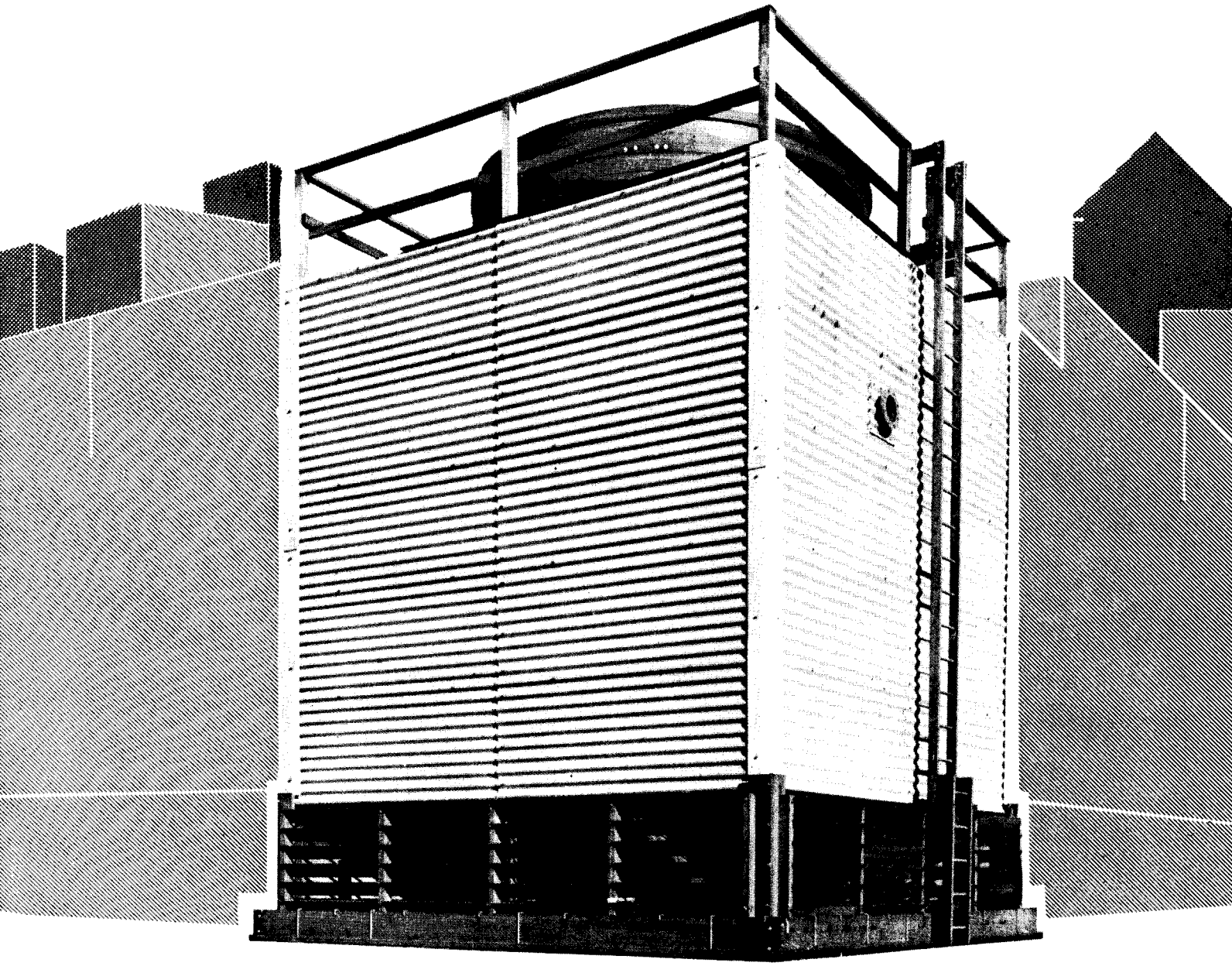
MODELS CW & CS MARLEY COOLING TOWERS

