SECTION 23 65 00 - COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Closed circuit, forced draft, counterflow cooling towers.
2. Open circuit, induced draft, counterflow cooling towers.
3. Open circuit, induced draft, crossflow cooling towers.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.

B. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7. 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."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation.

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

D. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.

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.

E. Source quality control test reports.

F. Field quality control test reports.

G. Startup service reports.

H. Operation and maintenance data.

I. Warranty.

1.4 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. Seattle Energy Code for energy efficiency.

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

1.5 WARRANTY

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

1. Fan assembly including fan, drive, and motor.
2. All components of cooling tower.
3. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CLOSED CIRCUIT, FORCED DRAFT, COUNTERFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Baltimore Aircoil Company; Models VFL and VF1.
2. Delta Cooling Towers, Inc.; Model Pioneer.
3. Evapco Inc.; Models LSWA and LRW.
4. Recold; Models JM and JW.

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

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

1. Casing and Frame Material: [**Galvanized steel, ASTM A 653, G210 coating**] [**Galvanized steel, ASTM A 653, G235 coating**] [**Polymer coated galvanized steel**].
2. Fasteners: Galvanized steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

E. Collection Basin:

1. Material: **Galvanized steel, ASTM A 653, G210 coating**] [**Galvanized steel, ASTM A 653, G235 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.

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

1. Enclosure: NEMA 250, Type 4.
2. Sensors: Solid-state, multiple electrode probes and relays to control water makeup valve.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Corrosion resistant material.
5. Solenoid Valve: Slow closing, controlled and powered through level controller in response to water level setpoint.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. 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 cooling tower cell.
3. Enclosure: NEMA 250, Type 3R.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water temperature setpoint. Water level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low level setpoint.
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.

H. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over fill 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: Plastic.

3. Piping Supports: Corrosion resistant hangers and supports designed to resist movement during operation and shipment.

I. Recirculating Piping: PVC.

J. 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 "Electric Motors for Mechanical Equipment" if not indicated below.
2. Motor Enclosure: Totally enclosed.
3. Energy Efficiency: Comply with Seattle Energy Code.

K. 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**] [**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.

L. Removable Drift Eliminator:

1. Material: FRP or 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.

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

N. Centrifugal Fan: Double width, double inlet, forward curved blades, and statically and dynamically balanced at the factory after assembly.

1. Number of Fans: Each cooling tower 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. Bearings designed for an L-10 life of 40,000 hours.

6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

O. Belt Drive:

1. Belt Drive 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.
6. Two Motor, Single Fan Drive:

    a. Two single speed motors per fan, one sized for full speed and load, and the other sized for 67 percent of full load speed.
    b. Belt Drives: Each motor shall have belt drive complying with requirements for belt drives and configured for operation when other motor fails.
    c. Motor controller and wiring same as two speed, two winding motor.

P. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature rating requirements specified in Division 23 Section "Electric Motors for Mechanical Equipment" if not indicated below.
2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
3. Energy Efficiency: Comply with Seattle Energy Code.
4. Insulation: [**Class F**] [**Class H**].

[**5. 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."**]

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

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

R. Capacity Control Dampers: Galvanized steel dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

S. Controls: Comply with requirements in Division 23 Section "Direct Digital Control (DDC) System."

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

1. NEMA 250, Type 3R enclosure with removable internally mount back plate.

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 cooling tower 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. Controls and wiring for "two motor, single fan drives" shall be same as two-speed, two-winding motor.
9. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
10. Single point, field power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each cooling tower 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. Comply with requirements in Division 23 Section “Variable Frequency Drives.”
11. Factory installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm with momentary test push button for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable Building Management System to remotely monitor and display the following:
    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving fluid temperature.

U. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls.
2. External Ladders with Safety Cages: Galvanized steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Galvanized steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Galvanized steel, complete with knee rail and toeboard at platforms and around top of cooling tower. Comply with 29 CFR 1910.23.

5. Internal Platforms: Galvanized steel bar grating.

    a. Spanning the collection basin from one end of cooling tower 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.

V. Characteristics:

1. Maximum Drift Loss: 0.005 percent of design water flow.
2. Fan Location: [**Bottom**] [**Side**].
3. Fan Motor: Type: [**Single speed**] [**Variable speed**].
4. Basin Heater:

    a. Basin Water Temperature: 40 deg F.
    b. Outdoor Ambient Temperature: 0 deg F.

