SECTION 236514.17 - CLOSED-CIRCUIT, INDUCED-DRAFT, COMBINED-FLOW COOLING TOWERS

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, closed-circuit, induced-draft, combined-flow cooling towers.

1.3 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at collection basin sweeper supply piping connections.
6. Drift loss as percent of design flow rate.
7. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

8. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
9. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
10. Pump flow rate, head, brake horsepower, and efficiency.

11. Pump motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
12. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation.
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

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

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts:

1. Furnish two set(s) of matching belts for each unique belt configuration and size furnished.

B. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least 1 inch high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.

1.9 WARRANTY

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

1. Provide a one (1) year warranty to include coverage for defects in material and workmanship labor only.
2. Fans, fan shafts, bearings, sheaves, gearboxes, drive shafts, couplings, and mechanical equipment support must be warranted against defects in materials and workmanship for a period of five (5) years; or seven (7) if motor space heater is properly wired.
3. Warranty Period: From date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. 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.

D. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when

power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.

2. Include means and methods required to satisfy requirement even if not explicitly indicated.

E. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.2 DESIGN ARRANGEMENT

A. Combined flow with airflow from one side and induced-draft, top-mounted, axial fan; and with pressurized pipe distribution.

2.3 CASING AND FRAME

A. Casing Material: Galvanized steel (Base Bid), Stainless steel, Grade 304 (Add Alternate #2).

B. Frame Material: Galvanized steel (Base Bid), Stainless steel, Grade 304 (Add Alternate #2).

C. Hardware: Stainless steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight by continuous welds.

2.4 COLLECTION BASIN

A. Factory-Assembled Collection Basin:

1. Material: Stainless steel, Grade 304.
2. Hardware: stainless steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight by continuous welds.
5. Removable stainless-steel strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.

2.5 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

A. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:

1. Enclosures: NEMA 250, Type 3R.

2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Stainless steel, Grade 304.
5. Makeup-Water Valve:

    a. Slow closing.
    b. Valve actuator controlled and powered through level controller in response to water-level set point.
    c. Actuator Enclosure: NEMA 250, Type 3R.
    d. Fail Position: Last.
    e. Action: Two position.

6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.6 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Shipped loose for field installation; 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 set point. Water-level probe shall monitor cooling tower 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.

2.7 PRESSURIZED DISTRIBUTION NETWORK

A. Main header and lateral branch piping designed for even distribution over fill and heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, nonclogging spray nozzles.

B. Pipe Material: Schedule 40 PVC.

C. Spray Nozzle Material: ABS or PVC.

D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.8 FILL

A. Materials: PVC, with maximum flame-spread index of 25 according to ASTM E84.

B. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.

C. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

D. Hardware: Stainless steel.

2.9 HEAT-EXCHANGER COILS

A. Galvanized Steel: The coil shall be constructed of continuous serpentine all prime surface steel, be pneumatically tested at 375 psig, and be hot-dip galvanized after fabrication. The coil shall be designed for free drainage of fluid and shall be ASME B31.5 compliant. Maximum allowable working pressure shall be 300 psig.

B. Field Piping Connections: Vent, supply, and return.

2.10 DRIFT ELIMINATORS

A. Material: PVC; with maximum flame-spread index of 25 according to ASTM E84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Arrangement: Multiple, easily removable sections.

D. Configuration: Multipass, designed and tested to reduce water carryover to 0.005 percent of design flow rate indicated.

E. Hardware: Stainless steel.

2.11 AIR INLET

A. Air-Intake Louvers:

1. Material: PVC.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

B. Hardware: Stainless steel.

2.12 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory.

B. 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: Multiple V-belt design.
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.

C. Fan Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: Totally enclosed air-over (TEAO).
5. Energy Efficiency: NEMA Premium Efficient.
6. Service Factor: 1.15.
7. 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."
8. Severe-Duty Rating:

    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.
    c. Internal Heater: Automatically energized when motor is de-energized.
    d. Complying with IEEE 841.

9. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
10. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than 0.5 percent of motor nameplate horsepower.