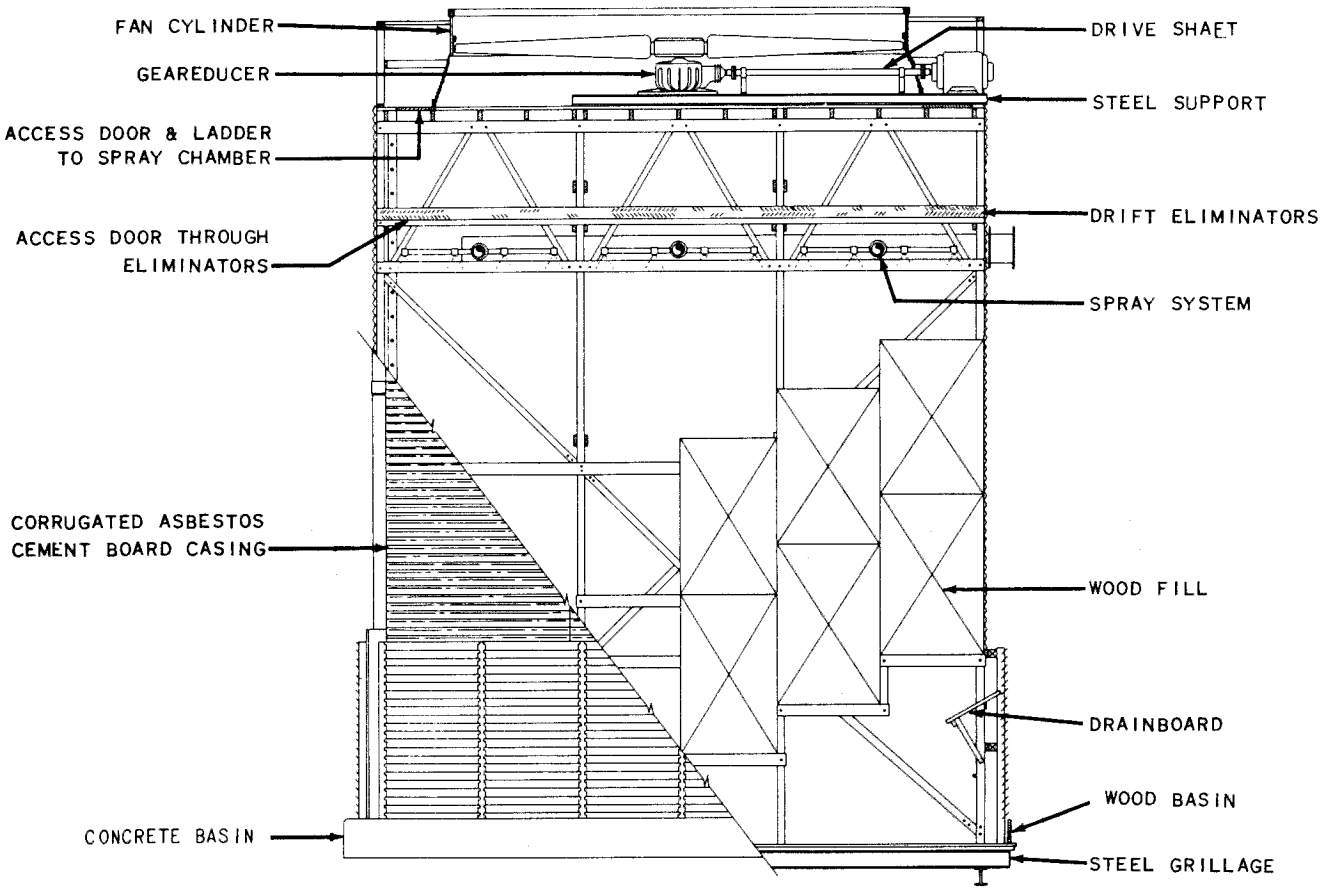
WOOD OR STEEL *Counter-Flow* INDUCED-DRAFT



