# SECTION 23 65 00

# COOLING TOWERS

**BASED ON DFD MASTER SPECIFICATION DATED 05/08/2020**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

# P A R T 1 - G E N E R A L

## SCOPE

This section includes specifications for factory assembled cooling towers and accessories. Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference

Reference Standards

Quality Assurance

Shop Drawings

Operation and Maintenance Data

Design Criteria

Warranty

PART 2 - PRODUCTS

Induced Draft Crossflow Cooling Tower

Induced Draft Counterflow Cooling Tower

Forced Draft Counterflow Cooling Tower

Fiberglass Cooling Tower

Electric Basin Heaters

Remote Cooling Tower Sumps

PART 3 - EXECUTION

Installation

Start-Up

Construction Verification Items

Functional Performance Testing

Agency Training

## RELATED WORK

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 23 05 48 – Supports and Anchors

Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

Section 23 05 48 – Vibration Isolation

Section 23 08 00 – Commissioning of HVAC

Section 23 25 00 - HVAC Water Treatment

Section 23 05 14 - Variable Frequency Drives

## REFERENCE

Applicable provisions of Division 1 shall govern work under this Section.

## REFERENCE STANDARDS

ANSI/AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings.

ANSI/AFBMA 11 Load Ratings and Fatigue Life for Roller Bearings.

ASTM E-84 Test Method for Surface Burning Characteristics of Building Materials.

ASTM D-3299 Standard Specification for filament wound glass fiber reinforced thermoset resin

chemical resistant tanks

ASTM D-4097 Standard Specification for contact molded glass fiber reinforced thermoset resin

chemical resistant tanks.

CTI ATC-105 Cooling Tower Institute - Acceptance Test Code for Water Cooling Towers.

## QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutes.

## SHOP DRAWINGS

Refer to Division 1, General Conditions, and Submittals.

Submit shop drawings including the following information:

* Cooling tower capacity and statement indicating that the capacity is CTI certified.
* Cooling tower water quality parameters for the proposed cooling tower.

Be aware that the tower supplier is required to provide one set of approved shop drawings to the chemical treatment supplier so that the chemical treatment supplier has documentation for the water quality parameters for the tower. Verify (during shop drawing review) that this information is included in the cooling tower submittals.

* Suggested structural supports including dimensions, sizes and locations for mounting bolt holes.
* Product data indicating dimensions, weights and point loading, accessories, required clearances, electrical requirements and wiring diagrams and locations and size of field connections.
* [Performance data for future operating conditions (if scheduled) along with written description of required modifications to the tower to achieve the future capacity.]
* Performance curve plotting leaving water temperature against wet bulb temperature.
* Manufacturer’s installation instructions, operation data, start-up instructions, maintenance data, parts lists, controls, accessories and maintenance data.
* [Discharge and inlet sound data for each octave band under full load operating conditions]

If the tower is in a potentially noise sensitive situation, then schedule maximum allowable tower sound data on the drawings or in these specs.

Provide one copy of the approved shop drawings to the chemical treatment system supplier (section 23 25 00).

## OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

Delete the following if there are no additional requirements.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. ***[A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]***

## DESIGN CRITERIA

Performance must be certified by the Cooling Tower Institute in accordance with CTI certification standard STD-201.

Tower must meet scheduled performance for the installation indicated on the drawings. [The entire tower structure, mechanical drive system, fill, etc. must be capable of the future operating conditions scheduled with only the following modifications:

* [List future modifications here]

list all future modifications to the tower needed to achieve the future operating capacity (if applicable).

Tower shall be capable of handling inlet water up to 120 [135] degrees F.

Specify 135 degrees F only if water above 120 degrees F may be circulated through the tower.

Tower must be suitable for used with the following water quality:

* [List the cooling tower water quality parameters here.]

This information should be included if extreme water conditions are anticipated or if water related problems have previously be encountered at the building. Specify tower materials that are compatible with the water conditions.

