**SECTION 236500 – COOLING TOWERS**

First Edition 5-16-2017

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for induced draft, crossflow cooling towers and related accessories.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design cooling tower support structure and seismic restraints and wind restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: 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.

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

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

### 1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, rated capacities, fan type, fan performance data and curves, nozzle pressure drop data, VFD data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. For each type of product indicated.

1. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

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

D. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. <Delete if not required>

1. Detail fabrication and assembly of support structure.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and wind restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

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

B. 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.

C. Source quality control reports.

D. Field quality control reports.

E. Startup service reports.

F. Warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

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

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

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water Cooling Towers Thermal Performance."

E. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Cooling Tower Design and Selection: Cooling tower(s) shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification to produce the specified maximum tonnage at the specified maximum electrical power input at full load when tested in accordance with CTI Standard 201 test criteria. The unit shall bear the CTI Standard 201 certification label as herein specified.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following: <Edit for Project>

1. Baltimore Aircoil Company; Series 1500 and 3000.
2. Marley Cooling Technologies; Models AV series, and/or NC Class.

2.2 OPEN CIRCUIT, INDUCED DRAFT, CROSSFLOW COOLING TOWERS

A. Description: Induced-draft, cross-flow cooling tower that is factory fabricated and factory assembled using manufacturer’s standard design and construction according to published product information and these specifications.

B. Towers shall be designed and constructed to withstand a wind pressure of not less than 35 pound-force/square foot (psf) on external surfaces. A 15 percent increased loading shall be included for ice or snow load.

C. Basic Cooling Tower Construction Materials:

1. Fiberglass Reinforced Plastic (FRP): FRP components shall be inert, corrosion resistant, and fire-retardant with a thickness of 10 ounces/square foot. FRP components shall contain an ultraviolet (UV) ray inhibitor as per CTI Std-137, Grade 1 or 3.
2. Hot dip Galvanized Steel: Components fabricated of hot dip galvanized steel shall be not lighter than 16 gauge steel Galvanized surfaces damaged due to welding shall be coated with zinc rich coating conforming to ASTM D 520, Type 1.
3. Polyvinyl Chloride (PVC) Formed Sheets: ASTM D 1784, Type I, Grade 1 with a flame spread rating of 25 or less per ASTM E 84.
4. Stainless Steel Sheet: Type 304 or Type 316.
5. Hardware: Bolts shall be cadmium-plated or Type 304 or 316 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads. Hardware shall meet the salt-spray fog test as defined by ASTM B 117.

D. Structure and Casing:

1. Framework, structural supports, and equipment supports shall be Type 304 stainless steel, or FRP.
2. Casing (exterior enclosing walls) shall be constructed of Type 304 stainless steel or FRP.
3. Materials provided for framework, casings and equipment supports shall be compatible. Structural supports shall be provided in accordance with the recommendations of the manufacturer of the tower unless otherwise indicated.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

E. Collection Basin:

1. Basin shall be completely watertight and constructed of Type 304 or Type 316 stainless steel with fully welded seams and joints. Basin shall be constructed and installed to ensure that air will not be entrained in outlets when operating and no water will overflow on shutdown.
2. Provide side outlet depressed sump and removable stainless steel basin strainer at each outlet with openings smaller than nozzle orifices. Strainers shall be secured in place utilizing stainless steel hardware to keep from floating around in the basin but can be removed if required. Outlet connection shall be ASME B16.5, Class 150 flange.

3. Provide overflow connection, make-up water connection, valved side drain connection and full size bottom equalizer connection. All connections shall be constructed of stainless steel.
4. Provide stainless steel flumes for equalization between cells in multi-cell towers, with removable cover plate for individual cell isolation.
5. The basin shall be provided with PVC sump sweeper piping with plastic eductor nozzles. The piping shall create a grid under the fill section and force dirt and debris to the center depressed section of the basin.
6. All items and accessories below the basin overflow level shall be stainless steel.