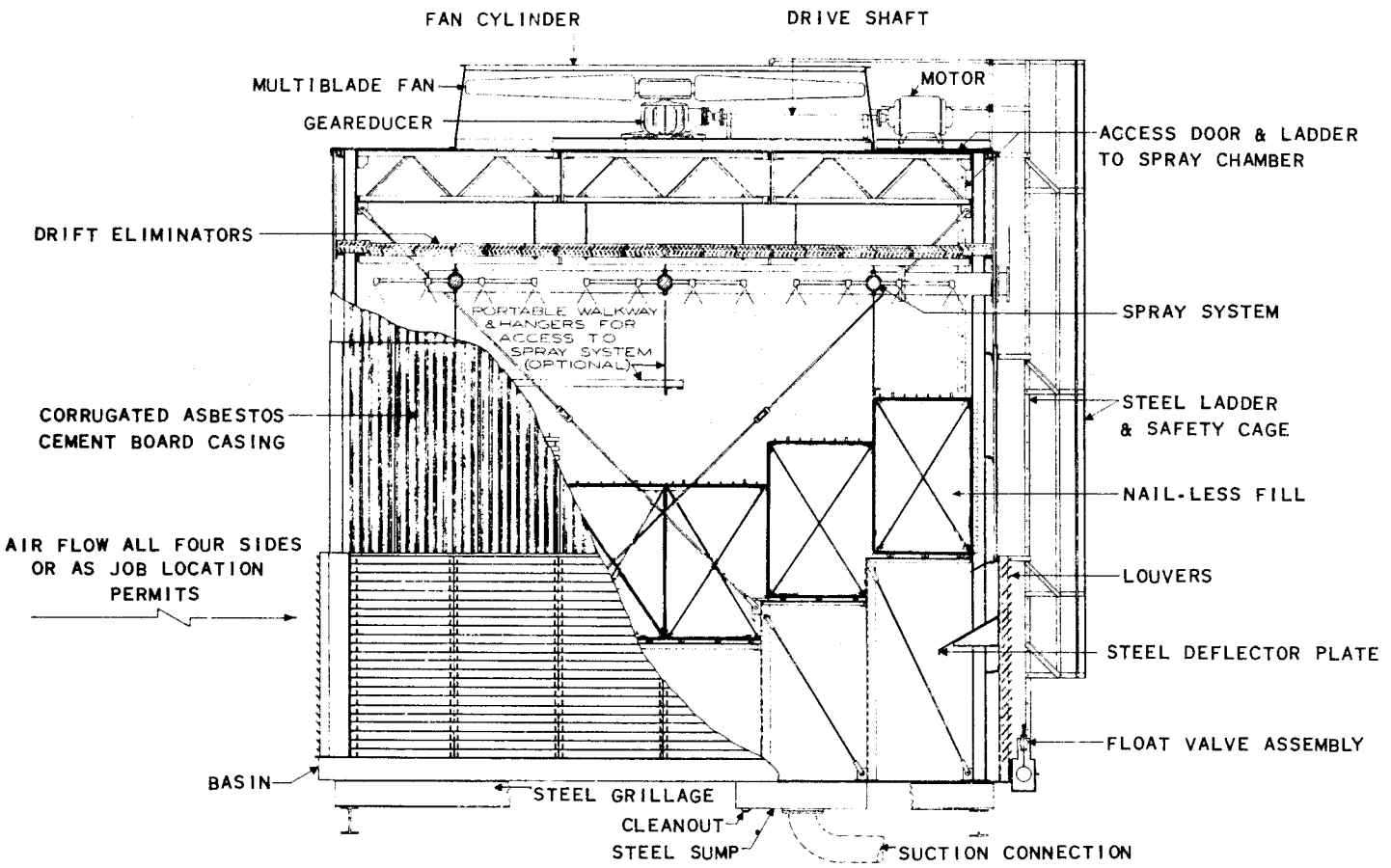
OPERATION AND MAINTENANCE INSTRUCTIONS

THE MARLEY COOLING TOWER COMPANY 5800 FOXRIDGE DRIVE MISSION, KANSAS 66202

Manual 92-1325



CUTAWAY VIEW OF WOOD TOWER (ABOVE) AND STEEL TOWER (BELOW)



COUNTER-FLOW COOLING TOWERS

MODELS CW & CS

OPERATION AND MAINTENANCE INSTRUCTIONS

These instructions have been prepared to assist the tower owner and operator to obtain the best results and long life from Marley cooling equipment. Any questions concerning tower operation and maintenance not covered by this bulletin should be referred to the nearest Marley representative. When writing for information or ordering parts, always mention the tower serial number shown on the plate fastened to the outside of each fan cylinder near the motor.