## WARRANTY

Warranty fans, shafts, bearings, mechanical equipment support and motor(s) for 5 years from startup. Warranty the remainder of the tower for 1 year from startup.

[Warranty the remote sump for 5 years from startup.]

# P A R T 2 - P R O D U C T S

Select cooling tower performance to provide energy efficient operation and where needed, low noise operation. All Cooling Towers scheduled must exceed the following minimum performance standards which are based on ASHRAE standard 90.1, 2004. Typical tower selections far exceed these minimum requirements. This table is information to the AE and should be edited from the bidding spec.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Equipment Type*** | ***Total System Heat Rejection Capacity at Rated Conditions*** | ***Subcategory or Rating Condition*** | ***Performance Required 7a*** | ***Test Procedureb*** |
| ***Propeller or Axial Fan Cooling Towers*** | ***All*** | ***95°F Entering Water***  ***85°F Leaving Water***  ***75°F wb Outdoor air*** | ***≥38.2 gpm/hp*** | ***CTI ATC-105***  ***And***  ***CTI STD-201*** |
| ***Centrifugal Fan Cooling Towers*** | ***All*** | ***95°F Entering Water***  ***85°F Leaving Water***  ***75°F wb Outdoor air*** | ***≥20 gpm/hp*** | ***CTI ATC-105***  ***And***  ***CTI STD-201*** |
| ***a: For purposes of this table, cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.*** | | | | |
| ***b: ASHRAE Standard 90.1-2004 Section, 12 contains a compete specification of the reference test procedure. Including the referenced year version of the test procedure.*** | | | | |

## INDUCED DRAFT CROSSFLOW COOLING TOWERS

Manufacturers: Baltimore Air Coil or Marley.

Towers are available with optional stainless steel cold water basin and/or optional stainless steel hot water basin. The towers are also available with optional stainless steel construction of all steel panels and structural elements including structural frame, louver supports, cold water basin, hot water basin, fan deck and mechanical equipment supports. Edit these specifications accordingly. For most applications use galvanized construction with stainless hot and cold water basins. Counterflow type towers are not an equal substitution during or after bidding.

Construct framework of G235 galvanized steel angles and channels. Construct casing of FRP (fiberglass reinforced polyester) or galvanized steel panels. The cooling tower must be suitable to resist wind loads up to 30 psf.

The hot water distribution basin shall be 304 stainless steel open gravity type with removable, interchangeable plastic metering orifices to provide even water distribution over the full fill area by gravity flow. Each tower cell shall have a single inlet connection and include flow balancing devices for each distribution basin. Provide removable stainless steel hot water basin covers. Design the fan deck and hot water basin covers for 50 psf live load or a 200 pound concentrated load.

Construct the fill material and drift eliminators of PVC with a maximum flame spread rating of 25 per ASTM E84. The drift eliminators shall limit drift losses to not more than 0.005% of the design water flow rate.

Construct the cold water basin of 304 stainless steel. Bottom shall slope towards a depressed section with side outlet connection, side overflow connection and side drain connection. Provide stainless steel strainer and anti-vortex hood.

Modify the above paragraph if bottom outlet connection is desired

Provide fiberglass reinforced polyester inlet louvers spaced to minimize water splash out.

Provide vertical discharge, axial flow fixed or adjustable pitch, prop fan with aluminum alloy blades, welded G-235 galvanized steel or molded FRP fan cylinder, galvanized steel wire guard, and self-aligning grease packed ball bearings designed for minimum L10 life of 40,000 hours. Provide extended grease lines from each fan shaft bearing to the outside of the tower. Drive shall be belt drive with cast aluminum sheaves or gear driven with right angle, oil lubricated, geared speed reducer. Extend oil gauge line and oil drain line to outside of tower casing with a means to read the gearbox oil level (for gear driven fans).

Apply a zinc rich primer to all cut edges of all galvanized steel components prior to assembly.

Factory installed make-up water assembly consisting of float, mechanical linkage and brass make up valve.

