SECTION 23 65 00
COOLING TOWERS

SPEC WRITER NOTES:
1. DELETE BETWEEN //---// if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs. Specify packaged cooling towers except in the rare cases where field assembled type has been selected.
2. Provide the year of latest edition to each publication given in Article 1.5 APPLICABLE PUBLICATIONS.

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers Packaged, //induced draft //forced draft //open circuit cooling tower// closed circuit fluid cooler//complete with fill, fan, //inlet louvers //and associated accessories and equipment.

1.2 RELATED WORK

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Section 03 30 00, CAST IN PLACE CONCRETE.

//D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

C. Section 22 10 00, FACILITY WATER REQUIREMENT.

E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

F. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

G. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

H. Section 23 21 13, HYDRONIC PIPING.

I. Section 23 25 00, HVAC WATER TREATMENT.

J. Section 23 31 00, HVAC DUCTS and CASINGS.

K. Section 26 29 11, MOTOR CONTROLLERS.

1.3 QUALITY ASSURANCE

A. Refer to Article, QUALITY ASSURANCE, in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Design Criteria:

1. Design to withstand _____Pa (___ psf) wind load.
2. Free water drift loss shall not be greater than five hundredths of one percent (0.005) of the water circulated to tower.

SPEC WRITER NOTE: Specify dB(A) level based on the project specific acoustic analysis and local ordinance.

3. Sound levels at 1.5 meters (5 feet) and 17 meters (55 feet) in any direction from the tower shall not exceed _____dB (A) and _____dB (A), respectively. Select "low Noise" model cooling towers, where available. Provide sound attenuators if necessary to meet the noise criteria.

C. Performance Criteria:

1. Manufacturer shall certify that performance of cooling towers will meet contract requirements, stating entering air wet bulb temperature, entering and leaving condenser water temperatures, water flow rates, fan kW (horsepower) //and pump head at base of tower//. Certification shall be made at the time of submittal.

SPEC WRITER NOTE: CTI certification under Standard 201 applies only to selections with entering water temperature of 51.7 degrees C (125 degrees F) or less, temperature ranges of 2.2 degrees C (4 degrees F) or more, temperature approaches of 2.8 degrees C (5 degrees F) or more, and wet bulb between 15.5 degrees C to 29.5 degrees C (60 degrees F to 85 degrees F).

2. Cooling Technology Institute (CTI) Certified Towers: These towers shall have been tested, rated, and certified in accordance with Cooling Technology Institute (CTI) Standard 201, and shall bear the CTI certification label, and shall be listed in the CTI directory of certified cooling towers.
3. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

1.4 SUBMITTALS

A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Shop Drawings

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include rated capacities, pressure drop, fan performance and rating curves, dimensions, weights, mounting details, front view, side view, equipment and device arrangement.
3. Include electrical rating, detail wiring for power, signals and controls.

//4. Pump characteristic curve for the closed circuit fluid cooler. //

5. Sound curves and characteristics of sound attenuators if required to meet the noise criteria.

SPEC WRITER NOTE: If the scope of work involves, total building commissioning, coordinate all documentation requirements with the commissioning efforts.

C. Certification:

1. Submit four copies of performance curves, for CTI certified cooling towers, showing compliance with actual conditions specified, to the Resident Engineer two weeks prior to delivery of the equipment.
2. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:

SPEC WRITER NOTE: Specify the seismic design category for the project so the cooling tower manufacturers can check/design seismic strength of their equipment. Delete the following paragraph if the seismic design category is A or B.

a. Certification from the manufacturer that the cooling tower(s), accessories, and components are suitable for seismic design category ___ installations and that the unit will be fully operational after the seismic event at the project site.
b. Certification by the manufacturer that the cooling towers conform to the requirements of the drawings and specifications.
c. Certification by the Contractor that the cooling towers have been installed, adjusted, and tested.

SPEC WRITER NOTE: Insert the year of approved latest edition of the publications between the brackets //----// and delete the brackets if applicable to this project.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standard Institute (ANSI/ASSE)

A10.18-//2007-R2012)//..Safety Requirements for Temporary Floors, Holes, Wall Openings, Stairways and Other Unprotected Edges in Construction and Demolition Operations

C. American Society of Mechanical Engineers (ASME):

PTC 23-//2003//.....Performance Test Codes on Atmospheric Water Cooling Equipment

D. American Society for Testing Materials (ASTM):

A385-//2017//.....Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)

B117-//2018//.....Standard Practice for Operating Salt Spray (Fog) Apparatus

B209-//2014//.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

E84-//2014//.....Standard Test Method for Surface Burning Characteristics of Building Materials

E. Cooling Technology Institute (CTI):

ATC-105-//2017//.....Acceptance Test Code for Water-Cooling Towers (CTI Code Tower Standard Specifications)

ATC-105S//2011//.....Acceptance Test Code for Closed Circuit Cooling Towers (CTI Code Tower Standard Specifications)

201-//2011//.....Standard for Certification of Water Cooling Tower Thermal Performance (CTI Code Tower Standard Specifications)

F. National Electrical Manufacturers Association (NEMA):

MG 1-//2019//Includes...Motors and Generators (ANSI)

250-//2014//.....Enclosures for Electrical Equipment (1000 Volts Maximum)

G. National Fire Protection Association (NFPA):

70-//2017//.....National Electrical Code

PART 2 - PRODUCTS

SPEC WRITER NOTE: Induced draft open circuit cooling towers should be used on a majority of projects. In general, cross-flow type shall be used, where winter operation is required, specify counter-flow type.

2.1 INDUCED DRAFT OPEN CIRCUIT COOLING TOWER:

A. Cooling tower shall be a factory assembled, induced draft, //cross-flow //counter-flow // type with a vertical discharge configuration.

DESIGNER NOTE: Use stainless steel for all principal panels and structural elements, hot and cold water basins, fan deck, etc. for the High-Humidity locations listed in the VA HVAC Design Manual

B. Casing: Heavy gage (minimum 16 gage)// Galvanized Steel// Stainless Steel // Fiberglass Reinforced Plastic (FRP) with UV inhibitors. //

//1. Galvanized Steel: Hot-dip galvanized steel complying with ASTM A653/A653M, and having G235 (Z700) coating. //

//2. Stainless Steel: ASTM A666, Type 304. //

//3. Fiberglass Reinforced Plastic: FRP with maximum flame spread rating of five according to ASTM E84 and with UV inhibitors. //

4. Fasteners: Zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.

5. Joints and Seams: Sealed watertight.

6. Welded connections: Continuous and watertight.

C. Framing: //Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating. //Rolled or formed structural stainless steel conforming to ASTM A666, Type 304. //

D. Louvers:

1. Spaced to minimize air resistance and prevent splash out. Louver materials shall be similar to the casings or may be polyvinyl chloride (PVC) if formed integral with the fill material.

//2. 25 mm (1 inch) inlet screen, hot dipped // galvanized steel or copper // stainless steel. // Attach the screen securely to air intakes.

E. Fill: // PVC // FRP // resistant to rot, decay and biological attack; with a maximum flame spread rating of five per ASTM E84 and fabricated, formed and installed by manufacturer to ensure that water breaks up into droplets.

F. Drift Eliminators: Same as fill material. Effectively trap water droplets entrained in discharge air stream and limit drift loss to less

than 0.005 percent of the total water circulated. Sections shall be assembled into easily removable racks of the same material as the casing. Eliminators can be PVC neoprene honeycomb type.

SPEC WRITER NOTE: Eliminate the combustible materials when cooling tower is located 12 meters (40 feet) or closer to hazards such as chimneys, and incinerators, or when roof mounted.

G. Hot Water Distribution System: Open basin, flume and troughs, or a pipe system with nozzles spaced for even distribution of water over fill material. Provide access door. System shall be self-draining and non-clogging. Spray nozzles, if used, shall be cleanable stainless steel, bronze or high impact plastic, non-clog, removable type properly spaced for even distribution. Provide cover for entire nozzle area or flume/trough area. // Provide manufacturer's standard pre-strainer assembly and butterfly or globe valve, for cross flow tower, to balance the water flow to each basin. //

H. Cold Water Collection Basin: Heavy gauge, zinc-coated or hot-dip galvanized steel, same as the casing // stainless steel // FRP with UV inhibitors //. Overflow, drain not less than DN (Deutsches Normung) 50 (NPS (Nominal Pipe Size) 2), and a 304 stainless steel strainer assembly with openings smaller than nozzle orifices and with built-in vortex baffling to prevent cavitation and air entrainment in the water basin circulating pump.

I. Accessories: Make-up water, overflow and drain connections//; Equalizer connection (multiple cooling tower systems)//; Flume plate between adjacent cells (multi-cell units only)//.

SPEC WRITER NOTE: On large multiple tower systems, on small systems with a single tower 50 tons or larger, or on systems requiring remote level indication/alarm capability, provide electronic level control. Locate the sensor in the equalization line on multiple tower systems.

J. Collection Basin Water Level Control: // Mechanically operated bronze adjustable make-up water float valve. // Electronic operated with slow closing 120V solenoid valve and NEMA MG 1, Type 4x enclosure. Solid state controls with stainless steel electrode probes and relays factory wired to a terminal strip to provide control of makeup valve, low and high level alarms and output for shutoff of pump on low level//.

K. Fans: Heavy duty axial flow type, //belt//gear// driven and balanced at the factory after assembly, with //cast aluminum or aluminum alloy //FRP // blades. Fans shall be driven by // single speed // variable speed // motor. The fan drive and moving parts shall be completely enclosed by removable hot-dip galvanized screens and panels complying with OSHA regulations. Fan shaft bearings of the self-aligning, grease-lubricated ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 29 and 149 degrees C (minus 20 and plus 300 degrees F). Bearings designed for an L-10 life of // 40,000 // 50,000 // hours and with extended lubrication lines to an easily accessible location outside of the wet air stream. Provide access doors for inspection and cleaning.