The attached Marley instructions and service manuals on fans, Geareducers, drive shafts, and electric motors should be reviewed before starting and operating the cooling tower.

TOWER CARE DURING NON-OPERATING PERIODS

Special care is recommended (1) for a new cooling tower if not started for two or more weeks, and (2) for intermittent operation with shutdown periods in excess of two weeks.

Mechanical equipment should be operated at least one hour each week. This will maintain lubrication in the Geareducer parts and keep shaft seals free. Bringing each electric motor up to operating temperatures at weekly intervals will be sufficient to dry out the windings and frame.

Tower should be inspected to be certain that there are no obstructions in the fan cylinder before these one-hour operating periods.

During non-operating periods of a wood tower, the tower lumber can be allowed to dry under ambient atmospheric conditions; however, if desired, several humidifying nozzles can be used near the top of each cell for continuous light wetting of the unit. Where a nearby fire hazard exists, some tower users have installed an auxiliary sprinkler system atop the wood-framed tower to protect the fan deck, fan cylinder, louvers, and other vulnerable parts. In this case, a tarpaulin covering should be spread over the motor.

PRE-STARTING

When a cooling tower is started for the first time, or after a long shutdown period, it should be cleaned and inspected. If it is a wood tower, water should be circulated over the tower continuously for several hours before starting the mechanical equipment and putting tower into continuous operation.

CLEANING. Remove any dirt and trash which has accumulated in the cold water collecting basin at the bottom of the tower. The basin may be hosed down and drained through the overflow connection (unscrew the pipe nipple) or remove cleanout plug in the sump. Clean suction screens and the hot-water spray nozzles if obstructions or corrosion are seen.

INSPECTION. A thorough check of operating assemblies is recommended. Following is a suggested check list of inspections to be made just before starting the operation of the tower:

1. Check for tightness of bolts attaching motor and Geareducer to supports, supports to tower framework, and framing bolted connections.

2. Check for tightness the following bolted joints in the fan and drive assembly:
   a. Fan-hub bolts.
   b. Fan-hub cover bolts.
   c. Geareducer bolts.
   d. Drive shaft couplings bolts and guard bolts.

3. Check drive shaft couplings alignment and adjust if necessary, see Marley Service Manual on drive shafts.

4. Check Geareducer oil for sludge or water by draining off sample through plugged hole near bottom of case, see Geareducer Service Manual. Check Geareducer Service Manual. Check Geareducer "oil level" at fill plug. If necessary, add oil per nameplate information.

5. Rotate fan wheel by hand to make sure of free rotation and ample tip clearance.

6. Check motor insulation with a "Megger", see Maintenance section of Marley Service Manual on "Installation, Operation and Maintenance of Electric Motors."

7. Check electric motor lubrication per motor manufacturer's instructions.

8. Test run each fan separately for short time to check for excessive vibration or unusual noise. If either is present, see "Tower Trouble Tips" on last page of this bulletin. Fan rotation must be clockwise when viewed from above. Directional arrows on each fan blade show proper rotation.

9. Check free operation of float valve to assure make-

up water supply.

10. Inspect hot-water spray nozzles through opening in fan deck. The nozzles must be clean and pointing downward, see sectional drawing.

11. Close access door on fan deck.

STARTING

FILLING THE WATER SYSTEM. Fill the cold water basin and connected pipe system until the operating water level is reached, see "Operation" section. The make-up water supply float valve should be adjusted to maintain this water level within the minimum-maximum (6 to 8 in.) limits. Open wide all hot-water valves, then prime and start the circulating water pumps. By valve adjustment, approximately equalize water distribution between cells (if more than one cell).

