

SECTION 236500 - 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:
 - 1. Closed-circuit, forced-draft, counterflow cooling towers.
 - 2. Open-circuit, induced-draft, crossflow cooling towers.
 - 3. Field-erected cooling towers.

1.3 DEFINITIONS

- A. BMS: Building management system.
- B. FRP: Fiber-reinforced polyester.

1.4 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.

1.5 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.
 - 1. Maximum flow rate.
 - 2. Minimum flow rate.
 - 3. Drift loss as percent of design flow rate.

Retain first subparagraph below if a remote storage tank is provided.

- 4. Volume of water in suspension for purposes of sizing a remote storage tank.
 - 5. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
 - 6. Performance curves for the following:

- a. Varying entering-water temperatures from design to minimum.
- b. Varying ambient wet-bulb temperatures from design to minimum.
- c. Varying water flow rates from design to minimum.
- d. Varying fan operation (off, minimum, and design speed).

7. Fan airflow, brake horsepower, and drive losses.

Retain first subparagraph below if pump is integral to closed-circuit cooling tower.

8. Pump flow rate, head, brake horsepower, and efficiency.
9. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
10. Electrical power requirements for each cooling tower component requiring power.

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

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

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

E. Source quality-control reports.

F. Field quality-control reports.

G. Startup service reports.

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

I. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. 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.

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

Retain first paragraph below if heat-exchanger coil of closed-circuit cooling towers requires ASME Boiler and Pressure Vessel Code construction.

- D. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."
- A. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.7 COORDINATION

Retain first paragraph below for mounting towers on concrete bases.

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

Retain first paragraph below for mounting towers on a structural-steel support structure.

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

Retain paragraph below for mounting tower on the roof.

- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- D. Cooling towers shall not be operated without chemical water treatments.

1.8 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.

1.9 MAINTENANCE SERVICE

- A. Cooling tower manufacturers shall have a readily available service department located in the State of Michigan to perform necessary repairs on short notice, within 24 hours to any emergency calls 7 days per week.

PART 2 - PRODUCTS

2.1 CLOSED-CIRCUIT, FORCED-DRAFT, COUNTERFLOW COOLING TOWERS

- A. Products: Subject to compliance with requirements, provide one of the following:
1. Baltimore Aircoil Company; Models VFL and VF1.
 2. Evapco Inc.; Models LSWA and LRW.
 3. Recold; Models JM and JW.
- B. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa).
- C. Casing and Frame:
1. Casing and Frame Material: ASTM A 653/A 653M, G235 (Z700) coating; except stainless steel series 304 for all panels in contact with water.
 2. Fasteners: Galvanized steel.
 3. Joints and Seams: Sealed watertight.
 4. Welded Connections: Continuous and watertight.
- D. Collection Basin:
1. Material: Stainless steel.
 2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
 3. Overflow and drain connections.
 4. Makeup water connection.
- E. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- Retain one of first three paragraphs below to require basin heaters for projects subject to freezing conditions. Use electric only if steam is not available.
- F. Electric Basin Heater:
1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
 2. Heater Control Panel: Mounted on the side of each cooling tower cell.
 3. Enclosure: NEMA 250.
 4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor 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.
 8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.
- G. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

- H. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.
- I. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over 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: PVC.
 - 3. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.
- J. Recirculating Piping: PVC.
- K. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.
 - 1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
- L. Heat-Exchanger Coils:
 - 1. Tube and Tube Sheet Materials: Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.
 - 2. 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.
 - 3. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.
- M. Removable Drift Eliminator:
 - 1. Material: PVC; with maximum flame-spread index of 5 according to ASTM E 84.
 - 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 - 3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
- N. Removable Air-Intake Screens: Galvanized-steel wire mesh.
- O. Centrifugal Fan: Double-width, double-inlet, 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 (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 100,000 hours.

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

P. Belt Drive:

1. 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.

Q. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."

Retain subparagraph below for belt-drive units.

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

R. Discharge Hoods:

1. Hood Configuration: Tapered; totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed insulation and access doors.

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

T. Vibration Switch: For each fan drive.

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

U. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

V. Personnel Access Components:

Five subparagraphs below are optional components. Retain applicable subparagraphs, based on Project conditions, to require these 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: Aluminum, galvanized- or stainless-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: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard at platforms and around top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Aluminum, FRP, or 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.

2.2 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

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

1. Baltimore Aircoil Company.
2. Marley Cooling Technologies, an SPX Corporation; NC Class.

B. Cooling tower designed to resist wind load of 30 lbf/sq. ft. (1.44 kPa).

C. Casing and Frame:

1. Casing and Frame Material: Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating.
2. Fasteners: Galvanized steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Continuous and watertight.

D. Collection Basin:

1. Material: Stainless steel.
2. 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.

If Project has a multiple-cell cooling tower or multiple cooling towers, retain one of first two subparagraphs below.

6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
7. Equalizer connection for field-installed equalizer piping.

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

Retain one of first three paragraphs below to require basin heaters for projects subject to freezing conditions. Use electric only if steam is not available.

- F. Electric Basin Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor 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.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

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

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

- I. 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: 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.

Retain first subparagraph below for projects subject to freezing conditions.

5. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
6. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable stainless-steel hardware.

Retain first subparagraph below if valves are to be provided with cooling tower. Delete if retaining "Single-Inlet, Field Pipe Connection" Subparagraph below.

7. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.

Retain subparagraph below for a single-inlet pipe connection.

8. Single-Inlet, Field Pipe Connection: PVC 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 unless otherwise indicated.

