

SECTION 236333 - EVAPORATIVE REFRIGERANT CONDENSERS

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: Forced and induced-draft evaporative refrigerant condensers.

1.3 DEFINITION

- A. BAS: Building automation system.

1.4 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. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and fans at design speed.
 - 5. 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).
 - 6. Fan airflow, brake horsepower, and drive losses.
 - 7. Pump flow rate, head, brake horsepower, and efficiency.
 - 8. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
 - 9. Electrical power requirements for each evaporative refrigerant condenser component requiring power.
- B. LEED Submittal:

Retain subparagraph below for LEED-NC Credit EA 4; coordinate with requirements selected in Part 2 for refrigerants.

1. Product Data for Credit EA 4: Documentation required by Credit EA 4 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. 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.
- E. Operation and Maintenance Data: For evaporative refrigerant condensers to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.5 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.

Retain first paragraph below if Owner prefers the security of a coil designed and fabricated according to ASME Boiler and Pressure Vessel Code or where required by state or local codes.

- 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.

LEED-NC Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IESNA 90.1-2004.

- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning" and Section 10 - "Other Equipment."

1.6 COORDINATION

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

Retain first paragraph below for mounting evaporative refrigerant condensers on a structural-steel support structure.

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

Retain paragraph below for mounting evaporative refrigerant condenser on the roof.

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

1.7 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.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FORCED-DRAFT EVAPORATIVE REFRIGERANT CONDENSERS

- A. Products: Subject to compliance with requirements, provide one of the following:
1. Baltimore Aircoil Company; Series V.
 2. EVAPCO, Inc.; Models LSCB.
 3. Recold; Series JC.
- B. Evaporative refrigerant condenser designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa).
- C. Casing and Frame:
1. Casing and Frame Material: Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating.
 2. Fasteners: Galvanized steel.
 3. Joints and Seams: Sealed watertight.
 4. Welded Connections: Continuous and watertight.

D. Collection Basin:

1. Material: Stainless steel.
2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
4. Makeup water connection.

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

Retain one of first three paragraphs below to require basin heaters for projects subject to freezing conditions. Avoid using electric basin heaters if steam is available.

F. 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.
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 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.

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

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

I. 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: PVC.
2. Spray Nozzle Material: PVC.
3. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.

J. Recirculating Piping: PVC.

K. 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 Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
- L. Heat-Exchanger Coils:
1. Tube and Tube Sheet Materials: Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.
 2. Heat-Exchanger Arrangement: Serpentine tubes with removable cover plate on inlet and outlet headers; 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.
- M. Removable Drift Eliminator:
1. Material: PVC; with maximum flame-spread index of 5 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.
- N. Removable Air-Intake Screens: Galvanized-steel wire mesh.
- O. 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 100,000 hours.
 6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
- P. Belt Drive:
1. Service Factor: 1.5 based on motor nameplate horsepower.
 2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
 3. Belt: One-piece, multigrooved, solid-back belt.
 4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
 5. Belt-Drive Guard: Comply with OSHA regulations.

Q. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. 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."

R. Discharge Hoods:

1. Hood Configuration: Tapered; 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.

S. Capacity-Control Dampers: Stainless-steel dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

T. Vibration Switch: For each fan drive.

1. 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.
2. Provide switch with manual-reset button for field connection to a BAS and hardwired connection to fan motor electrical circuit.
3. Switch shall, on sensing excessive vibration, signal an alarm through the BAS and shut down the fan.

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

1. Control-circuit transformer with primary and secondary side fuses.
2. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
3. 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.
4. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
5. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
6. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
7. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.

8. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
9. Single-point, field-power connection to a fused disconnect switch 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 BAS 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- and low-water-level alarms.

V. 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.

W. Capacities and Characteristics:

1. Maximum Drift Loss: 0.005 percent of design water flow.
2. Heat-Exchanger Coil(s):
 - a. Refrigerant Type: R-407C, R-410A, or HFC-134a.
3. Fan Motor: Variable speed.

2.2 INDUCED-DRAFT EVAPORATIVE REFRIGERANT CONDENSERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Baltimore Aircoil Company; Series CXV.
2. EVAPCO, Inc.; Models ATC.
3. Recold; Series MC.

