GRAND RIVER DAM AUTHORITY
UNIT NO. 1 UPGRADE
OPERATION AND MAINTENANCE MANUAL

1.0 TECHNICAL DATA

1.1 Cooling Tower Type

Mechanical Induced Draft Counterflow

1.2 Thermal Design Conditions

Number of Cells	14
Water Flow, GPM	189,000 *
Heat Load, Million BTU/hr.	2438.1
Range, °F	25.8
Approach, °F	7.5
Cold Water Outlet Temperature, °F	88.5
Ambient Dry Bulb Temperature, °F	99.0
Ambient Wet Bulb Temperature, °F	78.0
Design Inlet Wet Bulb Temperature, °F	81.0

1.3 Equipment Data

1.3.1 Fans

Number	14 (one new)
Manufacturer	Hudson
Type	APT 39.83 B8 Tuff Lite
Diameter	39'-10"
Number of Blades	8
Blade Pitch	8.5°
RPM	88

1.3.2 Gearboxes

Number	14 (two new)
Manufacturer	Amarillo
Type	Double Reduction
Model	1713 W
Ratio	20.45:1

* Note: Actual flow is 205,000 GPM

1.3.3 Motors

Number	14 (two new)
Manufacturer	Siemens
Type	RGZESD
Frame	47 TS
Speed	1760 RPM

1.3.4 Driveshaft/Coupling

Number	14
Manufacturer	Addax
Type	Carbon Fiber/Epoxy Composite
Model	CTC-700.1125

1.3.5 Fill

Manufacturer	Munters
Type	PVC 15, CF 19060 CPVC 15, CF 19060 (top layer)
Supports	7" x 4 " x .375 wall FRP beams

1.3.6 Drift Eliminator

Manufacturer	Brentwood
Material	PVC .025 in. sheet thickness
Model	DE080

2.0 COOLING TOWER DESCRIPTION

2.1 Tower Structures

The cooling tower is comprised of fourteen rectangular cells separated by cell partition walls.

The tower structure is of precast concrete construction consisting of the outer perimeter walls, the cell divider walls, the fan deck and a framework system of columns and beams which support the fan deck, the air moving equipment and the tower internals.

2.1.1 Tower Casing

The tower casing is composed of a series of vertical precast concrete double tees which are supported on a lower concrete beam (air inlet lintel) and which project above the fan deck to serve as an integral fan deck railing.

Openings are provided on the entire west side of the casing wall to serve as penetrations for the header nozzles of the water distribution system.

2.1.2 Partition Walls

The cell partition walls are carried by precast concrete beams. The partitions extend from 2 feet below the bottom of the fill to fan deck level.

2.1.3 Fan Deck

The fan deck is comprised of a number of precast concrete panels which join up with the fan stack.

A 2" to 3" reinforced concrete topping is applied over the entire tower fan deck to form an integral structural diaphragm.

The fan deck rests on a beaming system which is supported by the interior and exterior tower columns.

2.1.4 Fan Stack

The fan stack consists of four curved precast concrete elements which span self supporting, over the fan deck beam system and shape the fan opening. The connections between the four elements are grouted to attain a monolithic fan stack structure. Each stack permits a visual inspection of the air moving system through a viewport opening incorporated in one of the stack elements.

2.1.5 Windwall

A windwall consisting of precast double tee concrete panels is located at the center of the tower and extends longitudinally over the entire length of the tower. The windwall serves to control air distribution and water blowthrough during strong side wind conditions. Open spaces between the double tee elements are provided to avoid excessive dynamic pressure build ups.

2.1.6 Cold Water Basin

The cold water basin collects the water from the tower and channels it to the circulating water pump pit. The basin is a cast-in-place concrete structure, which is partially located below grade and previously served a wood framed cooling tower. The basin wall is designed to resist the internal lateral water pressure and the external lateral soil pressure.

Spread footers incorporated at basin floor level carry the column loads imposed by the tower structure and the internals. Reinforced concrete drilled piers were utilized for foundations on column line A and C for the new basin extension.

2.1.7 Expansion Joints

Expansion joints are incorporated into tower superstructure at every second cell, permitting thermal expansion and contraction of the individual tower sections.

2.1.8 Ramps

Two concrete ramps at the south end of the cooling tower provide access to the tower basin for a rubber tired front end loader for silt removal. Removable concrete panels are incorporated in the tower end walls above the ramps.

2.1.9 Acid Feed and Blow Down Houses

The existing structures were re-used.

2.1.10 Stairways

Three precast concrete stairways provide access from the ground level to the tower fan deck. Stairway No. 1 is arranged parallel to the pump pit at the north end of the tower and provides access from the east.

Stairway No. 2 is located at the longitudinal center of the tower and provides access from the east side. Stairway No. 3 is located at the south end of the tower and provides access from the west side.

2.1.11 Pump Pit

Existing Structure

2.2 HYDRAULIC SYSTEMS

2.2.1 Hot Water Supply Line

A hot water supply line of concrete construction extends along the west side of the tower below grade and connects to steel risers feeding pairs of cells (7 risers). A horizontal carbon steel distribution header located outside each cell connects to the riser and routes the hot water to the PVC distribution pipes located within each cell. A manually operated butterfly type isolation valve is incorporated at the base of each riser. Each distribution header is provided with a vertical steel vent pipe to prevent air entrapment during filling and draining operations.

Removable end caps are incorporated at the end of each of the distribution pipes to permit periodic flushing of silt deposits.

2.2.2 Spray System

The spray system consists of multiple sprayer assemblies located at uniform spacing intervals above the fill area. The individual sprayers are positively retained to the distribution pipes by means of stainless steel fasteners and are arranged to spray the warm water in an upward direction.

2.2.3 Fill

The fill is "Munters" type 19060, 15 mil, Plasdek. The bottom layers are of PVC rated at 130°F maximum water temperature, the top layer is CPVC material rated at 160°F maximum water temperature. The fill consists of individual wave form sheets that are laminated together in a cross corrugated pattern. Alternate layers of fill packs are stacked at right angles to each other to minimize bypass flow around fill packs and to improve flow distribution. The corrugated pattern of the sheets permits access of liquid and air from the channels of one sheet to the channels of the adjacent sheets.

The staggered and alternately oriented fill blocks provide, from the second bottom layer a sufficient interlocking to walk on the fill. Cautious handling in accordance with all safety regulations is advised in case fill sections need replacement, or in case the fill material becomes brittle. For maintenance access to the cleanout plugs and fan area fiberglass grid type walkways are provided immediately above the fill. In case of maintenance or repair work that requires walking on the fill packs, the fill packs shall first be covered with load distributing planks.

The fill is bottom support on type 1525 Pultrex fiberglass tube beams which are suspended from type SS 316 stainless steel rods. The rods are connected to precast concrete beams located at water distribution level.

2.2.4 Drift Eliminator System

The drift eliminators consist of panels which are basically 9'-10" long and 2 ft. wide. Some of the panels are smaller trimmed pieces to fit in or around specific locations in the tower. The panels are supported on 4" x 4" x 1/4" fiberglass I-beams which are carried by stainless steel suspension rods connected to the fan deck and upper concrete beams.

The drift eliminator panels are located approximately 6 Ft. above the water distribution level to provide headroom for inspection personnel. The drift eliminator panels and its supporting structure are not designed for any personnel loads.

Warning signs "DO NOT STEP ON DRIFT ELIMINATORS" are located at a strategic place in each cell.

2.2.5 Hot Water Bypass System

Existing Structure.

2.3 AIR MOVING SYSTEM

The air moving system is of the induced draft type and consists of axial propeller fans and associated drives. Each drive consists of a motor, drive shaft and coupling assembly and right angle speed reducing gearbox. The gearbox/fan system is bolted to a steel frame structure, which is welded to the upper deck beaming system. The drive motors are located outboard of the fan stacks. Each gear is mounted to a 1-1/2" thick baseplate to provide adequate support to the gear case.

2.3.1 Fans

The fans are axial flow type manufactured by Hudson.

The fan blade pitch is manually adjustable.

See the "Brochure" Section for detailed information on the fans.

2.3.2 Gearboxes

Each gearbox is equipped with the following accessories:

a) Level Sight Gauge
b) Vibration Monitor
c) Drain Valve
d) Backstop

The oil sight gauge and the drain valve are located outside of each fan stack. Specific details related to the gearbox and its attachments are provided in the "Brochure" Section.

Note: The drain line valve at the gearbox shall always be kept open to allow readings of the oil level at the gauge glass outside of the fan stack.

There may be some initial oil run out at the gauge glass vent due to thermal expansion if the drain line valve at the gearbox is shut off and the oil in the line expands.

2.3.3 Drive Shafts

The gearboxes and drive motors are connected by means of carbon fiber composite drive shafts manufactured by Addax which incorporate flex couplings to accommodate minor angular misalignments. A shaft guard is provided for the drive shaft system external to the fan stacks. In addition, two fan shaft restraints are incorporated inside each stack.

2.3.4 Motors

The drive motors are 200 HP high efficiency single speed TEFC induction motors equipped with space heaters. Specific motor design details are provided in the "Brochure" Section.

2.3.5 Bolting of the Mechanical Equipment

GEA-PCS mechanical equipment is bolted to motor and gear support frames using high strength ASTM A-325 fasteners. The high strength bolts shall be installed in accordance with the AISC specification for "Structural Joints Using ASTM A-325 or A-490 Bolts" to develop the required clamping force of a "friction-type" connection. The pre-load of the bolt and the friction between the mating surfaces is used to secure the equipment and hold this position for the life of the tower.

Pre-loading of high strength bolts is very important and must be closely administered. As a general rule, bolts are pre-loaded to 90% of their yield point. That is to say, a pre-load is introduced into the bolt to within 90% of the limit at which the bolt will begin to elongate and take a permanent set. In applying this pre-load, the ratio of the pre-load to the actual load is very high. This promotes a high endurance connection which will handle the variable loads resulting from the dynamic forces of the mechanical equipment.

The following table lists the torque values for high strength bolts used on the mechanical equipment and the proper torques necessary to create to pre-load. For other class bolts (lower grades) refer to the instructions given in the equipment manufacturer's brochures.

Bolt Identification	Torque Value (high strength)
1'1/4" (Item 15 & 16, 002-147)	875 Ft/Lbs
1" (Item 17, 002-147)	710 Ft/Lbs
3/4" (Item 18, 001-147)	320 Ft/Lbs

A calibrated torque wrench of the right capacity must be used to develop these torques. The torque values are for non-lubricated bolts. The reduction in friction when using a lubricant will result in an increased per load on the fastener which may exceed the yield point of the bolts, resulting in elongations and eventual bolt failure from fatigue.

2.4 ACCESS TO COOLING TOWER INTERIOR

Access from the ground level to the fan deck is provided by stairways as described in Section 2.1.11.

Hatches incorporated in the fan deck provide access to the hot water distribution level of each cell by means of a fiberglass ladder attached to the cell dividing walls.

Fiberglass grating along the east side of each cell serves as an inspection walkway for the control and operation of the distribution piping.

Additional fiberglass grating is routed to a ladder at the center column of each cell. The ladder provides access to a fiberglass platform arranged around the gearbox supporting frame for inspection and maintenance of the air moving system. For further important details regarding walking on the fill, please refer to paragraph 2.2.3, Fill.