J. Fill:

1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 15 mils (0.4 mm), 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 (49 deg C).

K. Drift Eliminator:

1. Material: PVC; with maximum flame-spread index of 5 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
4. Location: Separate and removable from fill.

L. Air-Intake Louvers:

1. Material: PVC.
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: Separate from fill.

M. Removable Air-Intake Screens: Polymer-coated, galvanized-steel wire mesh.

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

1. Blade Material: Aluminum.
2. Hub Material: Aluminum.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of 100,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

O. 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. Drive-to-Motor Connection: 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.
- P. Fan Motor:
1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
 2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
 3. Energy Efficiency: Comply with ASHRAE/IESNA 90.1.
 4. Service Factor: 1.15.
 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 Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
- Q. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.
1. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
- R. Vibration Switch: For each fan drive.
1. Enclosure: NEMA 250.
 2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
 3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
 4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.
- S. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- T. 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: Aluminum, galvanized- or stainless-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: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Aluminum, FRP, or 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.

2.3 FIELD-ERECTED COOLING TOWERS

For applications of 1000 tons or larger.

- A. Manufacturers: Subject to compliance with requirements, provide one of the following:
 1. Baltimore Aircoil Company.
 2. Marley Cooling Technologies; an SPX Corporation.
- B. Tower structural components, except where otherwise specified, shall be constructed of heavy gauge galvanized steel, with a minimum of 2 ½ oz. of zinc per square foot with lapped joints. Louvers shall be of heavy, mill galvanized steel of sufficient thickness to prevent sagging, and shall be slipfit.
- C. Cold water basin shall be of one piece welded design with heavy gauge stainless steel floor and sides. Basin shall be self-cleaning and complete with depressed center section, cleanout and drain fittings, side outlet sump with suction screen and anti-cavitation device, and float operated make-up valve. The basin shall be designed to support the tower when resting on only two grillage beams. To allow for effective cleaning and flushing cooling towers, bottom of tower fill shall be at least 2" higher than the bottom of cold water basin, and a 4" opening shall be provided either on the cold water basin sump or on the piping from the sump.
- D. Hot water distribution shall be heavy gauge stainless steel of the open basin type with plastic diffusing type metering orifices. Distribution basins shall be covered with removable stainless steel lids, and furnished with flanged connections suitable for direct piping connection or flow control valves as shown.
- E. Fill shall be light weight, noncombustible, and non-corrosive. Drift eliminators shall be two-pass, non-corrosive, noncombustible honeycomb supported in steel frames. Drift loss shall be limited to 0.2 percent.
- F. All bolts, nuts and washers shall be galvanized steel or stainless steel. All steel, except stainless, shall be galvanized with a minimum coating of 2-1/4 oz. per sq. ft.
- G. Motors shall be TEFC, VFD rated, and specially insulated for cooling tower duty. Motor shall be located outside airstream. Fan(s) shall be of the propeller type with cast aluminum blades. Each blade shall be adjustable and individually attached to a cast aluminum or cast iron hub. Fan drive(s) shall be through drive shafts and gear reducers. Drive shafts shall be dynamically balanced and equipped with non-lubricating type flexible links, where required. V-belt drives will not be acceptable. A tapered, hot dip galvanized steel fan cylinder shall be provided to minimize fan tip loss. External oil lines and dip stick shall be provided. Sight glass is not

acceptable. Oil line drains shall be installed so that they can be easily reached from basin floor. Synthetic oil shall be used.

- H. Access doors shall be provided on both endwalls for access to the eliminator and plenum section. Subway grating walkway at cold water basin shall be provided to allow access to float valves. Work platforms with steps or ladders to them shall be provided to allow access to doors. A hot dip galvanized wire, grill type, fan guard shall be provided over each fan cylinder. A perimeter handrail of 1-1/4 inch diameter steel pipe shall be provided on top of the tower and a small ladder of similar construction shall provide access from the base of the tower to the fan deck.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

Retain paragraph below for closed-circuit cooling towers.

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.
 - 1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cooling towers on support structure indicated.
- B. Equipment Mounting: Install cooling tower using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
- E. Install tower with consideration for fan shaft removal without walls or equipment removal.

- F. Indoor Towers:
 - 1. Install service access door to discharge ductwork.
 - 2. Install polypropylene inlet damper with stainless steel shaft.
- G. Outdoor Towers: Install service walkway with removable grating around the tower.

3.3 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. Balancing valves shall be installed to properly balance flow to each tower cell. Shut-off valves shall be provided to isolate units for servicing. Equalizing shall be installed for multiple tower applications.
- G. Provide for connection to electrical service, field piping connections, and field control wiring. All piping connected to the towers shall be supported separately from the units through the use of pipe hangers and supports.
- H. 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.
- I. 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, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a mechanical coupling.

Retain first paragraph below if external equalizer piping is required.

- J. 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.

Retain paragraph below if steam basin heater is installed.

- K. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Heating Piping." Connect steam supply to basin heater with shutoff valve, strainer, control valve, and union or flange and condensate piping with union or flange, shutoff valve, strainer, and an appropriate steam trap.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.
- C. Tests and Inspections: Comply with CTI ATC 105, "Acceptance Test Code for Water Cooling Towers."
- D. Cooling towers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 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.

Retain first subparagraph below for towers with gear drives.

- 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.

Retain first subparagraph below for cooling towers with basin heaters.

- k. Verify operation of basin heater and control.
- 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.

3.6 ADJUSTING

- A. Set and balance water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.

3.7 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