2.2 OPEN CIRCUIT, INDUCED DRAFT, COUNTERFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Delta Cooling Towers, Inc.; Model Paragon, Premier, TM Series.
2. Evapco Inc.; Models AT, ICT, REP, UBT, and USS.
3. Recold; Model MT.

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

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

1. Casing and Frame Material: [**Galvanized steel, ASTM A 653, G210 coating**] [**Galvanized steel, ASTM A 653, G235 coating**].
2. Fasteners: Galvanized steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

E. Collection Basin:

1. Material: [**Galvanized steel, ASTM A 653, G210 coating**] [**Galvanized steel, ASTM A 653, G235 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. Outlet Connection: ASME B16.5, Class 150 flange.
6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
7. Equalizer connection for field installed equalizer piping.

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

1. Enclosure: NEMA 250, Type 4.
2. Sensor: Solid state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Corrosion resistant material.
5. Solenoid Valve: Slow closing, controlled and powered through level controller in response to water level setpoint.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill 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: Plastic.
3. Piping Supports: Corrosion resistant hangers and supports to resist movement during operation and shipment.

H. Fill:

1. Materials: PVC, resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 15 mils, before forming.
3. Fabrication: Fill type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

I. Removable Drift Eliminator:

1. Material: FRP or PVC; resistant to rot, decay, and biological attack; 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.

J. Air Intake Louvers:

1. Material: Matching casing.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

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

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

1. Blade Material: Aluminum.
2. Hub Material: Aluminum.
3. Protective Enclosure: Removable, galvanized steel, wire-mesh screens, complying with OSHA regulations.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 40,000 hours.
5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

M. 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.
   a. Belt: One piece, multigrooved, solid back belt.
   b. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
   c. Belt-Drive Guard: Comply with OSHA regulations.

OR

N. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

O. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Electrical Motors for Mechanical Equipment" if not indicated below.
2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
3. Energy Efficiency: Comply with Seattle Energy Code.
4. Insulation: [**Class F**] [**Class H**].
5. 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."
5. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

P. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.

1. Stack Termination: Wire mesh, galvanized steel screens complying with OSHA regulations.

Q. Controls: Comply with requirements in Division 23 Section "Direct Digital Control (DDC) System."

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

1. NEMA 250, Type 3R enclosure with removable internally mount back plate.
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 based on cooling tower 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 level controller complying with requirements in "Electric/Electronic, Collection Basin Water Level Controller with Solenoid Valve" Paragraph.
7. Single point, field power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each cooling tower 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. Comply with requirements in Division 23 Section “Variable Frequency Drives.”

8. Factory installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor 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. Cooling tower shall have hardware to enable Building Management System to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving-fluid temperature.

S. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Galvanized steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Galvanized steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Galvanized steel, complete with knee rail and toeboard, around top of cooling tower to safeguard personnel while accessing components located on top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Galvanized steel bar grating.

    a. Spanning the collection basin from one end of cooling tower 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.

T. Characteristics:

1. Air-Inlet Arrangement: All sides.
2. Maximum Drift Loss: 0.005 percent of design water flow.
3. Fan Drive: Belt or direct.
4. Fan Motor: Type: [**Single speed**] [**Variable speed**].

2.3 OPEN CIRCUIT, INDUCED DRAFT, CROSSFLOW COOLING TOWERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Baltimore Aircoil Company; Series 1500 and 3000.
2. Marley Cooling Technologies, an SPX Corporation; Models Aquatower, AV series, NC Class, Primus.

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

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

1. Casing and Frame Material: [**Galvanized steel, ASTM A 653, G235 coating**] [**Polymer coated galvanized steel**].
2. Fasteners: Galvanized steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

E. Collection Basin:

1. Material: [**Galvanized steel, ASTM A 653, G235 coating**] [**Polymer coated galvanized steel**] [**Stainless steel**].
2. Removable[**stainless steel**] strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
4. Makeup water connection.
5. Outlet Connection: ASME B16.5, Class 150 flange.
6. Removable equalization flume plate between adjacent cells of multiple cell towers.
7. Equalizer connection for field-installed equalizer piping.