WATER DISCOLORATION. Redwood contains certain materials that provide its distinctive color and properties that resist decay. The most soluble of these materials are the tannins; these discolor the circulating water when a cooling tower is first placed in operation. The durability of the wood is not reduced appreciably by the removal of these soluble tannins. A low pH* (below 7.5) of the water is desirable to prevent possible leaching and resultant lowering of the wood durability.

Tannin is a surface-active agent that prevents the formation of scale; its presence in most circulating systems is actually beneficial. The water discoloration will disappear within several months usage; changing of the water is not necessary unless the color is objectionable. The water discoloration may be reduced by adding an oxidizing agent such as chlorine (small amount) since the tannins are powerful deoxidents.

STARTING THE FAN. Fan must run clockwise when viewed from above. If the fan vibrates, refer to "Tower Trouble Tips" on page 8. Vibration generally decreases when a wood tower has operated for a day (after soaking wood thoroughly). If the fan motor is not loaded in accordance with the contract horsepower, refer to "Fan Service Manual" for recommended correction procedure.

OPERATION

FAN DRIVE. If a two-speed motor is used on this tower, allow a time delay of a minimum of 20 seconds after de-energizing the high speed winding and before energizing the low speed winding. Tremendous strains are placed on driven machinery and motor unless the motor is allowed to slow to low speed rpm or less before the low speed winding is energized.

When changing fan direction or rotation, allow a minimum of two minutes time delay before energizing the fan motor.

HOT-WATER DISTRIBUTION SYSTEM. Maintain a uniform water distribution at the nozzles (uniform spray cone). The amount of water circulated should approximate the contract requirements, and the nozzle pressure should be kept between 4 and 6 lb. per sq. in. Lower pressures may indicate excessive losses in piping system and/or insufficient pump capacity; greater pressures might indicate clogged nozzles or overpumping. If a greatly reduced water flow is desired, it may be advisable to change nozzle sizes (or plug some) to obtain the desired pressure and good water distribution.

*pH is an indication of the hydrogen-ion concentration in a solution. A pH below 7 is acid, above 7 is alkaline.

COLD-WATER COLLECTING BASIN. Normal operating water level in a wood or steel basin is 6 to 8 in. above the base of the column; depth for a concrete basin is dependent on suction arrangement used. Enough depth must be maintained to keep pump from pulling air into the line. The amount of "make-up" water that is required to keep the water in the water collecting basin at this required depth, depends upon the "evaporation loss," "drift loss," and "blowdown". Water for make-up averages 1½ percent of the water circulated for a cooling range of 10F. Drift is negligible in these towers; clogged nozzles and overpumping cause drift.

WINTER OPERATION. Whenever the wet-bulb temperature is below freezing, regardless of the dry-bulb temperature, ice will form on the "relatively dry" parts of the tower where fine drops of water splash out into the entering air stream. The ice will form on the louvers, structural framing, and outer filling but will not occur in the flooded portions of the tower. The ice starts to form near the bottom, building inward and upward so that it seldom causes damage to the tower.

The formation of ice restricts the flow of air, so reduces the performance and causes a rise in the temperature of the water leaving the tower. It is only necessary to keep the tower sufficiently free of ice to obtain satisfactory cooling. Various methods are used to minimize freezing or remove ice, depending upon local conditions and the preference of the operator. To minimize ice formation one or more of the following procedures are recommended:

1. Shut down the fan but do not shut off the water.
2. Operate fan at half-speed which causes ice to form in thin sheets rather than as a heavy mass. Also, at half speed a fan requires only 17 percent of the power at full speed.
3. Cover upper portions of louvered areas with canvas.

