SECTION 15640

COOLING TOWERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cooling Towers:

1. Type: Open-circuit, forced-draft counterflow cooling towers.
2. Type: Open-circuit, forced-draft crossflow cooling towers.
3. Type: Induced-draft, counterflow cooling tower.
4. Type: Induced-draft, crossflow cooling tower.

1.2 RELATED SECTIONS

A. Section 05500 - Metal Fabrications.

B. Section 15700 - HVAC Equipment.

C. Section 15120 - Plumbing Piping Specialties.

D. Section 15180 - Heating and Cooling Piping.

E. Division 16 - Electrical.

1.3 REFERENCES

A. ASTM International (ASTM): ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. California Office of Statewide Health Planning and Development (OSHPD): Certification for Seismic Performance.

C. Cooling Technology Institute (CTI): CTI STD-201 - Certification Standard for Commercial Water-cooling Towers' Thermal Performance.

D. National Electrical Manufacturers Association (NEMA).

E. United Laboratories (UL).

F. National Electric Code (NEC).

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Submit manufacturer's product data for each model indicated, including, provide rated capacities at design conditions, physical dimensions, required clearances, weights, sizes, locations of field connections, electrical requirements, and accessories.
   1. Component sizes and rough-in requirements.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.
   5. Operation and maintenance data.
   6. Lift rigging recommendations.

C. Reports: Startup service reports.

D. Shop Drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, materials, and fabrication of doors, frames, sidelites, operator, motion/presence sensor control device, anchors, hardware, finish, options, and accessories.
   1. Wiring Diagrams: Showing internal tower wiring and required field connections by others.

E. Job Specific Submittals: kW/Ton design conditions and part load conditions.

   1. Standard Display:
      a. Tower Performance Analysis: Showing hot water flow in gallons per minute.
      b. Tower Inlet and Outlet Temperatures: In degrees Fahrenheit.
      c. Wet Bulb Temperatures: In degrees Fahrenheit.
      d. Required Motor Power in: HP.
   2. Metric Display:
      a. Tower Performance Analysis: Showing hot water flow in cubic meters per hour.
      b. Tower Inlet and Outlet Temperatures: In degrees Celsius.
      c. Wet Bulb Temperatures: In degrees Celsius.
      d. Required Motor Power in: kW.
   3. Drawings showing plan and elevation views with critical dimensions, tower weight (dry and operating), design operating conditions, and motor data.
   4. Dimensioned fabrication drawings of tower support structure accompanied by manufacturers engineering load calculations confirming design.
   5. Wiring diagrams showing internal tower wiring and required field connections by others.
   6. Drawing of tower “lift rigging” recommendations showing proper sizing of spreader bar, locations of pre-installed lifting brackets, and final leveling instructions.
   7. Wiring diagrams and installation drawings shall also be provided for optional equipment (motor control panel, variable-speed drive, basin heaters, ultrasonic level control) when applicable.
   8. Copy of manufacturers’ written warranty regarding materials and labor, along with the conditions under which warranty is subject.

1.5 QUALITY ASSURANCE

A. Electrical components, devices and accessories: UL-listed components and labeled per UL and NEC requirements.

B. Cooling Technology Institute (CTI) Certification: Cooling tower thermal performance at design conditions according to CTI STD-201 - Certification Standard for Commercial Water-cooling Towers’ Thermal Performance.

C. Seismic Certification: Cooling tower shall have OSHPD Special Seismic Certification Preapproval (OSP) certified for a minimum SDS of 2.0g for grade mounted units and 1.25g for roof mounted units.

D. ASHRAE 90.1: Compliant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards. Store materials within absolute limits for temperature and humidity recommended by manufacturer. Protect from damage.
   1. Upon arrival of cooling tower modules (prior to any lifting operation), the tower modules shall be inspected on the flatbed trailer by owner's representative for general acceptance. Any items of concern related to damage or lifting operations shall be documented and reported (in writing) to the manufacturer's representative or the manufacturer. The owner's representative or his crane operator shall inspect corner lifting brackets and their attachment bolting to the tower.

B. Cooling tower module shall arrive as single, fully assembled and wired component, on a flatbed trailer. The substructure legs, sump, and sump hardware shall be shipped on a separate pallet on the same trailer. When supplied, motor control panel and/or basin heater control panel shall also ship on separate pallet on same trailer.
   1. Store products in manufacturer's labeled packaging until ready for installation.