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

1. Enclosures: NEMA 250, Type 4.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Corrosion-resistant material.
5. Solenoid Valve: Slow closing, controlled and powered through level controller in response to water level setpoint.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Material: [**Galvanized steel, ASTM A 653, G235 coating**] [**Polymer coated galvanized steel**] [**Stainless steel**].
2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
3. Inlet Connection: ASME B16.5, Class 150 flange.
4. Joints and Seams: Sealed watertight.
5. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
6. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
7. Single Inlet, Field Pipe Connection: Galvanized steel pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the [**bottom**] [**side**] unless otherwise indicated.

H. Fill:

1. Materials: PVC, with maximum flame spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 15 mils, before forming.
3. Fabrication: Fill type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.

I. Drift Eliminator:

1. Material: FRP or 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.
4. Location: Separate and removable from fill.

J. Air Intake Louvers:

1. Material: Matching casing.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
4. Location: [**Integral to**] [**Separate from**] fill.

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

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

1. Blade Material: Aluminum.

2. Hub Material: Aluminum.
3. Protective Enclosure: Removable, galvanized steel, wire-mesh screens complying with OSHA regulations.
4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 40,000 hours.
5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

M. 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.
6. Two Motor, Single Fan Drive:
   a. Two single speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
   b. Each motor with belt drive and configured for operation when other motor fails.
   c. Controls and wiring same as two speed, two winding motor.

N. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.

1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Motor Drive Connection: [**Close coupled to motor using a flexible coupling**] [**Connected to motor located outside of cooling tower casing by a full-floating drive shaft**].
6. Drive Shaft Material: Corrosion resistant, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized steel piping. Provide installation with oil level sight glass.

O. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Electric Motors for Mechanical Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
3. Energy Efficiency: Comply with Seattle Energy Code.
4. Insulation: [**Class F**] [**Class H**].

5. 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."
6. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

P. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.

1. Stack Termination: Wire mesh, galvanized-steel screens; complying with OSHA regulations.

Q. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4.
2. Vibration Detection: Sensor with a field-adjustable, acceleration sensitivity setpoint in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch setpoint for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a Building Management System and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the Building Management System and shut down the fan.

R. Gear-Drive, Oil Level Switch: Low oil level warning switch for connection to a Building Management System. Switch shall, on reaching a low oil level setpoint recommended by cooling tower manufacturer, signal an alarm through the Building Management System.

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

T. Controls: Comply with requirements in Division 23 Section "Direct Digital Control (DDC) System."

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

1. NEMA 250, Type 3R enclosure with removable internally mount back plate.
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 based on cooling tower 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 level controller complying with requirements in "Electric/Electronic, Collection Basin Water Level Controller with Solenoid Valve" Paragraph.
7. Vibration switch for each fan, complying with requirement in "Vibration Switch" Paragraph.
8. Oil level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil Level Switch" Paragraph.

9. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each cooling tower 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. Comply with requirements in Division 23 Section "Variable Frequency Drives."

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. Cooling tower shall have hardware to enable Building Management System to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving-fluid temperature.
    d. Oil level alarm.

V. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Galvanized steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Galvanized steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Galvanized steel, complete with knee rail and toeboard, around top of cooling tower to safeguard personnel while accessing components located on top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Galvanized steel bar grating.

    a. Spanning the collection basin from one end of cooling tower 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.

W. Characteristics:

1. Air Inlet Arrangement: [**Single side**] [**Two sides**].
2. Maximum Drift Loss: 0.005 percent of design water flow.
3. Fan Drive: Belt or gear.
4. Fan Motor: Type: [**Single speed**] [**Variable speed**].

2.4 SOURCE QUALITY CONTROL

A. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting: Install cooling tower on concrete base using restrained spring isolators. Comply with requirements for concrete base in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for Mechanical Piping and Equipment."

1. Minimum Deflection: [**1/2 inch**] [**1 inch**] [**2 inches**] [**3 inches**].
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

OR

C. Equipment Mounting: Install cooling tower using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for Mechanical Piping and Equipment."

1. Minimum Deflection: [**1/2 inch**] [**1 inch**] [**2 inches**] [**3 inches**].

D. Install anchor bolts to elevations required for proper attachment to supported equipment.

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

F. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Domestic Water Piping: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.

G. Supply and Return Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union, flange, or mechanical coupling.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections: Comply with ASME PTC 23, "ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment."

C. Cooling towers will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

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

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.

f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.
h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.5 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water level control for proper operating level.

3.6 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 23 65 00