To remove ice use one or more of the following methods:

1. Reverse the rotation of the motor and fan, and use the warm exhaust air to melt the ice. This usually melts 80 to 90 percent of the ice within a half hour when the fans are reversed at full speed. Reversal at half speed is slower but the time required to remove the ice is not doubled. Be sure that the fans have stopped before attempting to change the direction of rotation.
2. Stopping the fans temporarily allows the hot water to fall vertically and melt the ice that has formed on the splash bars and tower structure, but this will not melt ice on the louvers.
3. Cover upper portions of louvered areas with canvas.

INTERMITTENT OPERATION. When the unit is operated intermittently during summer or winter weather, it is necessary that the water be drained from the basin and exposed piping to insure protection against freezing and possible rupture. Basin drains should be left open during winter shutdown periods to allow rain and melted snow to escape. These same precautions should be taken for seasonal shutdown of the tower.

UNIT MAINTENANCE

Well-maintained (clean) equipment gives the best operating results and the least maintenance cost. It is recommended that a regular inspection schedule be set up to insure effective operation of the cooling tower. In most cases, a daily general inspection should be sufficient. The schedule in Table I can be used by the operator to obtain continuously good performance with least tower maintenance. Keep a continuous lubrication and maintenance record for each cooling tower. Regular inspection and repair of personnel safety items, indicated by an asterisk in Table I, and a record of same is especially important. SAFETY FIRST.

HOT-WATER DISTRIBUTION SYSTEM. Keep the distribution system (piping and nozzles) clean and free of dirt, algae, and scale. Algae and scale may clog nozzles, eliminators, and piping; and may collect on the equipment served thus reducing its performance.

The access door in the fan deck with an in-line trap door in the eliminator and an inside ladder provide an easy means for inspection and maintenance of the spray system. Refer to cross section drawing of tower. If an internal (portable) walkway and hangers have been provided, the aluminum non-skid walkway sections can be arranged as a suitable support while cleaning and repairing nozzles.

If no hangers and aluminum walkway sections have been provided, 2 ft. × 3 ft. plywood standing boards may be placed on top of the redwood fill sections and used as a support while working on the spray system.

DRIFT ELIMINATORS. Eliminators should be kept clean. The top line of boards must direct the air toward the center of the fan. There is an arrow on each Presite* eliminator frame that points in the desired direction of air flow. Do not leave open spaces between eliminator bundles or between these bundles and sidewalls as that would allow excessive drift; keep closure strips, provided for these spaces, in place.

TOWER FRAMEWORK. Keep framework bolts tight (except when wood is very dry). Bolts in the framework sup-

*Registered U.S. Patent Office.

TABLE I

INSPECTION & MAINTENANCE SCHEDULE
General Recommendations

(More frequent inspection and maintenance may be desirable)

	FAN AND FAN GUARD	MOTOR	DRIVE SHAFT & GUARDS	GEAREDUCER	ELIMINATOR	FILLING	COLD WATER BASIN	DISTRIBUTION SYSTEM	FLOAT VALVE	STRUCTURAL MEMBERS	SUCTION SCREEN	CASING	LADDERS, STAIRS, DOORS, WALKWAYS & HANDRAILS*	DAVITS, DERRICKS & HOISTS*
1. Inspect for clogging								W			W			
2. Check for unusual noise or vibration	D	D	D	D						Y				
3. Inspect keys and set screws		S	S	S										
4. Make certain Geareducer vents are open				M										
5. Lubricate		S		S										
6. Check oil seals of Geareducer				S										
7. Check oil level, and oil for water and dirt				W										
8. Change oil (at least) of Geareducer				S										
9. Check water level in cold water basin							D							
10. Check water treatment system							D	D						
11. Check for leakage				W			Y		R					
12. Inspect general condition	S	S	S		Y	Y	Y		S	S		Y	S	S
13. Tighten loose bolts	S	S	S	M						Y		R		
14. Alignment of drive shaft			M											
15. Clean						R	R	R			M			
16. Repaint	R	R	R	R			R			R				
*17. Inspect and repair for safe use	Y		Y										Y	
*18. Inspect & repair before each use														R

D-daily; W-weekly; M-monthly; Q-quarterly; S-semi-annually; Y-yearly; R-as required

porting the mechanical equipment at the top of the tower should receive particular attention. Check structural steel bolted connections annually and tighten as required.

COLD-WATER COLLECTING BASIN. Repair all leaks that may occur in the water collecting basin, paying particular attention to expansion joints in concrete basins. Inspect suction screens frequently and clean when necessary. Float valve or water supply controls, if used, should operate freely and maintain the proper water level.

The basin may be drained by removing (unscrewing) the overflow nipple or by unscrewing the brass cleanout plug at bottom of suction sump, see section drawing of tower.

MOTOR LUBRICATION. The lubrication and maintenance of each electric motor should be in accordance with the manufacturer's instructions. Also see "Installation, Operation, and Maintenance of Electric Motors." Check motor anchor bolts semi-annually and tighten as required.

MOTOR WARRANTY. The motor warranty is usually worded so that the motor manufacturer warrants that the equipment will be of the type and quality described, suitable for the duty for which it was furnished, and free of defects in materials and workmanship. Therefore, if a motor fails for some other reason (like failing to grease it), the motor manufacturer is not liable.

The warranty period is for one year from date of delivery of tower to purchaser. If any motor failure occurs within this first year and the purchaser promptly notifies the motor manufacturer, the latter shall be liable and shall remedy any such failure by adjustment, repair, or replacement, f.o.b. factory, of any defective part or parts.

The motor should not be sent to a repair shop without the manufacturer's permission, or the manufacturer's warranty will be void. The motor manufacturer's warranty does not cover the cost of dismounting, shipping to and from the repair shop, or remounting of the motor. If repair work is necessary, contact nearest representative of the motor manufacturer. If the motor representative in a certain area is not known, contact the local Marley office for this information.

MOTOR DISCONNECT SWITCH. It is advisable to have a motor disconnect-switch in sight of the fan (preferably on fan deck) as a personnel safety precaution. On existing installations where there is no electric motor switch atop the tower, the electrician or maintenance man who turns off the fan should open the motor disconnect-switch ahead of the magnetic starter. A warning sign should be hung on the switch handle while working on the mechanical equipment, for example: "Maintenance personnel working on cooling tower fan — do not change the position of this switch until this tag has been removed by the undersigned. _____"

DRIVE SHAFT. The drive shaft may become misaligned during operation, and if allowed to operate that way, would seriously deteriorate the rubber bushings or rubber discs. For correcting misalignment, balancing, or replacing parts, see Marley Service Manual "Installation, Balancing, and Maintenance of Drive Shafts."

GEAREDUCER. All shaft bearings should be checked monthly by moving (by hand) tip of fan blade and pinion shaft back and forth, and feeling possible looseness in the bearings. Rotating the pinion shaft to and fro a few degrees by hand will give some idea of the amount of backlash, normally about 0.010 in. Check Geareducer anchor bolts semi-annually and tighten as required.

The oil level in the Geareducer should be checked weekly at the oil filler plug; oil should be added to overflowing level, with the units shut down. For detailed maintenance instructions refer to Marley "Service Manual for Geareducers." Use lubricating oils as described and listed on a page of recommended gear lubricants included in this Geareducer Manual.

FAN. The fan blade surfaces should be inspected periodically to assure continued trouble-free operation. For detailed maintenance information refer to Marley "Service Manual for Fans." Check fan assembly bolting semi-annually and tighten as required.

PAINTING. All metal parts subject to corrosion should be cleaned and painted periodically. Redwood does not require protection from the weather; however, if desired, it may be painted for appearance. Any high grade outside paint may be used, but the tower surfaces should be dry.

WATER TREATMENT

The Marley Cooling Tower Company does not act in the capacity of a water consultant, but offers the following summation of the problems involved and corrective measures which may be employed in order to obtain the desired water control. Water treatment must consider: (1) the protection of metals against corrosion; (2) scale prevention; (3) control of algae and slime; and (4) protection of the wood.