- B. Evaporative refrigerant condenser designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa).
- C. Casing and Frame:
 - 1. Casing and Frame Material: Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating.
 - 2. Frame Material: Galvanized steel, ASTM A 653/A 653M, G210 (Z600) coating.
 - 3. Fasteners: Galvanized steel.
 - 4. Joints and Seams: Sealed watertight.
 - 5. Welded Connections: Continuous and watertight.
- D. Collection Basin:
 - 1. Material: Stainless steel.
 - 2. Overflow and drain connections.
 - 3. Makeup water connection.
- E. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

Retain one of first three paragraphs below to require basin heaters for projects subject to freezing conditions. Avoid using electric basin heaters if steam is available.

- F. 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. 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.
 - 4. Control-circuit transformer with primary and secondary side fuses.
 - 5. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 - 6. Single-point, field-power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
 - 7. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.
- G. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.
- H. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.
- I. 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: PVC.

2. Spray Nozzle Material: PVC.
 3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
- J. Recirculating Piping: PVC.
- K. 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 Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
- L. Heat-Exchanger Coils:
1. Tube and Tube Sheet Materials: Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.
 2. Heat-Exchanger Arrangement: Serpentine tubes with removable cover plate on inlet and outlet headers; 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.
- M. Removable Drift Eliminator:
1. Material: PVC; with maximum flame-spread index of 5 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.
- N. Air-Intake Louvers:
1. Material: PVC.
 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.
- O. Axial Fan: Balanced at the factory after assembly.
1. Blade Material: Aluminum.
 2. Hub Material: Aluminum.
 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 100,000 hours.
 6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
- P. Belt Drive:
1. Service Factor: 1.5 based on motor nameplate horsepower.
 2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
 3. Belt: One-piece, multigrooved, solid-back belt.
 4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
 5. Belt-Drive Guard: Comply with OSHA regulations.
- Q. Fan Motor:
1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
 2. 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."
 3. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
- R. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.
1. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
- S. Vibration Switch: For each fan drive.
1. 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.
 2. Provide switch with manual-reset button for field connection to a BAS and hardwired connection to fan motor electrical circuit.
 3. Switch shall, on sensing excessive vibration, signal an alarm through the BAS and shut down the fan.
- T. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
1. Control-circuit transformer with primary and secondary side fuses.
 2. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

3. 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.
4. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
5. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
6. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
7. Single-point, field-power connection to a fused disconnect switch.
 - 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.
8. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
9. Visual indication of status and alarm with momentary test push button for each motor.
10. Audible alarm and silence switch.
11. Visual indication of elapsed run time, graduated in hours for each motor.
12. Evaporative refrigerant condenser shall have hardware to enable BAS 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- and low-water-level alarms.

U. 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.

V. Capacities and Characteristics:

1. Maximum Drift Loss: 0.005 percent of design water flow.
2. Heat-Exchanger Coil:
 - a. Refrigerant Type: R-407C, R-410A, or HFC-134a.
3. Fan Motor: Variable speed.
4. Basin Heater:
 - a. Basin Water Temperature: 40 deg F (5 deg C).

- b. Outdoor Ambient Temperature: 0 deg F (Minus 18 deg C).

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: Install evaporative refrigerant condensers on concrete base(s) using restrained spring isolators. Comply with requirements for concrete base(s) specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
 - 1. Minimum Deflection: 1/4 inch (6 mm).
- 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 Division 22 Section "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 Division 23 Section "Refrigerant Piping." Connect to evaporative refrigerant condenser coil with isolation valves at each connection.
- F. Steam and Condensate Piping: Comply with requirements in Division 23 Section "Steam and Condensate Heating Piping." 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.

Retain paragraph below if evaporative refrigerant condenser is installed indoors.

- G. Ducts: Comply with requirements in Division 23 Section "Metal Ducts." Connect ducts to evaporative refrigerant condenser inlet and outlet, full size of outlet, with flexible duct connection.
- H. Discharge ductwork connected to the indoor coolers or condensers shall have access doors to allow servicing.
- I. All piping connected to the coolers and condensers shall be supported separately from the units through the use of pipe hangers and supports.
- J. Balancing valves shall be installed to properly balance flow to each cooler. Shut-off valves shall be provided to isolate equipment for servicing.

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. 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 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain evaporative refrigerant condensers.

END OF SECTION 236333