L. Motors and drives:

1. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration limits specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
2. In addition to the requirements of specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC, the following shall apply:
   a. Motors: Totally enclosed or epoxy encapsulated NEMA MG 1. Protect fan, bearings, and appurtenances from damage by weather, corrosion, water spray and grit. Provide motors with severe duty rating with the rotor and stator protected with corrosion-inhibiting epoxy resin, double shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 29 and plus 149 degrees C (minus 20 and plus 300 degrees F), and an internal heater automatically energized when motor is de-energized. Provide an adjustable motor base or other suitable provision for adjusting belt tension.
   b. Fans for towers of 350 kW (100 tons) and less shall be belt driven. For towers larger than 350 kW (100 tons), fan shall be driven through a gear reducer, or driven by a V belt.
      1) Gear reducer drive: Specially designed for cooling tower operation, with dynamically balanced drive shaft assembly or shock absorbent flexible coupling requiring no lubrication, cast iron case with readily accessible oil drum and fill, and self-contained oil reservoir sealed against water entrance.

2) V Belt Drive: Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer's standard. Belt drives shall be "V" type as specified in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Belt driven fan and motor shafts shall have taper-lock sheaves fabricated from corrosion resistant material.

SPEC WRITER NOTE: Coordinate motor and starter requirements with ELECTRICAL.

c. Motor Controllers: Provide variable speed motors and controllers, if shown on drawings for cooling tower fans. See specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

d. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.

e. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

M. Fans over 1500 mm (60 inches) in diameter include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration. //Interface the vibration cut-out switch with the DDC control system to provide an alarm in the event the fans stop due to excessive vibration.//

SPEC WRITER NOTE: Designer shall show handrails, ladders, and platforms required for maintenance of cooling towers on drawings. The design shall comply with OSHA Standards. Coordinate with manufacturer's requirements for maintenance access.

N. Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:

1. Fan Guard: Removable fan discharge with a rigid framed screen guard, installed over the fan cylinder.
2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.

3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.
4. Platform: Galvanized steel with a bar grating floor.

SPEC WRITER NOTE: Delete paragraph O and P when winter operation is not required.

O. Electric Basin Heater: Furnish stainless steel electric immersion heater installed in a threaded coupling on the side of the basin and with watertight junction boxes mounted in the basin with sufficient capacity to maintain plus 4 degrees C (40 degrees F) water in the basin at ___degrees C (___degrees F) ambient. Provide a NEMA 250, //Type 3R // Type 4 // Type 4X// mounted on the side of each cooling tower cell with magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Provide a water-level probe to monitor cooling tower water level and de-energize the heater when the water reaches low-level set point. Provide a control-circuit transformer with primary and secondary side fuses, terminal blocks with numbered and color-coded wiring to match wiring diagram, Single-point, field-power connection to a // fused disconnect switch // nonfused disconnect switch // circuit breaker// and heater branch circuiting complying with NFPA 70. Provide a Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid tight conduit.

SPEC WRITER NOTE: Specify electric heat tracing if cooling tower is specified independent of HVAC Piping Systems.

P. Electric Heat Tracing: Provide in specification Section 23 21 13, HYDRONIC PIPING.

SPEC WRITER NOTE: Specify discharge hood, if necessary, to increase leaving air velocity to avoid recirculation.

//Q. Discharge Hood: // Tapered // Straight// // Hot-dip galvanized steel, // stainless steel, //same as the casing with factory installed access door. //

SPEC WRITER NOTE: Forced draft open circuit cooling towers should be used on projects where the tower is indoors, requires ductwork, or is operated in the winter.

2.2 FORCED DRAFT OPEN CIRCUIT COOLING TOWER:

A. Cooling tower shall be a factory assembled, forced draft, counter-flow type with a vertical discharge configuration.

DESIGNER NOTE: Use stainless steel for all principal panels and structural elements, hot and cold water basins, etc. for the High-Humidity locations.

B. Casing: Heavy gage (minimum 16 gage) // Galvanized Steel // Stainless Steel // Fiberglass Reinforced Plastic (FRP) with UV inhibitors. //

//1. Galvanized Steel: Hot-dip galvanized steel complying with ASTM A653/A653M, and having G235 (Z700) coating. //

//2. Stainless Steel: ASTM A666, Type 304. //

//3. Fiberglass Reinforced Plastic: FRP with maximum flame spread rating of five according to ASTM E84 and with UV inhibitors. //

4. Fasteners: Zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.

5. Joints and Seams: Sealed watertight.

6. Welded connections: Continuous and watertight.

C. Framing: //Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating. //Rolled or formed structural stainless steel conforming to ASTM A666, Type 304. //

D. Fill:// PVC // FRP // resistant to rot, decay and biological attack; with a maximum flame spread rating of five per ASTM E84 and fabricated, formed and installed by manufacturer to ensure that water breaks up into droplets.

E. Drift Eliminators: Same as fill material. Effectively trap water droplets entrained in discharge air stream and limit drift loss to less than 0.005 percent of the total water circulated. Sections shall be assembled into easily removable racks of the same material as the casing. Eliminators can be PVC neoprene honeycomb type.

SPEC WRITER NOTE: Eliminate the combustible materials when cooling tower is located 12 meters (40 feet) or closer to hazards such as chimneys, and incinerators, or when roof mounted.

