236500 PACKAGED COOLING TOWERS

Part 1 – GENERAL

1.1 Description

A. This section details the guidelines and expectations for the design and installation of packaged cooling towers and supporting equipment. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification and approval from the JHFRE Engineering and Energy Department, it is expected that these guidelines will govern the design and specifications.

1.2 Submittals

A. Specify a cooling tower (crossflow, counter-flow, induced draft, etc.) suitable for the proposed application/project requirements. The total heat rejection, project budget, space limitations and noise restrictions associated with the application shall be considered.

1.3 Quality Assurance

A. All cooling towers shall be certified by the Cooling Tower Institute (CTI). These towers shall be tested, rated, and certified in accordance with CTI Standards, shall bear the CTI certification label, and shall be listed in the CTI directory of certified cooling towers.

1. CTI certification shall be at the specified heat rejection capacity and ambient design conditions associated with the project.

B. Variable speed drive and indoor sumps shall be analyzed on all systems.

C. Forced draft cooling towers are to be used only as an exception and must be approved in advance by JHFRE.

D. Each cooling tower cell shall be capable of independent operation and supplied with individual makeup, drain, and overflow connections.

Part 2 – PRODUCTS

2.1 List of acceptable manufacturers:

A. Baltimore Air Coil

B. Delta Cooling Towers

C. Marley

D. Trane

2.2 Materials: The choice between FRP or Metal or PVC shall be approved by the owner based on the application.

A. Fiberglass Reinforced Polyester (FRP) shall be used in applications where there are components in the water that are highly corrosive to metal. FRP with maximum flame spread rating of five according to ASTM E84.

B. Acceptable Metals to be used:

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

2. Stainless Steel: ASTM A666, Type 304 or 316.

C. Polyvinyl chloride (PVC) shall be used in applications where there are corrosive materials in the water.

2.3 Fasteners shall be zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.

2.4 All cooling tower joints and seams shall be sealed and watertight. All welded connections shall be continuous and watertight. Cooling tower inlet and outlet connections shall be Class 150 flange.

2.5 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.

2.6 Louvers: Minimum splash out type. Material shall be similar to the casing or may be FRP or PVC if formed integral with the fill material. PVC air-intake louvers shall contain UV inhibitors to protect against UV radiation and shall be designed to prevent water from splashing out of the tower during all modes of operation (including operation with fans off). Removable air-intake screens shall be constructed of stainless-steel wire mesh and designed to prohibit large objects and debris from entering the tower. 25 mm (1”) inlet screen, hot-dipped/galvanized steel or copper/stainless-steel. Attach the screen securely to air intakes.

2.7 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.

2.8 Drift Eliminators: Same as fill material. Eliminators shall ensure a maximum drift rate of 0.001% of recirculated water. Eliminate the combustible materials when cooling tower is located 40’ or closer to hazards such as chimneys and incinerators or when roof mounted.

2.9 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 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.

2.10 Collecting Basin: Material same as the unit casing or concrete in accordance with manufacturer's standard details. Outlet pump may also be of heavy glass-reinforced polyester (GRP) for depressed side outlet type. Provide a bronze make-up water float valve, overflow, drain not less than 2" suction connections, and outlet sump of size and depth to prevent cavitation and air entrapment in pump. Basins shall have adequate depth to provide even distribution over the entire fill area throughout the full flow range indicated. Provide the following accessories:

A. Manufacturer's standard bronze make up water float valve with an adjustable linkage, electric float switch and a solenoid operated make-up valve.

B. Removable basin strainer, constructed of 304 stainless-steel, shall have openings smaller than nozzle orifices.

C. Make-up water, overflow and drain connections.

D. Equalizer connection (multiple cooling tower systems).

E. Flume plate between adjacent cells (multi-cell units only).

F. Stainless-steel basins shall be welded and include a 5-year leak warranty.

G. Basin covers comprised of matching material and secured to the tower by stainless steel hardware.

H. Installation/extraction tools shall be supplied with the cooling tower if necessary for nozzle removal.

I. Basin partitions (weirs) shall be provided if necessary to maintain adequate distribution.

2.11 Fans, Motors and Drives: Centrifugal or propeller type constructed of hot-dip galvanized steel, cast aluminum or aluminum alloy, glass fiber reinforced polyester or glass-reinforced epoxy, statically and dynamically balanced at factory for quiet and efficient operation. Forced-draft towers shall be centrifugal type only. Fans for induced-draft towers of 350 kW (100 tons) and less, and for forced draft towers shall be belt driven.

A. For induced draft towers larger than 350 kW (100 tons), fan shall be driven through a gear reducer, or driven by a special V belt.

B. 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.

C. Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt.

D. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance.

E. Motors and Motor Controllers: Evaluate variable speed motors and controllers.

2.12 Belt Drive:

A. Type: ANSI standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.

B. Dimensions, rating and selection standards: ANSI IP-20 and IP-21.

C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI service factor (not less than 20%) in addition to the ANSI allowances for pitch diameter, center distance, and arc of contact.

D. Maximum Speed: 25 m/s (5000 feet per minute).

E. Adjustment Provisions: For alignment and ANSI standard allowances for install and take-up.

F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.

G. Multiple Belts: Matched to ANSI specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.

H. Sheaves and Pulleys:

1. Material: Pressed steel, or close-grained cast iron. Induced draft units shall use aluminum sheaves due to corrosion potential.

2. Bore: Fixed or bushing type for securing to shaft with keys.

3. Balanced: Statically and dynamically.

4. Groove spacing for driving and driven pulleys shall be the same.

5. Minimum Diameter of V-Belt Sheaves (ANSI recommendations) in millimeters and inches:

Fractional Horsepower		Standard		High Capacity	
Cross Section	Min. OD mm (in)	Cross Section	Min. OD mm (in)	Cross Section	Min. OD mm (in)
2L	20 (0.8)	A	83 (3.25)	3V	67 (2.65)
3L	38 (1.5)	B	146 (5.75)	4V	180 (7.10)
4L	64 (2.5)	C	239 (9.40)	5V	318 (12.50)
5L	89 (3.5)	D	345 (13.60)		
		E	554 1.80)		

I. Drive Types, Based on ARI 435:

1. Provide adjustable-pitch or fixed-pitch drive as follows:

a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.

b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.

2. Provide fixed-pitch drives for drives larger than those listed above.

3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

2.13 Drive Guard:

A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor.

B. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.

C. Access for Speed Measurement: 25 mm (1”) diameter hole at each shaft center.

2.14 Electric Motors:

A. Provide special energy efficient motors as scheduled. Unless otherwise specified for a particular application use electric motors with the following requirements.

B. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. Provide a time-delay (20 seconds minimum) relay for switching from high to low speed.

D. Rating: Continuous duty at 100% capacity in an ambient temperature of 104° F (40° C); minimum horsepower as shown on drawings; maximum horsepower in normal operation not to exceed nameplate rating without service factor.

E. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

2.15 Variable Speed Motor Controllers:

A. The combination of controller and motor shall be sized as per the respective manufacturer's recommendations, and shall be rated for 100% output performance.

B. Each cooling tower fan shall be equipped with a dedicated variable frequency drive. Fan speed control shall be based upon the intended control approach (such as head pressure control or leaving water temperature).

1. Cooling towers installed without redundancy (<N+1) shall be specified with VFDs containing a manual three-contactor bypass circuit.

2. Variable frequency drives and motors shall be capable of reversing operation for use in defrosting the cooling tower.

a. Cooling towers shall be equipped with defrost systems where the possibility of freezing exists. Cooling towers shall be capable of operating at low ambient temperatures (design point shall be 0°F or 5°F less than ASHRAE 99.6 condition) whichever is less.

3. Cooling tower fan motor service disconnects shall have line of sight to tower fan motors (between the motor and the VFD) and disconnects that are not within line of sight of the VFDs need to be electrically interlocked with the VFD so that the VFD cannot be energized when the service disconnect switch is open.

C. Motors shall be energy efficient type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch C. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system. In addition to the requirements, the following shall apply:

1. Motors: Totally enclosed, epoxy encapsulated or totally enclosed fan cooled (TEFC) conforming to NEMA 250.

2. No remote lubrication fittings are allowed.

3. Fans over 60” in diameter 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 and be accessible from the exterior of the tower.

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

A. Fan Guard: Removable fan discharge with a rigid framed screen guard, installed over the fan cylinder.

B. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 12’ shall have safety cage. Ladders shall extend to within 1’ of the grade or the roof deck surface.

C. Hand Railing: Steel or aluminum hand railings not less than 42” high around perimeter of each fan-deck, or working surface 12’ or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.

D. Platform: Galvanized steel with a bar-grating floor. The platform shall be continuous and on all sides of the tower.

E. Catwalk: There shall be a galvanized catwalk inside of the cooling tower. It shall be located in such a location to ease access to service bearings, belts, motors.

2.17 Electric Basin Heater: Provide electric immersion heater with water-tight junction boxes mounted in the basin with sufficient capacity to maintain 40° F water in the basin. Heater shall be complete with control panel (NEMA 250, Type 4) field mounted on the exterior of the cooling tower and low water level heater protection (heaters shall automatically de-energize when the basin water-level reaches the low-level set point).

2.18 Electric Heat: Tracing during winter operation shall be provided by either manufacturer or installer. This shall include all outdoor piping and valves.

2.19 Cooling towers shall be provided with access doors (one on each end) large enough for personnel to access cooling tower internal components. Doors shall be operable from both inside and outside of the cooling tower.

2.20 Make-Up Water

A. For cooling towers that have makeup water connections at each tower, use an electronic water-level controller (NEMA 250, Type 4 enclosure) with a slow-acting solenoid makeup valve shall be supplied for each collection basin. The water-level controller shall be installed in a stainless-steel stilling chamber and be provided with both low and high-level auxiliary contacts.

B. Bubbler water level sensors are preferred for cooling towers with concrete sumps. For cooling towers that utilize a makeup water source in the suction line of the condenser pumps or other common location, use a bubbler water level sensor. This sensor shall be located in a standpipe on the common

pipe of the cooling towers and shall be the makeup water controller for designs feeding CHW makeup water to the suction of the CHW pumps. The equalizer line shall have a manual isolation valve.

C. Chilled/condenser water systems shall be fed from two diverse sources for reliability in case of failures, additions and deletions of loads; and maintenance issues. The chilled/condenser water sources can range from two chilled/condenser water plants to two different piping main sources.

D. The water source for makeup shall NOT be reclaimed rainwater.

Part 3 – EXECUTION

3.1 Provide permanent rigging, hoist beams, rollers, cranes, and similar devices as necessary to help facilitate future maintenance. This is important in such areas as motor and fan blade removal. If mounted outdoors such equipment shall be galvanized.

A. The contractor shall coordinate with cooling tower manufacturers to ensure that a system meeting the above requirements is provided. If cooling tower manufacturer is unable to provide equipment that meets these requirements, a system of this nature shall be installed by the contractor in the field. Field-erected systems shall not physically inhibit the replacement of the towers they serve.

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

3.3 Install cooling towers plumb, level and anchored on structure provided. Coordinate steel structure with cooling tower-mounting requirements.

3.4 Install vibration controls according to manufacturer's recommendations.

3.5 Maintain recommended clearances for service and maintenance.

3.6 Piping:

A. Install piping, including flanges or union adjacent to cooling towers to allow for service and maintenance.

B. Install flexible pipe connectors at connections to cooling towers mounted on vibration isolators.

C. Valves

1. Install shutoff/balancing valves at cooling tower inlet connections.

2. Heavy-duty, industrial grade balancing valves shall be provided for each hot water distribution basin. Valves shall be disc-type, with machined cast iron bodies and suitable for both balancing and isolation of each cooling tower cell.

3. Every tower needs to have a motorized isolation valve on the CWR and CWS, lines. A manual valve may be required if the motorized valve does not have a manual override.

D. Connect overflow drain and blow down lines to sanitary sewage system. Blow-down valves shall be full-port ball valves, and shall be heat traced with self-regulating heat tape.

E. Connect sheet metal ducts to inlet and outlet of liquid coolers if installed indoors.

3.7 A protected domestic water source shall be provided within 50’ of each cooling tower for maintenance purposes. The protected domestic water source shall be lockable, drainable, freeze protected, adequately sized, and contain a manual valve-operated 1-1/2” threaded hose connection.

3.8 Sufficient lighting shall be provided to perform all cooling tower maintenance. Convenience receptacles shall also be provided at the towers. For lighting and receptacle requirements, consult JHFRE Standards Division 26.

3.9 Any Variable Frequency Drives connected to the cooling tower shall be installed indoors.

3.10 Start-up and Testing:

A. Provide the services of a factory-authorized and qualified representative to perform start up service. Proper start-up procedure for water treatment and basin conditioning shall be detailed in the Contract Specifications and Contract Drawings.

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

C. Obtain and review performance curves and tables.

D. 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. Correct rotation if needed.

4. Adjust belts to proper alignment and tension.

5. Lubricate rotating parts.

6. Operate equipment controls and safeties.

7. Verify that tower discharge is high enough and it does not recirculate into air intake.

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

F. Check water treatment water system, including blow down for proper operation of the tower.

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