gas-fired boilers according to NFPA 54.

E. Comply with requirements for fuel-oil piping in Section 231113 "Facility Fuel-Oil Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

F. Connect oil piping full size to burner inlet with shutoff valve and union.

G. Install oil-fired boilers according to NFPA 31.

H. Install piping adjacent to chiller to allow service and maintenance.

I. 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 gage. Connect to heat-exchanger outlet with shutoff valve, check valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and

pressure gage,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].

J. Evaporator-Fluid Connections: Connect to evaporator inlet with shutoff valve, [**strainer,**] [**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gage,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].

K. Absorber/Condenser-Fluid Connections: Connect to inlet with shutoff valve, [**strainer,**] [**flexible connector,**] thermometer, and plugged tee with shutoff valve and pressure gage. Connect to outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with shutoff valve and pressure gage,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].

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

L. Refrigerant Pressure Relief Device Connections: Extend [**vent piping**] [**separate vent piping for each chiller**] to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

M. Extend [**purge vent piping**] [**separate purge vent piping for each chiller**] to the outdoors. Comply with ASHRAE 15.

N. 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.

O. 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 the outdoors.

P. Connect fuel-fired burner assembly and blower and associated damper for combustion air.

3.5 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Operate chiller for run-in period.
3. Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.
4. Verify that pumps are installed and functional.
5. Verify that thermometers and gages are installed.
6. Operate chiller for run-in period.
7. Verify that refrigerant pressure relief device is vented to the outdoors.
8. Verify proper motor rotation.
9. Verify proper fuel supply. Adjust air-fuel ratio and combustion.
10. Verify proper combustion-air source.
11. Verify proper exhaust emissions.

12. Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.
13. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
14. Verify and record performance of chiller protection devices.
15. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
16. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain chillers.[**Video record the training sessions.**]

END OF SECTION 236413.13