F. Hot Water Distribution System: Open basin, flume and troughs, or a pipe system with nozzles spaced for even distribution of water over fill material. Provide access door. System shall be self-draining and non-clogging. Spray nozzles, if used, shall be cleanable stainless steel, bronze or high impact plastic, non-clog, removable type properly spaced for even distribution. Provide cover for entire nozzle area or flume/trough area. // Provide manufacturer's standard pre-strainer assembly and butterfly or globe valve, for cross flow tower, to balance the water flow to each basin. //

G. Cold Water Collection Basin: Heavy gauge, zinc-coated or hot-dip galvanized steel, same as the casing // stainless steel // FRP with UV inhibitors //. Overflow, drain not less than DN (Deutsches Normung) 50 (NPS (Nominal Pipe Size) 2), and a 304 stainless steel strainer assembly with openings smaller than nozzle orifices and with built-in vortex baffling to prevent cavitation and air entrainment in the water basin circulating pump.

H. Accessories: Make-up water, overflow and drain connections, Equalizer connection (multiple cooling tower systems) Flume plate between adjacent cells (multi-cell units only).//

SPEC WRITER NOTE: On large multiple tower systems, on small systems with a single tower 50 tons or larger, or on systems requiring remote level indication/alarm capability, provide electronic level control. Locate the sensor in the equalization line on multiple tower systems

I. Collection Basin Water Level Control: // Mechanically operated bronze adjustable make-up water float valve. // Electronic operated with slow closing 120V solenoid valve and NEMA MG 1, Type 4x enclosure. Solid state controls with stainless steel electrode probes and relays factory wired to a terminal strip to provide control of makeup valve, low and high level alarms and output for shutoff of pump on low level//.

J. Fans: Centrifugal double width, double inlet, forward curved blades, belt driven and statically and dynamically balanced at the factory after assembly. Hot-dip galvanized steel centrifugal fans belt driven by // single speed // variable speed // motor. The fan drive and moving parts shall be completely enclosed by removable hot-dip galvanized screens and panels complying with OSHA regulations. Fan shaft bearings of the self aligning, grease-lubricated ball or roller

bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 29 and 149 degrees C (minus 20 and plus 300 degrees F). Bearings designed for an L-10 life of // 40,000 // 50,000 // hours and with extended lubrication lines to an easily accessible location outside of the wet air stream. Provide access doors for inspection and cleaning.

K. Motors and drives:

1. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration limits specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
2. In addition to the requirements of specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC, the following shall apply:
   a. Motors: Totally enclosed or epoxy encapsulated NEMA MG 1. Protect fan, bearings, and appurtenances from damage by weather, corrosion, water spray and grit. Provide motors with severe duty rating with the rotor and stator protected with corrosion-inhibiting epoxy resin, double shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 29 and plus 149 degrees C (minus 20 and plus 300 degrees F), and an internal heater automatically energized when motor is de-energized. Provide an adjustable motor base or other suitable provision for adjusting belt tension.
   b. V Belt Drive: Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer’s standard. Belt drives shall be "V" type as specified in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Belt driven fan and motor shafts shall have taper-lock sheaves fabricated from corrosion resistant material.

      SPEC WRITER NOTE: Coordinate motor and starter requirements with ELECTRICAL.

   c. Motor Controllers: Provide variable speed motors and controllers, if shown on drawings for cooling tower fans. See specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
   d. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.

e. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

L. Fans with motors over 15 KW (20 HP) shall include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration. //Interface the vibration cut-out switch with the DDC control system to provide an alarm in the event the fans stop due to excessive vibration.//

SPEC WRITER NOTE: Designer shall show handrails, ladders, and platforms required for maintenance of cooling towers on drawings. The design shall comply with OSHA Standards. Coordinate with manufacturer's requirements for maintenance access.

M. Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:

1. Fan Guard: Removable rigid framed screen guard, installed over the inlet side of the fan.
2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.
3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.
4. Platform: Galvanized steel with a bar grating floor.

SPEC WRITER NOTE: Delete paragraph N and O when winter operation is not required.

N. Electric Basin Heater: Furnish stainless steel electric immersion heater installed in a threaded coupling on the side of the basin and with watertight junction boxes mounted in the basin with sufficient capacity to maintain plus 4 degrees C (40 degrees F) water in the basin at ___degrees C (___degrees F) ambient. Provide a NEMA 250, // Type 3R // Type 4 // Type 4X// mounted on the side of each cooling tower cell with magnetic contactors controlled by a temperature sensor/controller

to maintain collection basin water-temperature set point. Provide a water-level probe to monitor cooling tower water level and de-energize the heater when the water reaches low-level set point. Provide a control-circuit transformer with primary and secondary side fuses, terminal blocks with numbered and color-coded wiring to match wiring diagram, Single-point, field-power connection to a // fused disconnect switch // nonfused disconnect switch // circuit breaker// and heater branch circuiting complying with NFPA 70. Provide a metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid tight conduit.

SPEC WRITER NOTE: Specify electric heat tracing if cooling tower is specified independent of HVAC Piping Systems.

O. Electric Heat Tracing: Provide in specification Section 23 21 13, HYDRONIC PIPING.

SPEC WRITER NOTE: Specify discharge hood, if necessary, to increase leaving air velocity to avoid recirculation. Provide automatic control damper on cooling towers designed to operate in the winter.

//P. Discharge Hood: // Tapered // Straight// // Hot-dip galvanized steel, // stainless steel, //same as the casing with factory installed access door// and automatic control damper.//

SPEC WRITER NOTE: Specify sheet metal ducts, if cooling tower is to be installed indoors.

//Q. Sheet Metal Ducts: Provide in specification Section 23 31 00, HVAC DUCTS AND CASINGS.//

SPEC WRITER NOTE: Induced draft closed circuit coolers will be used on projects requiring a cooler, installed outdoors and not operated in the winter.

2.3 INDUCED DRAFT CLOSED CIRCUIT FLUID COOLER

A. Cooler shall be a factory assembled, induced draft, //cross-flow //counter-flow // type with a vertical discharge configuration.

DESIGNER NOTE: Use stainless steel for all principal panels and structural elements, hot and cold water basins, fan deck, etc. for the High-Humidity locations listed in the VA HVAC Design Manual.

B. Casing: Heavy gage (minimum 16 gage) // Galvanized Steel // Stainless Steel // Fiberglass Reinforced Plastic (FRP) with UV inhibitors. //

//1. Galvanized Steel: Hot-dip galvanized steel complying with ASTM A653/A653M, and having G235 (Z700) coating. //

//2. Stainless Steel: ASTM A666, Type 304. //

//3. Fiberglass Reinforced Plastic: FRP with maximum flame spread rating of five according to ASTM E84 and with UV inhibitors. //

4. Fasteners: Zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.

5. Joints and seams: Sealed watertight.

6. Welded connections: Continuous and watertight.

C. Framing: //Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating. //Rolled or formed structural stainless steel conforming to ASTM A666, Type 304. //

D. Louvers:

1. Spaced to minimize air resistance and prevent splash out. Louver materials shall be similar to the casings or may be polyvinyl chloride (PVC) if formed integral with the fill material.

2. 12.7 mm (1/2 inch) // hot-dip galvanized-steel or copper // stainless steel // Attach screens securely to air intakes.

E. Drift Eliminators: Same as fill material. Effectively trap water droplets entrained in discharge air stream and limit drift loss to less than 0.005 percent of the total water circulated. Sections shall be assembled into easily removable racks of the same material as the casing. Eliminators can be PVC neoprene honeycomb type.

DESIGNER NOTE: Provide stainless steel basin for the High-Humidity locations listed in the VA HVAC Design Manual.

F. Cold Water Collection Basin: Heavy gauge zinc-coated or hot-dip galvanized steel, same as the casing // stainless steel // FRP with UV inhibitors //. Overflow drain not less than 50 mm (2-inches), and a 304 stainless steel strainer assembly with openings smaller than nozzle orifices and with built-in vortex baffling to prevent cavitation and air entrainment in the water basin circulating pump.

SPEC WRITER NOTE: On large systems (> 50 tons) or on systems requiring remote

level indication/alarm capability, provide electronic level control.

G. Collection Basin Water Level Control: // Mechanically operated bronze adjustable make-up water float valve. // Electronic operated with slow closing 120V solenoid valve and NEMA MG 1, Type 4x enclosure. Solid state controls with stainless steel electrode probes and relays factory wired to a terminal strip to provide control of makeup valve, low and high level alarms and output for shutoff of pump on low level//.

DESIGNER NOTE: Use copper or stainless steel tubes for the High-Humidity locations listed in the VA HVAC Design Manual.

H. Cooling Coil Sections: // Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication// Copper tube with stainless-steel sheet// // Stainless-steel tube and sheet//, tested at 2410 kPa (350 psig) air pressure under water. Slope tubes to permit free drainage of fluid. // Design and manufacture and test coils according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp. Design coil and casing housing section for easy removal of coil. Coil section shall be of the serpentine design type with coil tubing welded into service pipe connection header. Provide flanged piping connections suitable for field mounting on the vent, supply and return water lines to the coil.

I. Water Distribution System: Open gravity type or individual removable non-clogging spray nozzle type and specifically designed that each trough or spray nozzle extends the entire length of the cooling coil section to complete wetting of the cooling coil at all times. Construct water distribution system of hot-dip galvanized steel or Schedule 40 PVC. Provide corrosion resistant hangers and supports designed to resist movement during operation and shipment.

J. Cooler Water Distribution Circulating Pump: Close coupled bronze fitted centrifugal circulating pump with mechanical seal suitable for outdoor use, suction strainer, and flow balancing valve. Pump shall be completely piped to suction strainer and water distribution system, mounted to drain completely when tower basin is drained. Include a bleed line with valve between pump discharge and overflow pipe. For pump motor, see specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

K. Fans: Heavy duty axial flow type, //belt//gear// driven and balanced at the factory after assembly, with //cast aluminum or aluminum alloy //FRP // blades. Fans shall be driven by // single speed // variable speed // motor. The fan drive and moving parts shall be completely enclosed by removable hot-dip galvanized screens and panels complying with OSHA regulations. Fan shaft bearings of the self aligning, grease-lubricated ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 29 and 149 degrees C (minus 20 and plus 300 degrees F). Bearings designed for an L-10 life of // 40,000 // 50,000 // hours and with extended lubrication lines to an easily accessible location outside of the wet air stream. Provide access doors for inspection and cleaning.

L. Motors and drives:

1. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration limits specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
2. In addition to the requirements of specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC, the following shall apply:
   a. Motors: Totally enclosed or epoxy encapsulated NEMA MG 1. Protect fan, bearings, and appurtenances from damage by weather, corrosion, water spray and grit. Provide motors with severe duty rating with the rotor and stator protected with corrosion-inhibiting epoxy resin, double shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 29 and plus 149 degrees C (minus 20 and plus 300 degrees F), and an internal heater automatically energized when motor is de-energized. Provide an adjustable motor base or other suitable provision for adjusting belt tension.
   b. Fans for coolers of 350 kW (100 tons) and less shall be belt driven. For coolers larger than 350 kW (100 tons), fan shall be driven through a gear reducer, or driven by a V belt.
      1) Gear reducer drive: Specially designed for cooler operation, with dynamically balanced drive shaft assembly or shock absorbent flexible coupling requiring no lubrication, cast iron case with readily accessible oil drum and fill, and self-contained oil reservoir sealed against water entrance.

2) V Belt Drive: Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer's standard. Belt drives shall be "V" type as specified in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Belt driven fan and motor shafts shall have taper-lock sheaves fabricated from corrosion resistant material.

SPEC WRITER NOTE: Coordinate motor and starter requirements with ELECTRICAL.

c. Motor Controllers: Provide variable speed motors and controllers, if shown on drawings for cooling tower fans. See specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

d. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.

e. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

M. Fans over 1500 mm (60 inches) in diameter include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration. //Interface the vibration cut-out switch with the DDC control system to provide an alarm in the event the fans stop due to excessive vibration.//

SPEC WRITER NOTE: Delete paragraph N and O when winter operation is not required.

N. Electric Basin Heater: Furnish stainless steel electric immersion heater installed in a threaded coupling on the side of the basin and with watertight junction boxes mounted in the basin with sufficient capacity to maintain plus 4 degrees C (40 degrees F) water in the basin at ___degrees C (___degrees F) ambient. Provide a NEMA 250, // Type 3R // Type 4 // Type 4X// enclosure mounted on the side of each cooler cell with magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Provide a water-level probe to monitor cooler water level and de-energize the heater when the water reaches low-level set point. Provide a control-circuit transformer with primary and secondary side

fuses, terminal blocks with numbered and color-coded wiring to match wiring diagram, Single-point, field-power connection to a // fused disconnect switch // nonfused disconnect switch // circuit breaker// and heater branch circuiting complying with NFPA 70. Provide a Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid tight conduit.

SPEC WRITER NOTE: Specify electric heat tracing if fluid cooler is specified independent of HVAC Piping Systems.

O. Electric Heat Tracing: Refer to specification Section 23 21 13, HYDRONIC PIPING.

SPEC WRITER NOTE: Designer shall show handrails, ladders, and platforms required for maintenance of fluid coolers on drawings. The design shall comply with OSHA Standards. Coordinate with manufacturer's requirements for maintenance access.

P. Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:

1. Fan Guard: Removable fan discharge with a rigid framed screen guard, installed over the fan cylinder.
2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.
3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.
4. Platform: Galvanized steel with a bar grating floor.

SPEC WRITER NOTE: Specify discharge hood, if necessary, to increase leaving air velocity to avoid recirculation.

//Q. Discharge Hood: // Tapered // Straight// // Hot-dip galvanized steel, // stainless steel, //same as the casing with factory installed access door.//

SPEC WRITER NOTE: Forced draft closed circuit coolers will be used on projects requiring a cooler, installed indoors or outdoors and suitable to be operated in the winter.

2.4 FORCED DRAFT CLOSED CIRCUIT FLUID COOLER

A. Cooler shall be a factory assembled, forced draft, counter-flow type with a vertical discharge configuration.

DESIGNER NOTE: Use stainless steel for all principal panels and structural elements, hot and cold water basins, etc. for the High-Humidity locations listed in the VA HVAC Design Manual.

B. Casing: Heavy gage (minimum 16 gage) // Galvanized Steel // Stainless Steel // Fiberglass Reinforced Plastic (FRP) with UV inhibitors. //

//1. Galvanized Steel: Hot-dip galvanized steel complying with ASTM A653/A653M, and having G235 (Z700) coating. //

//2. Stainless Steel: ASTM A666, Type 304. //

//3. Fiberglass Reinforced Plastic: FRP with maximum flame spread rating of five according to ASTM E84 and with UV inhibitors. //

4. Fasteners: Zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.

5. Joints and Seams: Sealed watertight.

6. Welded Connections: Continuous and watertight.

C. Framing: //Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating. //Rolled or formed structural stainless steel conforming to ASTM A666, Type 304. //

D. Drift Eliminators: Same as fill material. Effectively trap water droplets entrained in discharge air stream and limit drift loss to less than 0.005 percent of the total water circulated. Sections shall be assembled into easily removable racks of the same material as the casing. Eliminators can be PVC neoprene honeycomb type.

E. Cold Water Collection Basin: Heavy gauge zinc-coated or hot-dip galvanized steel, same as the casing // stainless steel // FRP with UV inhibitors //. Overflow; drain not less than 50 mm (2-inches), and a 304 stainless steel strainer assembly with openings smaller than nozzle orifices and with built-in vortex baffling to prevent cavitation and air entrainment in the water basin circulating pump.