Motor: Premium efficiency totally enclosed air over (TEAO) or totally enclosed fan cooled (TEFC) type with special moisture protection, mounted on welded steel frame in fan deck. Refer also to Section 23 05 13 for additional requirements. [Motor is to be suitable for use with a variable frequency drive specified in Section 23 05 14 - Variable Frequency Drives.]

Coordinate motor power requirements with the electrical consultant. If capacity reduction is needed, then use a VFD on the tower fan. Do not use two speed motors for cooling tower fans.

Provide Hinged access doors at both sides of tower for access to all internal components.

Provide a walking surface on the top of the tower including a galvanized steel handrail with knee rail and toe board. Provide a ladder, attached to the tower, from 12” above the roof or ground to the top of the tower. [Include a galvanized steel safety cage around the ladder from 7’-0” above the roof or ground to the top of the handrail on the fan deck.] The walking surface, handrail and ladder assembly must comply with OSHA guidelines.

Include the safety cage only if the tower deck is 20’-0” or more above the roof or ground. OSHA requires a safety cage on ladders 20’ or taller. If the tower has a single air inlet similar to, BAC 1500 or Marley AV series, then delete the above paragraph and include the following paragraph.

[Provide an external service platform the full width of the tower including handrails, knee rails and a ladder attached to the tower and extending to 12” above the roof or ground. Position the platform to provide access to the water distribution system. [Include a galvanized steel safety cage around the ladder from 7’-0” above the roof or ground to the top of the surface platform handrail.] The platform, handrail and ladder assembly must comply with OSHA guidelines.

Include the safety cage only if the service platform is 20’-0” or more above the roof or ground. OSHA requires a safety cage on ladders 20’ or taller.

[Provide a permanent, factory installed, galvanized, internal service platform inside the tower air plenum to provide service access to fan, drive and motor assembly. Include permanent ladder and railings]

Include the above paragraph if the internal moving parts of the tower are not within reasonable reach from the cold water basin for maintenance and repair work.

## INDUCED DRAFT COUNTER FLOW COOLING TOWERS

Manufacturers: Evapco or Marley.

Towers are available with optional stainless steel hot water basin. The towers are also available with optional stainless steel construction of all steel panels and structural elements including structural frame, louver supports, cold water basin, fan deck and mechanical equipment supports. Edit these specifications accordingly.

Construct framework and casing of [G235 galvanized][304 stainless] steel angles and channels. Design the cooling tower to resist wind loads up to 30 psf.

The hot water distribution shall be internal and all plastic consisting of schedule 40 PVC headers and branch arms. Polypropylene, nonclogging, replaceable hot water distribution nozzles. The hot water connection shall be located outside the tower and shall accept a 125# flange. Design the fan deck for 50psf live load or a 200 pound concentrated load.

Provide fill material constructed of cellular film made of PVC supported by [G-235 galvanized][304 stainless] steel girts. The drift eliminators shall be constructed of PVC and limit drift losses to not more than 0.005% of the design water flow rate.

Construct the cold water basin of [G-235 galvanized steel][304 stainless steel]. Bottom shall slope towards a depressed section with outlet connection, overflow connection and drain connection. Provide stainless steel strainer and anti-vortex hood.

Provide cellular PVC inlet louvers to minimize water splash out.

Provide vertical discharge axial flow fixed or adjustable pitch prop fan with aluminum alloy blades, welded [G-235 galvanized][stainless] steel or molded FRP fan cylinder, [G-235 galvanized steel][stainless steel] wire guard, cast aluminum sheaves and self-aligning grease packed ball bearings designed for minimum L10 life of 40,000 hours. Provide extended grease lines from each fan shaft bearing to the outside of the tower. Drive shall be belt drive with cast aluminum sheaves or gear driven with right angle, oil lubricate, geared speed reducer. Extend oil gauge line and oil drain line to outside of tower casing with a means to read the gearbox oil level (for gear driven fans).

[Apply a zinc rich primer to all cut edges of all galvanized steel components prior to assembly.]