F. Water Level Controller and Makeup Water Valve:

1. Water Level Control Assembly: Provide an electric/electronic water level control assembly as follows:

a. Manufacturer: Marley, Model SPX, part number E80315 and five (5) probe system, part number 206503. This is a UMB Standard for Water Level Control Assemblies, no substitutions will be allowed.

b. Control Panel: Control panel shall be a NEMA 4X fiberglass weathertight enclosure with stainless steel piano hinged door, swingout panel door with stainless steel clamps, lock off capability, top and bottom mounting flanges and the following electrical components:

1) Main Breaker Disconnect.
2) Hand – Off – Auto selector switch for manual fill control when makeup card is used.
3) Output contact internally wired for 120Vac for use by owner when makeup card is used.
4) User terminal points for connecting field devices such as solenoid valve, water level probes and alarms to the BAS.
5) Raised terminal strip for easy access.
6) Wiring diagram and user manual secured in literature pocket inside the panel door.
7) Built to UL and CUL Standards.
8) Single enclosure for all control cards.
9) For level cards see "Probe Assembly.
10) Electrical Connection Requirements: 120 V, single phase, 60 Hz.

c. Probe Assembly: Probe assembly shall include a noncorrosive PVC enclosure box with twenty (20) feet of wire lead for each probe. Each probe shall have a type 303 stainless steel electrode tip. Also include a stainless steel stilling chamber to be installed over the probes to calm the water for accurate readings. The probe assembly shall be configured as follows:

1) High water alarm.
2) Make up water off.
3) Make up water on.
4) Low water alarm.
5) Ground Reference.

d. Installation: For multiple cell towers controller shall be suitable for installation in the top of a four (4) inch vertical plastic standpipe external to the tower off of the equalizing pipe. For single cell towers mount controller in the cell.

e. Interface with the BAS: Control and alarm points shall be wired to the BAS.

2. Makeup Water Valve: Makeup water valve shall be provided as part of the BAS. Valve shall be connected to the water level controller and control system by the BAS contractor. Make up water valve shall be installed by mechanical contractor.

G. Electric Basin Heater: <Delete if not required>

1. Stainless Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Size: Size heater with sufficient capacity to maintain basin water temperature above 40º F at an ambient temperature of -10ºF. Heater shall be 480V, 3 phase, 60 Hz, complete with control thermostat and low water cutout.
3. Heater Control Panel: Mounted on the side of each cooling tower cell.
4. Enclosure: NEMA 250, Type 3R.
5. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water temperature set point. Separate water level controller shall monitor cooling tower water level and deenergize the heater when the water reaches low level set point.
6. Control circuit transformer with primary and secondary side fuses.
7. Terminal blocks with numbered and color coded wiring to match wiring diagram.
8. Provide a single point power connection to a fused disconnect switch and heater branch circuiting complying with NFPA 70.
9. Factory Wiring Method: Metal raceway for factory installed wiring outside of enclosures, except make connections to each electric basin heater with liquid tight conduit.

H. Gravity Hot 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: 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 lb. 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 stainless steel hardware.
6. Valves: Valves for tower cell isolation and flow balancing shall be provided by the mechanical contractor.
7. Flow Turndown: Provide with weir dams that allow for 50% flow turn-down.
8. Inlet Connections: Provide manufacturers standard top inlet connections (two (2) per cell) for each cell. Each connections shall be suitable for mating with exterior FRP piping using ASME B16.5, Class 150 lb. flanges.

I. Fill:

1. Materials: PVC, with maximum flame spread index of five (5) according to ASTM E 84.
2. Fabrication: Fill type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
3. Fill Material Operating Temperature: Suitable for entering water temperatures up through 120°F.

J. Drift Eliminator:

1. Material: PVC, with maximum flame spread index of five (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: Integral to fill.
5. Performance: Limit drift loss to 0.005% of design flow rate.

K. Air-Intake Louvers:

1. Material: Galvanized steel conforming to ASTM A 653/A 653M, G235 (Z700) coating or formed PVC with a maximum flame-spread rating of five (5) per ASTM E 84. Type 304 or Type 316 Stainless Steel or FRP. Materials provided for casings and louvers shall be compatible; one material shall not produce stains upon the other. Air intakes shall be provided with 1 inch stainless steel mesh.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation. <For PVC louvers only>
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: Separate from fill.