D. Hardware: Galvanized or stainless steel.

2.13 AIR DISCHARGE

A. Discharge Hood:

1. Hood Configuration: Straight; totally surrounding heat exchanger, pressurized distribution system and drift eliminators; constructed of same material as casing.
2. Discharge Dampers: Positive-closure, automatic, isolation dampers constructed of galvanized-steel or stainless-steel with stainless steel linkages and electric actuators with NEMA 250, Type 4X enclosure.

    a. If not provided with factory controls, provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

B. Hardware: Galvanized or stainless steel.

2.14 RECIRCULATING WATER DISTRIBUTION SYSTEM

A. Pump: Close-coupled, single-stage, bronze-fitted centrifugal pump; with mechanical seal and suitable for outdoor service. Factory install pump with the following:

1. Flanges at pump connections to piping.

B. Pump Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
3. Motor Enclosure: Totally enclosed fan-cooled (TEFC).
4. Rotor: Random-wound, squirrel cage.
5. Energy Efficiency: NEMA Premium Efficient.
6. Service Factor: 1.15.
7. Temperature Rise: Match insulation rating.
8. Insulation: Class H.
9. Severe-Duty Rating:

    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.
    c. Complying with IEEE 841.

C. Piping: Interconnecting collection basin to pump and pressurization distribution system.

1. Design delegated to manufacturer.
2. External to and supported from cooling tower casing and frame.
3. Material: PVC.
4. Install flanges at connections to collection basin and pressurized distribution system.
5. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.

2.15 ELECTRICAL POWER

A. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, fused.
3. 600-V rated.
4. Minimum short-circuit current rating (SCCR) shall be as required by electrical power distribution system, but not less than 65,000
5. Enclosure: NEMA 250, Type 3R.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Include a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

B. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors as indicated.
3. Enclosure: NEMA 250, Type 3R, with hinged full-front access door with lock and key.
4. Externally Operated, Door-Interlocked Disconnect: Fused disconnect switch with lockable handle.
5. SCCR shall be as required by electrical power distribution system, but not less than 65,000 A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

2.16 CONTROLS

A. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 3R.
2. Mechanical with local reset.

2.17 COOLING TOWER CONTROL PANEL

A. Provide single point power connection control panel UL 508A, Type 3R outdoor enclosure. Panel shall include main non-fused disconnect with external operating handle, lockable in the off position. The main will feed various circuits integrated into the Cooling Tower Panel including but not limited to, fan VFD with 3 contactor manual bypass, Spray Pump starter,

Basin Heater Feeder and vibration shutdown for each fan. Provide operational status and remote input terminal blocks. Operator controls shall be door mounted and shall include but not limited to:

1. Remote mounted VFD keypad/display for each VFD
2. Power ON Light
3. RUN Light for VFD Bypass and Spray Pump
4. Vibration Shutdown Light for each fan
5. HAND-OFF-AUTO selector switches
6. VFD-BYPASS selector switches
7. DRY-WET selector switch
8. OPEN indication for Positive Close Damper

Basin Heater shall be interlocked with spray pump to prevent operation when spray pump is in operation.

VFDs must meet the requirements of Section 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS.

2.18 SERVICE ACCESS

A. Doors:

1. Large enough for personnel to access cooling tower internal components.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.
4. Hinges and handles shall be galvanized.

B. Fan Deck Floor between Cooling Tower Cells:

1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
2. Floor materials shall match adjacent cooling tower cell fan deck.
3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
4. Frame shall be constructed of same materials as cooling tower frame.

C. Internal Platforms: Bar grating.

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

D. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.19 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule on design drawings.

2.20 SOURCE QUALITY CONTROL

A. Heat-Exchanger Factory Pressure and Leak Tests:

1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
2. Test pressure not less than 375 psig.
3. Submit report documenting test and results.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "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."

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

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

D. Maintain clearances required by governing code.

E. Loose Components: Install components, devices, and accessories furnished by manufacturer with the cooling tower that are not factory mounted.

3.3 PIPING CONNECTIONS

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

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install drain piping with valve at cooling tower drain connections and at low points in piping.

D. Connect cooling tower overflows and drains, and piping drains, to storm sewer.

E. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage and drain connection with valve and union.

F. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and DDC system for remote monitoring and control of cooling towers. Comply with Direct Digital Control (DDC) specifications.

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identification products and installations.

3.6 FIELD QUALITY CONTROL

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

3.7 STARTUP SERVICE

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

B. Provide factory start-up assistance for VFD to assure proper programming for cooling tower operation.

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

D. Obtain performance data from manufacturer.

1. Complete installation and startup check 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. Verify pump rotation for correct direction, vibration, cavitation and flow and correct problems.
    h. Adjust belts to proper alignment and tension.
    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.

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

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

3.8 ADJUSTING

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

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

C. Adjust basin heater control for proper operating set point.

3.9 DEMONSTRATION

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

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than two (2) hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 236514.17