C. Should tower need to be temporarily placed on the ground prior to its final positioning, the tower shall be stored on sound and level surface in accordance with manufacturer's recommendations.
   1. Prior to lifting tower, excess water should be removed from basin.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Warranty: Provide cooling tower manufacturer's standard material and labor warranty, in accordance with conditions specified within written warranty. Towers not covered by a warranty of this scope will not be accepted.
   1. External Shell: Fifteen years from date of shipment from factory. Excludes normal wear and tear and cosmetic and superficial damage.
   2. Internal Components and Fans: Five years from date of shipment from factory.
   3. Fill Media and Drift Eliminators: Five years from date of shipment from factory.
   4. Cold Water Basin and Tower Casing: Fifteen years from date of shipment from factory.
   5. Motors, Sump, Water Collection Devices, Fans: Five years from date of shipment from factory.
   6. Labor: One year from date of shipment from factory.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Tower Tech; 5400 N.W. 5th St.; Oklahoma City, OK 73127. ASD. Phone: 405-290-7788. Fax: 405-979-2131. Email: Sales@towertechusa.com. Web Site: www.TowerTechusa.com.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 COOLING TOWERS - GENERAL

A. Cooling Towers: TTXR Series as manufactured by Tower Tech.

1. Model: As indicated on Drawings.

B. General Requirements: Furnish and install as shown on the plans a factory-assembled, forced draft, counter-flow, modular cooling tower.

1. Design Loading: As indicated on Drawings.
2. Design Loading: Tower shell and substructure (support legs) shall be designed to withstand a sustained wind load of 200 MPH (41 psf) 321 km/h (ASCE7-05).
3. Seismic: force factor of Cs = 0.4 x weight, category D (Ss = 200, S1 = 150, soil class E) as referenced in the International Building Code 2009.

C. System Requirements: Cooling tower modules must be capable of operating independently or in combination with future modules.

1. Minimum Cells or Modules: As indicated on Drawings.

2. Overall Dimensions Not Exceeding:
   a. Length: ___ feet (___ m).
   b. Width: ___ feet (___ m).
   c. Height: ___ feet (___ m).
3. Overall Dimensions Not Exceeding: As indicated on Drawings.
4. The cooling tower's principal construction shall be of pultruded Fiberglass Reinforced Polyester (FRP) and must have a flame spread rating less than 25 (ASTM E 84) or a flammability coefficient of 94-V0.
5. Cooling towers constructed of metal shall have basin, panels, and structural elements manufactured from stainless steel to equal corrosion resistance of fiberglass.

   a. Stainless Steel Alloy: As indicated on Drawings.
   b. Stainless Steel Alloy: 304.
   c. Stainless Steel Alloy: 316.

2.3 MATERIALS

A. Thermal Performance:
1. Cooling tower nozzles shall be capable of handling variable flow rates from 100 gallons per minute (6.3 liters per second) to 300 gallons per minute (18.9 liters per second) per nozzle without any manual adjustments or nozzle replacements.

2. Peak Load Conditions:
   a. Tower shall be capable of cooling, at peak load conditions, ___ gallons per minute (___ cubic meters per hour) of circulating water from ___ degrees F (___ degrees C) HWT, to ___ degrees F (___ degrees C) CWT, at ___ degrees F (___ degrees C) entering wet bulb temperature, operating with a total fan motor power of ___HP (___kW) maximum.
   b. Tower shall be capable of cooling ___ gallons per minute (___ cubic meters per hour) of circulating water from ___ degrees F (___ degrees C) HWT, to ___ degrees F (___ degrees C) CWT, at ___ degrees F (___ degrees C) air entering wet bulb temperature, operating with a total fan motor power of ___ BHP (___kW) maximum.
3. The manufacturer shall guarantee the towers are certified as to thermal performance by Cooling Technology Institute (CTI) as set forth in the current version of CTI Certification Standard STD-201.

B. Compliance: Cooling tower must be CTI Certified as set forth in the current version of CTI Certification Standard STD-201. Towers claiming to be CTI “listed” or “designed” to CTI specifications shall not be acceptable.

2.4 CONSTRUCTION

A. Cold Water Basin and Tower:
1. The cold water basin and the tower casing shall be constructed of pultruded Fiberglass Reinforced Polyester (FRP) with UV inhibitors.
2. FRP
   a. Minimum Thickness: 1/4 inch (6.35 mm).
   b. Minimum Density: 0.7 oz./cu. in. (1.21 grams/cm3).
3. Specially placed reinforcement and an ultraviolet veil layer will ensure the structural strength and longevity.