L. Fan Deck and Fan Assemblies:

1. Fan Deck:
   a. Each fan shall be mounted in a fan cylinder (or stack) to elevate the fan discharge air. Total extension height shall not exceed six (6) feet above the fan deck. Each fan cylinder shall be provided with a conical, non-sagging, removable, welded, 12 gauge, hot dipped galvanized fan guard connected to the fan cylinder.
   b. Fan decks shall be designed to withstand a live load of not less than 50 psf in addition to the concentrated or distributed loads of equipment mounted on the fan decks.
   c. Fan deck and cylinders shall be constructed of Type 304 stainless steel, or FRP and be compatible with the entire tower construction.

2. Fans: Fan shall be the adjustable-pitch propeller type, constructed of Type 304 stainless steel or aluminum. Fan shall have a maximum tip speed of 12,900 fpm. Fan blade assembly shall be both statically and dynamically balanced at the factory after assembly of the cooling tower. Fan hub shall be constructed of stainless steel or cast aluminum with adequate surface protection against corrosion. Blade pitch shall be field adjustable. Complete fan assembly (fan and mounting) shall be designed to give maximum fan efficiency and long life when handling saturated air at high velocities.

3. Fan Shafts and Bearings: Fan shaft bearings shall be self-aligning, ball or roller bearings with moisture proof seals and premium, moisture resistant grease suitable for temperatures between -20°F and +300°F. Bearings shall be designed for an L-10 life of forty thousand (40,000) hours. Provide external, extended grease lines and fittings to an easily accessible location.

4. Fan Motors: Fan motor shall be variable speed, inverter duty, totally enclosed fan cooled (TEFC), [1,800] rpm motor, designed for [gear drive] [belt drive] [direct drive] application for cooling tower service. Motor nameplate shall be stamped for inverter duty application. Furnish each motor with shaft grounding rings similar to AEGIS SGR to prevent bearing from shaft current. Refer to motor and VFD specification sections for additional motor requirements. <For Direct Drive applications engineer shall verify motor rpm with manufacturer and edit paragraph accordingly>

   Fan Drive Options <Coordinate with UMB and Choose one of the following>

5. Gear Drive Fan System: Include the following:
   a. Fan shall be driven by a gear drive with the motor mounted outside the airstream. Gear drive shall be right angle, oil-lubricated, industrial duty, geared speed reducer. Gears shall be designed in accordance with CTI

STD-111. Gear drive shall have a minimum service factor of 2.0 based on design fan horsepower and shall be suitable for forward and reverse operation. Oil level fill port and sight glass shall be provided on the gear drive to facilitate inspection and maintenance of the drive.

b. Fan Motor: Fan motor(s) shall be totally enclosed air over (TEAO), reversible, squirrel cage, ball bearing type designed specifically for cooling tower service. The motor shall be furnished with special moisture protection on windings, shafts and bearings. Fan motors shall be premium efficient/inverter duty type designed per NEMA Standard MG1, Section IV Part 31. Space heater shall be provided in fan motor(s) and wired according to the motor nameplate. The use of the motor space will carry a minimum seven (7) year parts warranty on the motor from date of shipment.

6. Direct Drive Fan System: Include the following:
   a. Fan(s) shall be driven by direct drive TEAO motor(s) with an IP66 NEMA enclosure rating for the cooling tower mechanical assemblies. Fan system shall be capable of operating at any speed with no minimum requirement. Motor insulation type shall be Class H and shall be rated at 1,850 volts peak. Motor paint shall be capable of passing a 1,000 hour salt fog test. Motor shall be provided with normally closed thermostats. Space heater shall be included if drive system does not include automatic protection from moisture for motor windings. If oil is required, an extended oil fill line, electric oil heater, low oil level switch, and oil level sight glass shall be included. Mechanical systems with coupled gear drives are not an acceptable alternative.
   b. Variable Frequency Drives: See paragraph below.

7. Belt Drive Fan System: Include the following:
   a. Fan Drive: The fan(s) shall be driven by a one-piece, multi-groove, solid back V- type power band with taper lock sheaves designed for 150% of the motor nameplate horsepower. The power band shall be constructed of neoprene reinforced polyester cord and be specifically designed for cooling tower service. Belt drive fan system shall be suitable for variable frequency operation with a minimum 10:1 turndown ratio (6 Hz).
   b. Fan Motor: Fan motor(s) shall be totally enclosed air over (TEAO), reversible, squirrel cage, ball bearing type designed specifically for cooling tower service. The motor shall be furnished with special moisture protection on windings, shafts and bearings. Fan motors shall be premium efficient/inverter duty type designed per NEMA Standard MG1, Section IV Part 31. Space heater shall be provided in fan motor(s) and wired according to the motor nameplate. The use of the motor space will carry a minimum seven (7) year parts warranty on the motor from date of shipment.