Delete the above sentence if an all stainless steel tower is specified.

Factory installed make-up water assembly consisting of float, mechanical linkage and brass make up valve.

Motor: Premium efficiency totally enclosed air over (TEAO) type or totally enclosed fan cooled (TEFC) with special moisture protection, mounted on [galvanized][stainless] steel frame in fan deck or supported on outside of tower. Refer also to Section 23 05 13 for additional requirements. [Motor is to be suitable for use with a variable frequency drive specified in Section 23 05 14 - Variable Frequency Drives.]

Coordinate motor power requirements with the electrical consultant. If capacity reduction is needed, then use a VFD on the tower fan. Do not use two speed motors for cooling tower fans.

Provide an access door for entry into the mechanical equipment area above the fill. Include an interior fold down panel to create a working platform in the mechanical equipment area. Also provide an access door to access the cold water basin and associated accessories and/or provide easily removable inlet louver sections to provide access to the cold water basin.

Provide an access platform, with handrails and knee rails, at the level of the upper access door for access to the mechanical equipment. Construct platform of galvanized steel and include an aluminum ladder attached to the tower and extending down to 12” above the roof or ground. [Include a galvanized steel safety cage around the ladder from 7’-0” above the roof or ground to the top of the platform handrail.]

Include the safety cage only if the platform is 20’-0” or more above the roof or ground. OSHA requires a safety cage on ladders 20’or taller.

## FORCE DRAFT COUNTERFLOW COOLING TOWERS

Manufacturers: Baltimore Air Coil or Evapco.

This type of tower is available with stainless steel construction for various components. If you are specifying stainless, then supplement and modify this specification accordingly based on what level of stainless construction is available from the manufacturers and with what is intended.

Construct the pan/fan section and tower casing of G-235 galvanized steel. Locate the fans and motor(s) in the dry entering airstream. Provide gasketed circular access doors on both ends of tower to permit inspection and servicing of tower sump

The hot water distribution shall be internal and all plastic consisting of schedule 40 PVC headers and branch arms. ABS non-clogging spray nozzles. The hot water connection shall be steel, located outside the tower, and shall accept a 125# flange.

The fill material shall be made of PVC and be encased in galvanized steel panels. Fill shall have a flame spread rating of 5 per ASTM E84.

Drift eliminators shall be constructed of PVC and limit drift losses to not more than 0.002% of the design water flow rate.

Fans shall be forward curved, centrifugal type, constructed of galvanized steel, statically and dynamically balanced to be free from vibration. Solid steel shafts, minimum L10 life of 40,000 hours self-aligning bearing with cast iron housings. V-belt type fan drives designed for 150% of the motor horsepower. The entire fan /motor assembly shall be protected by a removable galvanized steel wire screen. Provide extended grease lines each fan shaft bearing to permit lubrication without removing protective screens.

Motor: Premium efficiency totally enclosed air over (TEAO) type or totally enclosed fan cooled (TEFC) with special moisture protection, mounted on an adjustable base. Refer also to Section 23 05 13 for additional requirements. [Motor is to be suitable for use with a variable frequency drive specified in Section 23 05 14 -Variable Frequency Drives.]

Coordinate motor power requirements with the electrical consultant. If capacity reduction is needed, then use a VFD on the tower fan. Do not use two speed motors for cooling tower fans.

Apply a zinc rich primer to all cut edges of all galvanized steel components prior to assembly.

Factory installed make-up water assembly consisting of float; mechanical linkage and brass make up valve.

[Provide a galvanized steel tapered discharge hood equipped with access panels. Hood should be configured to reduce discharge air recirculation. Submitted tower performance shall include the effects of the discharge hood.]

Determine the need for a discharge hood with the product representative based on the site conditions.

Tower(s) shall be disassembled into fewest number of components practicable for ease of handling during shipping and rigging.