4. Metal Tower: Basin shall be constructed of stainless steel.

   a. Stainless Steel Alloy: As indicated on Drawings.
   b. Stainless Steel Alloy: 304.
   c. Stainless Steel Alloy: 316.
5. Perimeter Basin: External shell.
6. Tower shell or casing shall have an integral perimeter basin. Its elevated basin shall reduce operational pump head requirements.
7. High Velocity Water Flow: 5-7 feet per second during operation shall minimize accumulation of sediment.
8. Perimeter Basin: Equipped with one inspection port, at each corner support member, on the front and rear surfaces.
9. Towers constructed of metal shall have stainless steel casing and structure.

   a. Stainless Steel Alloy: As indicated on Drawings.
   b. Stainless Steel Alloy: 304.
   c. Stainless Steel Alloy: 316.
10. Basin shall be equipped with a pair of 2-inch NPT stainless steel drain connections located on opposite sides of the tower perimeter basin floor, and mid-basin inspection ports located in the floor of the tower water basin, between each set of fans.

11. Basin Heaters: As indicated on Drawings.
12. Heater shall have corrosion and liquid proof enclosure.

13. The basin heater package shall include a combination controller and probe (temperature and level sensor) preset at 45 degrees F (7.2 degrees C). This sensor probe is stainless steel with a 1/2-inch NPT mounting fitting.
14. The control panel contains the electronic temperature/flow liquid level control, control voltage transformer, and magnetic contactor used to energize and de-energize heater.
15. Heater must be interlocked with pump control to deactivate heaters when cooling tower pumps are operating.
16. Control panel door includes standard lockout disconnect.
17. Panel and probes shipped loose for field install.
18. A separate 3-Phase power source must be supplied to the control unit.
19. Interlock with pump control and flow/pressure switch to be completed in the field by others (temperature controls contractor or electrician).
20. Compliance: Control panel is NEMA-4X, UL rated.
21. Towers with conventional basin designs shall provide a “Sweeper” piping system to prevent sediment buildup and/or stagnant water areas that permit algae and other biological growth. Sweeper piping system shall include necessary “Eductor” nozzles, piping, pump, sediment separator, and electronic controllers for a completely automatic system.

B. Sump: Mechanical component.
1. Tower shall be equipped with a terminally mounted (end wall) outlet sump with a bottom outlet providing a flanged 150 lb bolt pattern discharge connection for simplified piping. Sump casing shall be manufactured of rotationally molded Polypropylene (PP). Towers having depressed center-type sumps shall use 316 stainless steel for sump construction.
2. Standard equipment shall include a manufacturer supplied and mounted brass float valve with brass or stainless steel components.

3. Connection Size: As indicated on Drawings.
4. Connection Size: 1 inch NPT.
5. Connection Size: 2 inch NPT.
6. Also included are a flanged overflow/equalization connection, and a corrosion-free, easily removable debris screen. Contractor to be responsible for modifications and additions for towers that utilize alternative equalization and overflow designs.
7. Maximum Rated Operating Pressure for Float Valve: 25 psi (1.72 Bar).
8. Install pressure reducing valve if site water pressure is above 25 psi (1.72 Bar).

9. A manufacturer-supplied, field installed ultrasonic level sensor probe and a NEMA-4X non-metallic enclosure containing a water level controller capable of operating a solenoid water make-up valve (supplied and installed by others). The level sensor shall be located in the overflow/equalization piping. The water make-up valve shall be located on the cooling tower circulating water piping (indoors). The enclosure shall have a low level audible alarm and indicating light, as well as a make-up valve “ACTIVATE” pilot light mounted on the door. A corrosion resistant water stilling chamber is required for this option.
10. Towers with conventional basin designs shall provide a solid stainless steel, heavy gauge basin with depressed center section, and an adequate drain (removable standpipe) for flushing.

    a. Stainless Steel Alloy: As indicated on Drawings.
    b. Stainless Steel Alloy: 304.
    c. Stainless Steel Alloy: 316.

C. Fill and Drift Eliminators: Internal component.

1. Fill shall be Polyvinyl Chloride (PVC) of cross-fluted design, 10-mil after forming, impervious to decay, fungus and biological attack, with a flame spread index of 5 according to ASTM E 84 and a maximum operating temperature of 130 degrees F (54.4 degrees C). Fill sheets shall be self-spacing, supported on maximum spans of 12 inches (305 mm). Each fill sheet shall have a microstructure to improve heat transfer. Fill sheets shall be bonded together to form a cross-corrugated pattern by application of glue to dedicated glue joints or by engineered mechanical attachment. Where glued, random application of glue shall not be acceptable.
2. The flute opening of the fill pack shall not be less than around 3/4 inch (19 mm). Fill packs or blocks shall be placed in the tower so as to provide the tightest fit possible without damage to the fill.
3. Drift eliminators shall be minimum three-pass Polyvinyl Chloride (PVC) material of cellular design impervious to decay, fungus and biological attack, with a flame spread index of 5 according to ASTM E 84 and a maximum operating temperature of 130 degrees F (54.4 degrees C). Drift losses shall not exceed 0.0004 percent of the design circulating flow rate at full fan speed.

D. Water Distribution Systems: Internal component.
1. Water shall enter the tower through a single inlet comprised of an enclosed, low pressure, non-corrosive Polyvinyl Chloride (PVC) Schedule 40 piping system. Water will be distributed further using 4-inch Schedule 40 PVC laterals. Water shall be evenly sprayed over the fill media by evenly spaced and sized High Density Polyethylene (HDPE) spray nozzles. The nozzles shall have a 2 inch NPT connection and rotating turbine for atomized water, producing a square pattern, and shall be installed not more than 3 inches (762 mm) above the fill media.
2. The nozzles must operate at a pressure from a minimum of .5 psi (3.45 kPa) to a maximum of 2 psi (13.8 kPa).
3. Nozzles shall be capable of a variable flow of 25 gpm (2.5 lps) to 75 gpm (4.7 lps) to while maintaining full coverage of fill media. Towers that utilize a hot water gravity basin design shall be constructed of 316 stainless steel, and the hot water basin covers shall be constructed of stainless steel or corrosion resistant material of equal quality.

    a. Stainless Steel Alloy: As indicated on Drawings.
    b. Stainless Steel Alloy: 304.
    c. Stainless Steel Alloy: 316.
4. Hardware used for securing panels to basin shall be stainless steel.

    a. Stainless Steel Alloy: As indicated on Drawings.
    b. Stainless Steel Alloy: 304.
    c. Stainless Steel Alloy: 316.
5. Towers operating with fixed orifice nozzles shall include a ladder equipped with safety cage and a fan deck handrail system to provide access to the gravity distribution basin or nozzles for routine maintenance. The water distribution system shall provide full fill media coverage through the entire operating flow range of the circulating water system.

E. Water Collection Systems: Internal component.
1. The tower shall utilize a water collection system positioned beneath the fill media and above the air inlet.
2. The water collection system shall collect cold water as it falls from the fill media and channel the water into the tower’s elevated perimeter basin permitting the mechanical equipment to be mounted in the dry entering air stream beneath the tower.

3. The water collectors shall be made of extruded flame retardant acrylonitrile butadiene styrene copolymer (ABS) material and shall contain an integral barometric damper system that causes the dampers to open and close mechanically with airflow.
4. Each fan's damper system will prevent entry of airborne debris into the tower when the fan below the damper is OFF.
5. For towers utilizing an open sediment-type basin design, air inlet louvers shall be installed and the following type of louvers installed.

    a. Louvers Materials: FRP.
    b. Louvers Materials: Stainless steel, 304 alloy.
    c. Louvers Materials: Stainless steel, 316 alloy.

F. Motors: Mechanical component.

1. Motors: A minimum of two equally sized motors shall be provided. Tower modules offering a single motor for the design conditions shall be unacceptable.
2. Motors Per Tower Module: As indicated on Drawings.

3. Power: ___HP (___ kW) per motor, for a total maximum installed ___HP (___ kW) per tower module.
4. Power: As indicated on Drawings.

    a. Service Factor: At least 1.15.

5. Must be Suitable For: Voltage as indicated on Drawings.

6. Frequency: As indicated on Drawings.

7. At Service Temperature: As indicated on Drawings.
8. At Service Temperature: ___ degrees F (___ degrees C).

9. Motors: High Efficiency, Inverter Duty MG-1 Part 31, IP55, RPM as indicated on Drawings.

10. Wiring: As indicated on Drawings.
11. Wiring: Motors shall be factory pre-wired using oil resistant, VFD compatible, quantum-shielded cable connected to a NEMA-4X junction box which allow service to be performed on an offline fan/motor while the remaining fans continue to operate.
12. Wiring: Motors shall be factory pre-wired using oil resistant, VFD compatible, quantum-shielded cable connected to individual rotary disconnect switches which allow service to be performed on an offline fan/motor while the remaining fans continue to operate.
13. Towers having motors located in the exit air stream are not acceptable. Towers having motors with greater than 7.5 HP (5.6 kW) per motor shall provide a davit system designed to remove motors from top of tower to base of tower.