SPEC WRITER NOTE: On large systems (> 50 tons) or on systems requiring remote

level indication/alarm capability, provide electronic level control.

F. Collection Basin Water Level Control: // Mechanically operated bronze adjustable make-up water float valve. // Electronic operated with slow closing 120V solenoid valve and NEMA MG 1, Type 4x enclosure. Solid state controls with stainless steel electrode probes and relays factory wired to a terminal strip to provide control of makeup valve, low and high level alarms and output for shutoff of pump on low level//.

DESIGNER NOTE: Use copper or stainless steel tubes for the High-Humidity locations listed in the VA HVAC Design Manual.

G. Cooling Coil Sections: // Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication// Copper tube with stainless-steel sheet// // Stainless-steel tube and sheet//, tested at 2410 kPa (350 psig) air pressure under water. Slope tubes to permit free drainage of fluid. // Design and manufacture and test coils according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp. Design coil and casing housing section for easy removal of coil. Coil section shall be of the serpentine design type with coil tubing welded into service pipe connection header. Provide flanged piping connections suitable for field mounting on the vent, supply and return water lines to the coil.

H. Water Distribution System: Open gravity type or individual removable non-clogging spray nozzle type and specifically designed that each trough or spray nozzle extends the entire length of the cooling coil section to complete wetting of the cooling coil at all times. Construct water distribution system of hot-dip galvanized steel or Schedule 40 PVC. Provide corrosion resistant hangers and supports designed to resist movement during operation and shipment.

I. Cooler Water Distribution Circulating Pump: Close coupled bronze fitted centrifugal circulating pump with mechanical seal suitable for outdoor use, suction strainer, and flow balancing valve. Pump shall be completely piped to suction strainer and water distribution system, mounted to drain completely when tower basin is drained. Include a bleed line with valve between pump discharge and overflow pipe. For pump motor, see specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

J. Fans: Centrifugal double width, double inlet, forward curved blades, belt driven and statically and dynamically balanced at the factory after assembly. Hot-dip galvanized steel centrifugal fans belt driven by // single speed // variable speed // motor. The fan drive and moving parts shall be completely enclosed by removable hot-dip galvanized screens and panels complying with OSHA regulations. Fan shaft bearings of the self aligning, grease-lubricated ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 29 and 149 degrees C (minus 20 and plus 300 degrees F). Bearings designed for an L-10 life of // 40,000 // 50,000 // hours and with extended lubrication lines to an easily accessible location outside of the wet air stream. Provide access doors for inspection and cleaning.

K. Motors and Drives:

1. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration limits specified in specification Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
2. In addition to the requirements of specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC, the following shall apply:
   a. Motors: Totally enclosed or epoxy encapsulated NEMA MG 1. Protect fan, bearings, and appurtenances from damage by weather, corrosion, water spray and grit. Provide motors with severe duty rating with the rotor and stator protected with corrosion-inhibiting epoxy resin, double shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 29 and plus 149 degrees C (minus 20 and plus 300 degrees F), and an internal heater automatically energized when motor is de-energized. Provide an adjustable motor base or other suitable provision for adjusting belt tension.
   b. V Belt Drive: Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer’s standard. Belt drives shall be "V" type as specified in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Belt driven fan and motor shafts shall have taper-lock sheaves fabricated from corrosion resistant material.

c. Motor Controllers: Provide variable speed motors and controllers, if shown on drawings for cooling tower fans. See specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

d. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.

e. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

L. Fans with motors over 15 KW (20 HP) shall include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration. //Interface the vibration cut-out switch with the DDC control system to provide an alarm in the event the fans stop due to excessive vibration.//

SPEC WRITER NOTE: Delete paragraph M and N when winter operation is not required.

M. Electric Basin Heater: Furnish stainless steel electric immersion heater installed in a threaded coupling on the side of the basin and with watertight junction boxes mounted in the basin with sufficient capacity to maintain plus 4 degrees C (40 degrees F) water in the basin at ___degrees C (___degrees F) ambient. Provide a NEMA 250, // Type 3R // Type 4 // Type 4X// enclosure mounted on the side of each cooler cell with magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Provide a water-level probe to monitor cooler water level and de-energize the heater when the water reaches low-level set point. Provide a control-circuit transformer with primary and secondary side fuses, terminal blocks with numbered and color-coded wiring to match wiring diagram, Single-point, field-power connection to a // fused disconnect switch // nonfused disconnect switch // circuit breaker// and heater branch circuiting complying with NFPA 70. Provide a metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid tight conduit.

SPEC WRITER NOTE: Specify electric heat tracing if fluid cooler is specified independent of HVAC Piping Systems.

N. Electric Heat Tracing: Refer to specification Section 23 21 13, HYDRONIC PIPING.

SPEC WRITER NOTE: Designer shall show handrails, ladders, and platforms required for maintenance of fluid coolers on drawings. The design shall comply with OSHA Standards. Coordinate with manufacturer's requirements for maintenance access.

O. Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:

1. Fan Guard: Removable rigid framed screen guard, installed over the inlet side of the fan.
2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.
3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.
4. Platform: Galvanized steel with a bar grating floor.