## FIBERGLASS COOLING TOWERS

Typically, steel towers are used on DFD projects. If there is a special need for a fiberglass tower, then consult with DFD engineer prior to specifying fiberglass cooling tower. The configuration of fiberglass cooling towers varies from manufacturer to manufacturer. The space requirements, heights, air and water flow arrangements, mechanical systems, and service access requirements are completely different for each type of tower. Only certain towers or a certain tower may be compatible with a specific installation situation. Modify this specification to reflect only those towers that are compatible with the installation.

Manufacturers: Ceramic Cooling Tower Company, Evapco, Marley or Tower Tech

Tower shall be counterflow induced draft, counterflow forced draft or crossflow induced draft.

The entire structure (except for mechanical supports) shall be factory assembled and constructed of fiberglass (FRP) with a fire retardant polyester resin system and designed for 30 psf wind load.

The hot water distribution shall be internal and all plastic consisting of schedule 40 PVC headers and branch arms with polypropylene, ABS, or rotary polypropylene nozzles. Or it shall be open gravity type constructed of FRP with removable/interchangeable polypropylene nozzles. Gravity hot water basins shall have removable FRP covers. The hot water connection shall be located outside the tower and shall accept a 125# flange.

Provide cellular film type fill constructed of PVC and supported by stainless steel or FRP structural members. The PVC shall conform to ASTM D1784, Type 1, Grade 1, with a flame spread rating of 15 or less per ASTM E84. The drift eliminators shall be constructed of PVC with inhibitors to prevent damage from UV light and limit drift losses to not more than 0.005% of the design water flow rate.

Construct the cold water basin of FRP with a depressed section with outlet connection, overflow connection and drain connection. Provide stainless steel strainer and anti-vortex hood.

For induced draft type towers provide PVC cellular inlet louvers to minimize water splash out.

Provide axial flow fixed or adjustable pitch prop fan with aluminum alloy blades and stainless steel or rubber coated wire guard. Provide extended grease lines from each fan shaft bearing to the outside of the tower. Drive shall be direct drive, belt drive with cast aluminum sheaves or gear driven with right angle, oil lubricated, geared speed reducer. Extend oil gauge line and oil drain line to outside of tower casing with a means to read the gearbox oil level (for gear driven fans).

Factory installed make-up water assembly consisting of float, mechanical linkage and brass make up valve.

Nuts, bolts, and washers shall be stainless steel

Motor(s): Premium efficiency totally enclosed air over (TEAO) type or totally enclosed fan cooled (TEFC) with special moisture protection, mounted on stainless steel frame in fan deck or supported on outside of tower. Towers with multiple fans and motors per cell that do not exceed 7.5 hp may be direct drive single speed motors. Refer also to Section 23 05 13 for additional requirements. [Motor is to be suitable for use with a variable frequency drive specified in Section 23 05 14 - Variable Frequency Drives.]

Coordinate motor power requirements with the electrical consultant. If capacity reduction is needed, then use a VFD on the tower fan. Do not use two speed motors for cooling tower fans.

On induced draft type towers provide an access door for entry into the mechanical equipment area (above the fill in crossflow type towers). Include an interior fold down panel to create a working platform in the mechanical equipment area. Also provide an access door to access the cold water basin and associated accessories and/or provide easily removable inlet louver sections to provide access to the cold water basin.

On induced draft counterflow towers provide a permanent, factory installed, galvanized, internal service platform inside the tower air plenum to provide service access to fan, drive and motor assembly. Include permanent ladder and railings.

Include the above paragraph if the internal moving parts of the tower are not within reasonable reach from the cold water basin for maintenance and repair work.

Any tower that requires access to its top for any maintenance, inspection, cleaning or part replacement shall be provided with walking surfaces or platforms, safety handrails and ladder in accordance with OSHA requirements.

A blow through arrangement with direct driven propeller fans and a water collection system directly below the fill and above the fans, as provided by Tower Tech, will be acceptable.

Extended grease lines are not required for fans located outside of the tower housing and within five feet of the roof or ground.