14. Motors in each cooling tower module shall be connected to and operated by a single variable-frequency drive (VFD), having maximum motor current of (72?), housed in an enclosure. Single-winding; equipped with a VFD with 3-contactor automatic bypass.

    a. Enclosure Rating: As indicated on Drawings.
15. Drive to have 3-contactor automatic bypass connected to fans on a cooling tower module. Fans in each cooling tower module shall be modulated equally.

16. Motor Speeds: As indicated on Drawings.
17. For towers with motors installed in the hot, moist, exiting air stream, the motors shall be furnished with special moisture protection on windings, shafts and bearings or, alternatively, the motors must be mounted outside of the moisture laden air stream. Towers with gear reducers shall include bearing lube lines that extend to the exterior of the tower shell and corrosion-proof drive shaft.
18. Towers operating with top mounted motors shall include a ladder equipped with safety cage, a fan deck handrail system to provide access to the mechanical system for routine inspection and maintenance, and a hoist or small crane (davit) (shipped loose for field installation) for motor or gear reducer removal. Maximum ___BHP (___kW) shall not exceed the nameplate ___BHP (___kW) at operating design conditions. The motors, fans, and drive trains shall be mounted to stainless steel sub-structure using .

    a. Stainless Steel Alloy: 304.

19. Stainless Steel Bolts:

    a. Stainless Steel Alloy: 304.

G. Fans: Mechanical component.
1. Each tower module shall have a minimum of two fans to handle the design conditions.
2. Fans shall be of an axial, airfoil design positioned within an aerodynamically streamlined fiberglass shroud and installed with a minimum tip clearance for maximum efficiency. Fan blades shall be manufactured of Fiberglass-Reinforced Polypropylene and be pitch-adjustable. Fan hubs shall be manufactured of high strength, low weight aluminum alloy to minimize stress and wear on motor bearings.

3. Direct-Drive Fans Per Tower Module: As indicated on Drawings.
4. The fan assembly and motor shall both be located outside exiting air stream.

5. Towers utilizing gear reducers or belt-driven units positioned in the moist exiting air stream must provide one replacement spare of each mechanical component.
6. Towers utilizing gear reducers or belt-driven units positioned in the moist exiting air stream are not acceptable.
7. Towers utilizing gear reducers shall provide a davit system designed to remove gear reducers from top of tower to base of tower. Gear reducer units shall be equipped with remote oil fill and drain lines.
8. Towers utilizing gear reducers shall have a vibration switch for each fan drive. Vibration switches shall be NEMA 250 Type 4X with a field adjustable acceleration sensitivity setpoint in a range of 0-1g and frequency range of 0-3000 cycles per minute. Vibration switch to have manual and remote reset capability.

H. Personnel Access Components:
1. Doors, external ladders, platforms, and handrails: Towers having fans located on the top shall be equipped with fixed ladders with ladder extensions to access top of cooling tower from adjacent grade without the need for portable ladders.

    a. Ladder Materials: As indicated on Drawings.
    b. Ladder Materials: FRP.
    c. Ladder Materials: Aluminum.
    d. Ladder Materials: Stainless steel, 304 alloy.
    e. Ladder Materials: Stainless steel, 316 alloy.

2. Handrails, knee rails, toe boards around the top of tower shall be supplied.

    a. Handrail Materials: As indicated on Drawings.
    b. Handrail Materials: FRP.

c. Handrail Materials: Aluminum.
d. Handrail Materials: Stainless steel, 304 alloy.
e. Handrail Materials: Stainless steel, 316 alloy.

3. Towers having access doors to internal components shall provide internal platform spanning the collection basin from one end of the tower to the other and positioned to form a path between access doors. Platform shall be elevated so that parts remain above the high water level of the collection basin.

a. Internal Platform Materials: As indicated on Drawings.
b. Internal Platform Materials: FRP.
c. Internal Platform Materials: Aluminum.
d. Internal Platform Materials: Stainless steel, 304 alloy.
e. Internal Platform Materials: Stainless steel, 316 alloy.

END OF SECTION