SPEC WRITER NOTE: Specify discharge hood, if necessary, to increase leaving air velocity to avoid recirculation. Provide automatic control damper on cooling towers designed to operate in the winter.

//P. Discharge Hood: // Tapered // Straight// // Hot-dip galvanized steel, // stainless steel, //same as the casing with factory installed access door// and automatic control damper.//

SPEC WRITER NOTE: Specify sheet metal ducts, if fluid cooler is to be installed indoors.

//Q. Sheet Metal Ducts: Provide in specification Section 23 31 00, HVAC DUCTS AND CASINGS. //

2.5 CONTROL PANEL

A. Provide factory furnished control panel for each //cooling tower//fluid cooler//.

B. Control panel shall be a //factory pre-wired//field installed/wired// NEMA 250 Type 3 – Drip-proof type enclosure, containing:

1. Unfused disconnect switch.
2. Fan motor variable speed drives/motor starters.
3. Interlocks and relays.
4. Pilot lights and push buttons.
5. //Provide contacts for remote start/stop and for Engineering Control Center (ECC) interface //.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cooling tower according to equipment manufacturer's written instruction.

B. Install cooling towers plumb, level and anchored on structure provided. Coordinate steel structure with cooling tower mounting requirements. If installed on concrete base, refer to Section 03 30 00 CAST IN PLACE CONCRETE for concrete materials and installation requirements.

C. Install vibration controls according to manufacturer's recommendations.

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

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

F. Piping:

1. Install piping, including flanges or union adjacent to cooling towers to allow for service and maintenance.
2. Install flexible pipe connectors at connections to cooling towers mounted on vibration isolators.
3. Install shutoff/balancing valves at cooling tower inlet connections.
4. Install piping adjacent to cooling towers to allow service and maintenance.
5. Provide drain piping with valve at cooling tower drain connections and at low points in piping.
6. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.
7. Domestic Water Piping: Comply with applicable requirements in Section 22 11 00, FACILITY WATER DISTRIBUTION. Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
8. Supply and Return Piping: Comply with applicable requirements in Section 23 21 13, 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 // union // // flange // mechanical coupling // union, flange, or mechanical coupling //.

SPEC WRITER NOTE: Retain first paragraph below if external equalizer piping is required.

9. 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.

//10. Connect sheet metal ducts to inlet and outlet of liquid tower if installed indoor. Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS, for compliance with material and installation requirements. //

//G. Seismic Restraints: Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

H. Electrical Wiring: Install electrical devices, components and accessories furnished loose by manufacturer, including remote flow switches and variable frequency drives. Refer to Section 26 29 11 MOTOR CONTROLLERS.

3.2 FIELD QUALITY CONTROL

A. Provide the services of an independent testing and inspection agency to perform the field tests and inspections of non-CTI certified cooling towers, 700 kW (200 tons) and larger, according to // ASME PTC-23 "Performance Test Code on Cooling Tower Equipment" // Cooling Technology Institute ATC-105 for Cooling Towers // Cooling Technology Institute ATC-105C for Liquid Coolers.// Submit qualification of the independent testing agency to the COR two weeks prior to the inspection for approval.

B. If the cooling tower does not meet the specified performance, the Contractor shall make the tower corrections necessary to bring the tower into compliance with the specified performance including replacing the tower if necessary. Additional tests will be required until the tower meets the specified performance. Costs for the tower corrections or replacement, and tests shall be borne by the Contractor.

SPEC WRITER NOTE: Coordinate testing with the total building commissioning effort.

3.3 STARTUP AND TESTING

A. Provide the services of a factory-authorized and qualified representative to perform start up service.

B. Clean entire unit including basin.

C. Inspect field-assembled components and equipment installation, including piping and electrical connections.

D. Verify that accessories are properly installed.

E. Obtain and review performance curves and tables.

F. Perform startup checks, according to manufacturer's written instructions, and as noted below:

1. Check clearances for airflow and tower servicing.
2. Check for vibration isolation and structural support.
3. Verify fan rotation for correct direction and for vibration or binding and correct problems.
4. Adjust belts to proper alignment and tension.
5. Lubricate rotating parts and bearings.

SPEC WRITER NOTE: Retain first paragraph below for towers with gear drives.

6. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
7. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
8. Check vibration switch setting. Verify operation.
9. Verify operation of basin heater and control.
10. Operate equipment controls and safeties.
11. Verify that tower discharge is high enough and it does not recirculate into HVAC air intakes. Recommend corrective action.

G. Adjust water level for operating level and balance condenser water flow to each tower inlet.

H. Check water treatment water system, including blow down for proper operation of the tower. Refer to Specification Section 23 25 00 HVAC WATER TREATMENT. Check makeup water-level control and valve.

I. Start cooling tower, including condenser water pumps and verify the tower operation.

J. Prepare and submit a written report of startup and inspection service to the COR.

K Replace defective and malfunctioning units.

SPEC WRITER NOTE: Coordinate training with the total building commissioning process.

3.4 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.5 DEMONSTRATION AND TRAINING

A. Provide the services of a competent, factory-trained engineer or technician for a 3-hour period for instructing VA personnel in operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the COR. Coordinate this training with that of the chiller, if furnished together.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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