## ELECTRIC BASIN HEATERS

Provide electric immersion heater system with controls for each cooling tower. Heater system shall consist of stainless steel immersion heater(s) installed in threaded couplings provided in the side of the basin. A magnetic contactor to energize heaters, transformer to provide 24v control power and controls for temperature control and low water cutoff. Include a probe mounted in the basin to monitor water temperature and water level.

Determine appropriate sump water design temperature and design ambient temperatures and schedule heating capacity accordingly. Coordinate the electrical requirements with the electrical consultant. Heaters will not be needed on most projects. Consult with DFD engineering personnel to determine if heaters are appropriate.

## REMOTE COOLING TOWER SUMPS

If any type of remote sump is used then edit the above cooling tower specifications accordingly to modify the tower basins, water level controls, etc. to reflect the use of a remote sump. The consultant must design the remote sump, and associated accessories, and clearly indicate on the drawings specifically what is to be provided. The remote sump tank design should address the potential problems associated with remote sumps such as water level height and draw down, pump suction head, vortexing at tank water outlet and air entrainment due to tank water inlet position. Provide input to cast in place concrete sump design to include all features needed for the hvac design. If extreme water quality conditions are anticipated, then modify this specification accordingly to include materials that will hold up to the water.

[A concrete sump is being provide by others as indicated on the drawings.]

[Provide a remote sump tank, as configured on the drawings, constructed of glass fiber reinforced plastic. Construct tank to comply with ASTM D3299 or ASTM D4097.][Provide a remote sump tank as configured on the drawings, constructed of welded structural grade steel with factory applied 6 mil thick epoxy resin lining applied to sandblasted white metal surface. Exterior of tank to be primed and painted with oil based enamel.] The tank must be suitable for cooling tower water from 40 degrees F to 130 degrees F. Tank shall be totally enclosed and vented to atmosphere. Include a minimum 11”x15” elliptical manhole for access to interior of tank and to access makeup water valve. Provide brass makeup water valve with adjustable float and anti vortexing hood and or partitions to prevent air entrainment. Tank shall be furnished with integral supports and integral connections for inlet, outlet, drain, overflow, makeup water, and gauge glass. Provide gauge glass with shutoff valves.

# P A R T 3 - E X E C U T I O N

## INSTALLATION

Install in accordance with manufacturer’s instructions maintaining all required clearances.

Install tower on the structure as shown on the plans. Coordinate the tower support requirements with the structural support being provided. If a tower is provided that is significantly different than what is indicated on the drawings, then the contractor is responsible for any and all additional costs to provide and/or modify the structure support for the tower.

Modify the above paragraph to suit the situation. I.E. is it an existing structure, a new structure, steel, concrete, etc. Coordinate the structural base requirements with the structural design. Coordinate and clearly identify who is furnishing and installing structural supports for the tower. Clearly indicate specifically where, on the structure or supports, the responsibility changes from one contractor to another.

Connect all piping including condenser water supply and return, make-up water, overflow and drain piping as indicated on the drawings.

It is the responsibility of the consultant that the overall system design provides for enough elevation change between the tower and the pump inlet to ensure that there will be sufficient net positive suction head at the pump inlet. Do not locate a strainer between the tower outlet and the pump inlet unless there is sufficient elevation change available.

[Provide vibration isolators and flexible connectors as indicated in section 23 05 48.]

Determine if vibration isolation is needed. Clearly indicate on the drawings and incorporate into the design if vibration isolation is required. It may not be needed if the tower is located on grade. Edit section 23 05 48 accordingly.

Coordinate with Division 26 00 00 - Electrical for installation and wiring of new motor(s).

This contractor is responsible for revisions and/or additions to power wiring, starters, disconnects, breakers and additional wiring necessary for any motor or motors that are different from what is scheduled.

[Install internal sump tank on a concrete pad. Connect all piping as indicated on the drawings.]

## START-UP

Inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturers recommendations.

## CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

## FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 23 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01 or 01 91 02

## AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION