SECTION 236333 - EVAPORATIVE REFRIGERANT CONDENSERS

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: Factory-assembled and -tested, [**forced**] [**induced**]-draft evaporative refrigerant condensers.

1.3 DEFINITION

A. DDC: Direct digital control.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design evaporative refrigerant condenser support structure[**and seismic restraints**] [**and wind restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Evaporative refrigerant condenser support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to [**ASCE/SEI 7**] <**Insert requirement**>.

1. Dead Loads: <**Insert loads**>.
2. Live Loads: <**Insert loads**>.
3. Roof Loads: <**Insert loads**>.
4. Snow Loads: <**Insert loads**>.
5. Seismic Loads: <**Insert loads**>.
6. Wind Loads: <**Insert loads**>.
7. <**Insert loads or load combinations**>.
8. Deflection Limits: Design system to withstand design loads without deflections greater than the following:

a. <**Insert deflection limits**>.

C. Wind-Restraint Performance:

1. Basic Wind Speed: <**Insert value**>.
2. Building Classification Category: [**I**] [**II**] [**III**] [**IV**].
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

D. Seismic Performance: Evaporative refrigerant condenser 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**]."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, installation instructions, furnished specialties, and accessories.

1. Maximum flow rate.
2. Minimum flow rate.
3. Drift loss as percent of design flow rate.
4. Volume of water in suspension for purposes of sizing a remote storage tank.
5. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and fans at design speed.
6. Performance curves for the following:

a. Varying entering-water temperatures from design to minimum.
b. Varying ambient wet-bulb temperatures from design to minimum.
c. Varying water flow rates from design to minimum.
d. Varying fan operation (off, minimum speed, and design speed).

7. Fan airflow, brake horsepower, and drive losses.
8. Pump flow rate, head, brake horsepower, and efficiency.
9. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
10. Electrical power requirements for each evaporative refrigerant condenser component requiring power.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

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

1. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field piping and wiring connection.
2. Wiring Diagrams: Power, signal, and control wiring.

D. Delegated-Design Submittal For evaporative refrigerant condensers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
2. [**Wind-**] [**and**] [**Seismic-**]Restraint Details: Detail fabrication and attachment of restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include handrails, ladders, and equipment mounting frame.
4. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**] and for designing vibration isolation bases.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, 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 and wiring roughing-in requirements (determine spaces reserved for electrical equipment).
3. Access requirements for service and maintenance.

B. Seismic Qualification Certificates: For evaporative refrigerant condensers, 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.

C. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For evaporative refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Comply with NFPA 70.

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning" and Section 10 - "Other Equipment."

1.9 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.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

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

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

a. Fan, motor, drive shaft, bearings, and motor supports.
b. Tube bundle.
c. External-circuit circulating pump.
d. <**Insert failure modes**>.

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

PART 2 - PRODUCTS

2.1 FORCED-DRAFT EVAPORATIVE REFRIGERANT CONDENSERS

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

B. Fabricate evaporative refrigerant condenser mounting base with reinforcement strong enough to resist evaporative refrigerant condenser movement during a seismic event when evaporative refrigerant condenser is anchored to field support structure.

C. Evaporative refrigerant condenser designed to resist wind load of [**30 lbf/sq. ft. (1.44 kPa)**] <**Insert value**>.

D. Casing and Frame:

1. Casing[**and Frame**] Material: [**FRP with UV inhibitors**] [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Polymer-coated galvanized steel**] [**Stainless steel**].
2. Frame Material: [**FRP with UV inhibitors**] [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Polymer-coated galvanized steel**] [**Stainless steel**].
3. Fasteners: [**Galvanized**] [**Stainless**] steel.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

E. Collection Basin: Configure evaporative refrigerant condenser for installation with a field-constructed collection basin.

F. Collection Basin:

1. Material: [**FRP with UV inhibitors**] [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Polymer-coated galvanized steel**] [**Stainless steel**].
2. Strainer: Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
4. Makeup water connection.
5. Basin Sweeper Distribution Piping and Nozzles:

    a. Pipe Material: [**PVC**] <**Insert material**>.
    b. Nozzle Material: [**Plastic**] <**Insert material**>.
    c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

G. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

H. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, [**Type 4**] [**Type 4X**] <**Insert type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide [**control of water makeup valve**] [**control of water makeup valve and low-level alarm**] [**control of water makeup valve and low- and high-level alarms**] [**control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level**].
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: [**Corrosion-resistant material**] [**FRP**] [**Galvanized steel**] [**PVC pipe**] [**Stainless steel**].
5. Solenoid Valve: Slow closing[**with stainless-steel body**]; controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

I. Electric Basin Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each evaporative refrigerant condenser cell.
3. Enclosure: NEMA 250, [**Type 3R**] [**Type 4**] [**Type 4X**].
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor evaporative refrigerant condenser water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

J. Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

K. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

L. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

M. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat exchanger coil throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.

1. Pipe Material: [**Fiberglass**] [**PVC**] [**Galvanized steel**] <**Insert material**>.
2. Spray Nozzle Material: [**Plastic**] [**Polypropylene**] [**PVC**] <**Insert material**>.
3. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.

N. Recirculating Piping: [**PVC**] <**Insert pipe material**>[**, with connections for separately provided, remote spray pump**].

O. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: [**Totally enclosed**] [**Totally enclosed nonventilated (TENV)**] [**Totally enclosed fan cooled (TEFC)**] [**with epoxy or polyurethane finish**].
3. Energy Efficiency: [**Comply with ASHRAE/IESNA 90.1**] [**NEMA Premium Efficient**].
4. Service Factor: [**1.0**] [**1.15**] <**Insert value**>.

P. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: [**Copper tube with stainless-steel sheet**] [**Stainless-steel tube and sheet**] [**Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication**].
2. Heat-Exchanger Arrangement: [**Serpentine tubes**] [**Serpentine tubes with removable cover plate on inlet and outlet headers**] [**Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube**]; and sloped for complete drainage of fluid by gravity.
3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.
4. Field Piping Connections: Vent, supply, and return[**suitable for mating to ASME B16.5, Class 150 flange**].

Q. [**Removable**]Drift Eliminator:

1. Material: [**FRP**] [**PVC**] [**FRP or PVC**] <**Insert material**>; with maximum flame-spread index of [**5**] [**25**] <**Insert value**> according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

R. [**Removable**]Air-Intake Screens: [**Galvanized**] [**Polymer-coated, galvanized**] [**Stainless**]-steel wire mesh.

S. Centrifugal Fan: Double-width, double-inlet fan with forward-curved blades; and statically and dynamically balanced at the factory after assembly.

1. Number of Fans: Each evaporative refrigerant condenser cell shall have a single fan or multiple fans connected to a common shaft.
2. Fan Wheel and Housing Materials: Galvanized steel.
3. Fan Shaft: Steel, coated to resist corrosion.
4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of [**40,000**] [**50,000**] <**Insert value**> hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

T. Belt Drive:

1. Service Factor: [**1.5**] <**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt: Multiple V-belt design with a matched set of[**cogged**] belts.
4. Belt: One-piece, multigrooved, solid-back belt.
5. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
6. Belt-Drive Guard: Comply with OSHA regulations.

U. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: [**Totally enclosed**] [**Totally enclosed air over (TEAO)**] [**Totally enclosed fan cooled (TEFC)**] [**with epoxy or polyurethane finish**].
3. Energy Efficiency: [**Comply with ASHRAE/IESNA 90.1**] [**NEMA Premium Efficient**].
4. Service Factor: [**1.15**] <**Insert value**>.
5. Insulation: [**Class F**] [**Class H**] <**Insert class**>.
6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Severe-duty rating with the following features:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
    c. Internal heater automatically energized when motor is de-energized.

8. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

V. Discharge Hoods:

1. Hood Configuration: [**Tapered**] [**Straight**]; totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed [**insulation and**]access doors.
2. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.

    a. Provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

W. Capacity-Control Dampers: [**Galvanized-steel**] [**Stainless-steel**] <**Insert material**> dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

X. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, [**Type 4**] [**Type 4X**] <**Insert type**>.
2. Vibration Detection: Sensor with a field-adjustable acceleration sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Evaporative refrigerant condenser manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch[**with manual-reset button**] for [**field connection to a DDC system for HVAC and**]hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration,[**signal an alarm through the DDC system for HVAC and**] shut down the fan.

Y. Controls: Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Z. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, [**Type 3R**] [**Type 4**] [**Type 4X**] enclosure with removable internally mounted backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan[**and spray pump**] based on evaporative refrigerant condenser leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
6. Collection basin, electric/electronic level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
9. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
10. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
11. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each evaporative refrigerant condenser cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

12. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
13. Visual indication of status and alarm[**with momentary test push button**] for each motor.
14. Audible alarm and silence switch.
15. Visual indication of elapsed run time, graduated in hours for each motor.
16. Evaporative refrigerant condenser shall have hardware to enable DDC system for HVAC to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Evaporative refrigerant condenser leaving-fluid temperature.
    d. Fan vibration alarm.
    e. Collection basin [**high**] [**low**] [**high- and low**]-water-level alarms.
    f. <**Insert conditions to be monitored**>.

AA. Personnel Access Components:

1. Doors: Large enough for personnel to access evaporative refrigerant condenser internal components from [**both**]evaporative refrigerant condenser end walls.[**Doors shall be operable from both sides of the door.**]
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of evaporative refrigerant condenser from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at evaporative refrigerant condenser access doors when evaporative refrigerant condensers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard at platforms and around top of evaporative refrigerant condenser. Comply with 29 CFR 1910.23.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

    a. Spanning the collection basin from one end of evaporative refrigerant condenser to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.

BB. Capacities and Characteristics:

1. Number of Cells: <**Insert quantity**>.
2. Maximum Drift Loss: [**0.005**] <**Insert number**> percent of design water flow.
3. Heat-Exchanger Coil(s):

    a. Refrigerant Type: [**R-22**] [**R-407C**] [**R-410A**] [**HFC-134a**] <**Insert type**>.
    b. Refrigerant Type: R-407C, R-410A, or HFC-134a.
    c. Minimum Heat Rejection: <**Insert Btu/h (kW)**>.
    d. Condensing Temperature: <**Insert deg F (deg C)**>.
    e. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Fan Location: [**Bottom**] [**Side**].
5. Fan Motor:

    a. Type: [**Single speed**] [**Two speed, single winding**] [**Two speed, two winding**] [**Variable speed**].
    b. Horsepower/Cell: <**Insert horsepower**>.
    c. Full-Load Ampacity: <**Insert value**>.
    d. Minimum Circuit Ampacity: <**Insert value**>.
    e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
    f. Electrical Characteristics: [**208**] [**240**] [**480**] <**Insert value**>-V ac, 3 phase, 60 Hz.

6. Spray Pump and Motor:

    a. Water Flow/Cell: <**Insert gpm (L/s)**>.
    b. Horsepower/Cell: <**Insert horsepower**>.
    c. Full-Load Ampacity: <**Insert value**>.
    d. Minimum Circuit Ampacity: <**Insert value**>.
    e. Maximum Overcurrent Protection Device: <**Insert amperage**>.

f. Electrical Characteristics: [**120**] [**208**] [**240**] [**277**] [**480**] <**Insert value**>-V ac, [**single**] [**3**] phase, 60 Hz.

7. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**> [**when measured according to CTI ATC 128**].
8. Basin Heater:

a. Basin Water Temperature: [**40 deg F (5 deg C)**] <**Insert value**>.
b. Outdoor Ambient Temperature: [**0 deg F (Minus 18 deg C)**] [**Minus 20 deg F (Minus 29 deg C)**] <**Insert value**>.
c. Capacity/Cell: <**Insert kilowatts**>.
d. Full-Load Ampacity: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection Device: <**Insert amperage**>.
g. Electrical Characteristics: [**208**] [**240**] [**480**] <**Insert value**>-V ac, 3 phase, 60 Hz.
h. Capacity/Cell: <**Insert MBtu/h (kW)**>.
i. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
j. Fluid Flow Rate: <**Insert gpm (L/s)**>.
k. Fluid Pressure Drop: <**Insert psig (kPa)**>.
l. Capacity/Cell: <**Insert MBtu/h (kW)**>.
m. Steam Flow: <**Insert lb/h (L/s)**>.
n. Steam Pressure: <**Insert psig (kPa)**>.