8. Vibration Switch: Each fan shall be provided with electronic remote reset type vibration limit switch which shall stop the corresponding fan motor in the event of sensing excessive fan vibration. The switch shall be provided with contacts for remote monitoring by the Building Automation System (BAS).

M. Fan Control - Variable Frequency Drives (VFD): <Edit for Project>

1. Direct Drive System: The variable frequency drive shall be provided by the motor manufacturer and configured specifically for a direct drive motor application. Due to the nature of the direct drive motor configuration, the variable frequency drive shall not include a mechanical bypass function. See VFD specification for additional requirements. The variable frequency drive enclosure shall be provided in a NEMA 1 indoor-rated enclosure for mounting in the mechanical room (NEMA 3R can be substituted for outdoor VFD applications).

2. Belt Drive and Gear Drive Systems: For requirements see Division 26, Electrical Specification Section "Variable Frequency Drives".

N. Vibration Switch: For each fan drive include:

1. Enclosure: NEMA 250, Type 4.
2. Vibration Detection: Sensor with a field-adjustable, acceleration sensitivity set point in a range of zero (0) to one (1) g and frequency range of zero (0) to three thousand (3,000) cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual reset button for hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS BAS and shut down the fan.

O. Controls: Comply with requirements in Division 23 Specification Sections for "Building Automation System."

P. Disconnect Switch: Furnished and installed by the Electrical Contractor.

Q. Equipment Removal Davit: Provide the mechanical equipment removal davit to aid in motor removal or gear drive. Each tower shall have a steel mounting frame assembly for mounting the davit in the tower. The davit shall be portable from cell to cell and the heaviest piece shall weigh 60 lbs. The davit shall lower the motor or gear drive from the mechanical equipment supports down to an internal metal working surface.

R. Personnel Access Components:

1. Doors: Provide access doors for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door. Minimum door size shall be thirty (30) inched wide by seventy two (72) inches high.
2. External Platforms with Handrails: Provide aluminum, galvanized steel or stainless steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
3. Handrail: Provide aluminum, galvanized steel, or stainless steel hand rails complete with knee rail and toe board, around top of cooling tower to safeguard personnel while accessing components located on top of cooling tower. Comply with 29 CFR 1910.23. All handrail ladder access points shall have safety gates.
4. Internal Platforms: Provide aluminum or stainless steel bar grating including the following:
    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 and sufficiently sturdy to support the heaviest component to be removed plus three (3) men.
    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.
5. External Motor Platform: For gear drive fan motors provide galvanized steel service platform and ladder for access to the external fan motor. Working surface shall be able to withstand 100 psf live load or 300 pound concentrated load.
6. Ladders: Provide aluminum or galvanized steel ladder that complies with requirements of 29 CFR 1910.27 (OSHA), from the roof elevation to top of cooling tower working surface. The ladder shall be securely attached at the top, bottom and intermediate points. Provide a ladder from each access door platform down to the roof.
7. Safety Cage: Galvanized-steel safety cage that complies with requirements of 29 CFR 1910.27 (OSHA), mounted around the ladder from the top of the handrail to within seven (7) feet of the bottom of the ladder.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install cooling towers on equipment supports where indicated on the drawings.

B. Equipment Mounting: Comply with requirements for vibration isolation and seismic control devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

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

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

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

3.2 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Specification Section " HVAC Piping System and Specialties." Drawings indicate general arrangement of piping, fittings, valves, 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.

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. Supply and Return Piping: Comply with applicable requirements in Division 23 Specification Section "HVAC Piping Systems and Specialties." 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.

G. Equalizer Piping: Piping material to match external supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve. <Delete if not applicable to project>

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to assist the mechanical contractor in assembling the cooling tower components, and equipment installations, including final connections, for each tower cell.

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. Verify proper oil level in gear drive housing. Fill with oil to proper level.
h. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
i. Check vibration switch setting. Verify operation.
j. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
k. Verify operation of basin heater and control. <Delete if not required>
l. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
m. 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 236500