2.2 INDUCED-DRAFT EVAPORATIVE REFRIGERANT CONDENSERS

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

B. Fabricate evaporative refrigerant condenser mounting base with reinforcement strong enough to resist evaporative refrigerant condenser movement during a seismic event when evaporative refrigerant condenser is anchored to field support structure.

C. Evaporative refrigerant condenser designed to resist wind load of [**30 lbf/sq. ft. (1.44 kPa)**] <**Insert value**>.

D. Casing and Frame:

1. Casing[**and Frame**] Material: [**FRP with UV inhibitors**] [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Stainless steel**].
2. Frame Material: [**FRP with UV inhibitors**] [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Polymer-coated galvanized steel**] [**Stainless steel**].
3. Fasteners: [**Galvanized**] [**Stainless**] steel.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

E. Collection Basin: Configure evaporative refrigerant condenser for installation with a field-constructed collection basin.

F. Collection Basin:

1. Material: [**Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating**] [**Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating**] [**Stainless steel**].
2. Overflow and drain connections.
3. Makeup water connection.

G. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

H. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, [**Type 4**] [**Type 4X**] <**Insert type**>.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide [**control of water makeup valve**] [**control of water makeup valve and low-level alarm**] [**control of water makeup valve and low- and high-level alarms**] [**control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level**].
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: [**Corrosion-resistant material**] [**FRP**] [**Galvanized steel**] [**PVC pipe**] [**Stainless steel**].
5. Solenoid Valve: Slow closing[**with stainless-steel body**]; controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

I. Electric Basin Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each evaporative refrigerant condenser cell.
3. Enclosure: NEMA 250, [**Type 3R**] [**Type 4**] [**Type 4X**].
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor evaporative refrigerant condenser water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

J. Hot-Water-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

K. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

L. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

M. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.

1. Pipe Material: [**Fiberglass**] [**PVC**] [**Galvanized steel**] <**Insert material**>.
2. Spray Nozzle Material: [**Plastic**] [**Polypropylene**] [**PVC**] <**Insert material**>.
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

N. Recirculating Piping: [**PVC**] <**Insert pipe material**>[**, with connections for separately provided, remote spray pump**].

O. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: [**Totally enclosed**] [**Totally enclosed nonventilated (TENV)**] [**Totally enclosed fan cooled (TEFC)**] [**with epoxy or polyurethane finish**].
3. Energy Efficiency: [**Comply with ASHRAE/IESNA 90.1**] [**NEMA Premium Efficient**].
4. Service Factor: [**1.0**] [**1.15**] <**Insert value**>.

P. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: [**Copper tube with stainless-steel sheet**] [**Stainless-steel tube and sheet**] [**Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication**].
2. Heat-Exchanger Arrangement: [**Serpentine tubes**] [**Serpentine tubes with removable cover plate on inlet and outlet headers**] [**Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube**]; and sloped for complete drainage of fluid by gravity.
3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.
4. Field Piping Connections: Vent, supply, and return[**suitable for mating to ASME B16.5, Class 150 flange**].

Q. [**Removable**]Drift Eliminator:

1. Material: [**FRP**] [**PVC**] [**FRP or PVC**] <**Insert material**>; with maximum flame-spread index of [**5**] [**25**] <**Insert value**> according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

R. Air-Intake Louvers:

1. Material: [**FRP**] [**PVC**] [**Matching casing**].
2. UV Treatment: Treat louvers with inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into evaporative refrigerant condenser, to minimize air resistance, and to prevent water from splashing out during all modes of operation including operation with fans off.

S. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: [**Aluminum**] [**FRP**] [**Galvanized steel**].
2. Hub Material: [**Aluminum**] [**FRP**] [**Galvanized steel**].
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of [**40,000**] [**50,000**] <**Insert value**> hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

T. Belt Drive:

1. Service Factor: [**1.5**] <**Insert value**> based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt: Multiple V-belt design with a matched set of[**cogged**] belts.
4. Belt: One-piece, multigrooved, solid-back belt.
5. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
6. Belt-Drive Guard: Comply with OSHA regulations.

U. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: [**Totally enclosed**] [**Totally enclosed air over (TEAO)**] [**Totally enclosed fan cooled (TEFC)**] [**with epoxy or polyurethane finish**].
3. Energy Efficiency: [**Comply with ASHRAE/IESNA 90.1**] [**NEMA Premium Efficient**].
4. Service Factor: [**1.15**] <**Insert value**>.
5. Insulation: [**Class F**] [**Class H**] <**Insert class**>.
6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Severe-duty rating with the following features:
    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C).
    c. Internal heater automatically energized when motor is de-energized.
8. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

V. Fan Discharge Stack: Material shall match casing, [**manufacturer's standard**] [**velocity recovery**] design.

1. Stack Extension: Fabricated to extend above fan deck <**Insert distance**> unless otherwise indicated.
2. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.

W. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, [**Type 4**] [**Type 4X**] <**Insert type**>.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Evaporative refrigerant condenser manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch[**with manual-reset button**] for [**field connection to a DDC system for HVAC and**]hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration,[**signal an alarm through the DDC system for HVAC and**] shut down the fan.

X. Controls: Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Y. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, [**Type 3R**] [**Type 4**] [**Type 4X**] enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan[**and spray pump**] based on evaporative refrigerant condenser leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
6. Collection basin electric/electronic level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
9. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each evaporative refrigerant condenser cell**].

    a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
11. Visual indication of status and alarm[**with momentary test push button**] for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Evaporative refrigerant condenser shall have hardware to enable DDC system for HVAC to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Evaporative refrigerant condenser leaving-fluid temperature.
    c. Fan vibration alarm.
    d. Collection basin [**high**] [**low**] [**high- and low**]-water-level alarms.
    e. <**Insert conditions to be monitored**>.

Z. Personnel Access Components:

1. Doors: Large enough for personnel to access evaporative refrigerant condenser internal components from both evaporative refrigerant condenser end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of evaporative refrigerant condenser from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at evaporative refrigerant condenser access doors when evaporative refrigerant condensers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel, complete with kneerail and toeboard at platforms, and around top of evaporative refrigerant condenser. Comply with 29 CFR 1910.23.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

    a. Spanning the collection basin from one end of evaporative refrigerant condenser to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high-water level of the collection basin.
    b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

AA. Capacities and Characteristics:

1. Number of Cells: <**Insert quantity**>.
2. Maximum Drift Loss: [**0.005**] <**Insert number**> percent of design water flow.
3. Heat-Exchanger Coil:

    a. Refrigerant Type: [**R-22**] [**R-407C**] [**R-410A**] [**HFC-134a**] <**Insert type**>.
    b. Refrigerant Type: R-407C, R-410A, or HFC-134a.
    c. Minimum Heat Rejection: <**Insert Btu/h (kW)**>.
    d. Condensing Temperature: <**Insert deg F (deg C)**>.
    e. Entering-Air Wet-Bulb Temperature: <**Insert deg F (deg C)**>.

4. Fan Motor:

a. Type: [**Single speed**] [**Two speed, single winding**] [**Two speed, two winding**] [**Variable speed**].
b. Horsepower/Cell: <**Insert horsepower**>.
c. Full-Load Ampacity: <**Insert value**>.
d. Minimum Circuit Ampacity: <**Insert value**>.
e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
f. Electrical Characteristics: [**208**] [**240**] [**480**] <**Insert value**>-V ac, 3 phase, 60 Hz.

5. Spray Pump and Motor:

a. Water Flow/Cell: <**Insert gpm (L/s)**>.
b. Horsepower/Cell: <**Insert horsepower**>.
c. Full-Load Ampacity: <**Insert value**>.
d. Minimum Circuit Ampacity: <**Insert value**>.
e. Maximum Overcurrent Protection Device: <**Insert amperage**>.
f. Electrical Characteristics: [**120**] [**208**] [**240**] [**277**] [**480**] <**Insert value**>-V ac, [**single**] [**3**] phase, 60 Hz.

6. Sound Pressure Level: <**Insert dBA**> at <**Insert distance in feet (m)**> [**when measured according to CTI ATC 128**].
7. Basin Heater:

a. Basin Water Temperature: [**40 deg F (5 deg C)**] <**Insert value**>.
b. Outdoor Ambient Temperature: [**0 deg F (Minus 18 deg C)**] [**Minus 20 deg F (Minus 29 deg C)**] <**Insert value**>.
c. Capacity/Cell: <**Insert kilowatts**>.
d. Full-Load Ampacity: <**Insert value**>.
e. Minimum Circuit Ampacity: <**Insert value**>.
f. Maximum Overcurrent Protection Device: <**Insert amperage**>.
g. Electrical Characteristics: [**208**] [**240**] [**480**] <**Insert value**>-V ac, 3 phase, 60 Hz.
h. Capacity/Cell: <**Insert MBtu/h (kW)**>.
i. Entering-Fluid Temperature: <**Insert deg F (deg C)**>.
j. Fluid Flow Rate: <**Insert gpm (L/s)**>.
k. Fluid Pressure Drop: <**Insert psig (kPa)**>.
l. Capacity/Cell: <**Insert MBtu/h (kW)**>.
m. Steam Flow: <**Insert lb/h (L/s)**>.
n. Steam Pressure: <**Insert psig (kPa)**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete bases, anchor-bolt sizes and locations, piping systems, and electrical systems to verify actual locations and sizes before evaporative refrigerant condenser installation.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install evaporative refrigerant condensers 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."

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

C. Loose Equipment: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Install piping adjacent to evaporative refrigerant condensers to allow service and maintenance.

B. Install flexible pipe connectors at final connection of evaporative refrigerant condensers mounted on vibration isolators.

C. Run overflow, drain, and bleed lines to sanitary sewage system.

D. Domestic Water Piping: Comply with requirements in Section 221116 "Domestic Water Piping." Connect to water-level control with shutoff valve and union or flange at each connection.

E. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to evaporative refrigerant condenser coil with isolation valves at each connection.

F. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect to supply and return basin-heater tappings with shutoff valve, strainer, control valve, and union or flange on supply connection and union or flange and balancing valve on return connection.

G. Steam and Condensate Piping: Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Piping Specialties." Connect steam supply to basin heater with shutoff valve, strainer, control valve, and union or flange and condensate piping with union or flange, shutoff valve, strainer, and an appropriate steam trap.

H. Ducts: Comply with requirements in Section 233113 "Metal Ducts." Connect ducts to evaporative refrigerant condenser inlet and outlet, full size of outlet, with flexible duct connection.

3.4 STARTUP SERVICE

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

B. Obtain performance tables from manufacturer.

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Clean entire unit including basins.
3. Verify that accessories are properly installed.
4. Check makeup water float.
5. Verify clearances for airflow and for evaporative refrigerant condenser servicing.
6. Check for vibration isolation and structural support.
7. Lubricate bearings on fans and shafts.
8. Verify fan wheel rotation for correct direction and for vibration or binding. Correct vibration and binding problems.
9. Adjust belts to proper alignment and tension.
10. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
11. Check vibration switch setting. Verify operation.
12. Verify water level in basin. Fill to proper startup level. Check makeup water-level control and valve.
13. Start external-circuit circulating pumps.
14. Verify operation of evaporative refrigerant condenser basin, makeup line, automatic freeze protect dump, and controlling device. Replace defective and malfunctioning units.
15. Verify operation of basin heater and control thermostat. Replace defective and malfunctioning units.
16. Verify that evaporative refrigerant condenser discharge is not recirculating into air intakes. Recommend corrective action.
17. Check HVAC water treatment system for proper operation, and measure chemical treatment levels. Verify operation of evaporative refrigerant condenser basin automatic blowdown and of controlling device.

3.5 ADJUSTING

A. Adjust water-level control for proper operating level.

B. Occupancy Adjustments: When requested within [**12**] <**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain evaporative refrigerant condensers.

END OF SECTION 236333