A complete chemical analysis of the make-up water should be obtained in order to determine the magnitude of treatment required. The analysis will also help to set up an economic balance between required treating materials and blowdown. It is significant that small cooling towers, located in areas where treated city water is available, take less water treatment than the large industrial towers. In many instances the circulating water on the small tower will require no treatment provided an adequate blowdown on the system is maintained.

CORROSION AND SCALE. Make-up water carrying an excess of free carbon dioxide may be corrosive to metal parts of the cooling system. Mineral acidity, usually present as sulfuric acid, is formed in some surface waters which have been contaminated by industrial wastes or seepage from mines. This type of water may require the addition of some type of inhibitor, such as a phosphate, chromate, or nitrate.

Some scale-forming constituents are found in practically all water. The most common of these are calcium bicarbonate, ferrous bicarbonate, and silicon. Silicon is generally found in the form of the soluble sodium sili-

cate. Occasionally a water may have a high content of calcium sulfate which can be scale forming if the concentration in the circulating water is allowed to exceed the solubility of this compound. Sulfuric acid may be used to convert the carbonates to the more soluble sulfates.

There are many proprietary poly-phosphate compounds which may be used to hold the carbonate constituents in solution. These compounds are effective only within certain limits of carbonate concentration, and for this reason they are often used as an auxiliary aid to acid treatment.

The advice of a competent water chemist can be invaluable in setting up a treatment and method of control which will be both effective and economical. Regardless of the water treatment selected, it must be used in conjunction with the required amount of blowdown in order to maintain the amount of dissolved solids constant.

BLOWDOWN, OVERFLOW AND MAKE-UP. Most of the heat dissipated by a cooling tower is the result of the evaporation of a part of the circulating water. The evaporation removes none of the dissolved solids, so their concentration will build up if no water is removed from the system. The removal of this small quantity of water is called blowdown. For most make-up waters, the solids content of the circulating water may be held at two to three concentrations. As the number of concentrations is lowered below two, the percent of blowdown required becomes increasingly greater. As the number of concentrations is increased above three, the saving in blowdown becomes increasingly less. It is sufficient to say that the number of concentrations which may be carried will depend upon the type of solids, the amount of solids per concentration, and the method of treatment prescribed.

Table II gives the blowdown rate to maintain three concentrations in the water-circulating system.

TABLE II.

Cooling Range Degrees F	Blowdown, Per Cent of Water Circulated
6	0.15
7½	0.22
10	0.33
15	0.54
20	0.75
25	0.96
30	1.17

Assume a water circulation over the tower of 5000 gpm and a 17 F cooling range. The blowdown rate, determined by interpolation from Table II, is 0.624% of the circulating water rate, or 31 gpm.

A build-up of solids content in water can increase the electrolytic strength and hence accelerate galvanic corrosion between dissimilar metals. In addition, the alkaline or acidic salts build-up in the water will in some instances accelerate the straight chemical corrosion.

The blowdown may be removed from any point in the system. The minimum waste would occur if the blowdown connection were made in the hot water line near the top of the piping, so that water would be removed only when the pump is operating. A valve should be installed in the blowdown line to regulate the flow. A continuous overflow from the hot or cold water basin could be used as an alternate blowdown arrangement.

The amount of "make-up" water that is required to maintain the desired water level in the cold water basin depends upon the "evaporation loss," "drift loss," and "blowdown." Water for make-up averages 1½ percent of the water circulated for a cooling range of 10 F. Where make-up water is obtained from a city or domestic water main, sanitary codes require an air gap (not less than twice the diameter of the tower make-up pipe) between the supply opening and the top of the cold-water basin rim.

ALGAE. Algae and slime may be controlled by the use of such algaecides as chlorine, copper sulphate, or sodium pentachlorophenate. Algae and slime may become immune to some poisons, such as copper sulphate and sodium pentachlorophenate, but there is less likelihood of their becoming immune to chlorine.

Chlorine can be used continuously or intermittently. A continuous residual of ½ ppm of chlorine will usually control algae and slime. The residual should not exceed 1 ppm, except with shock treatment. The effectiveness of chlorine as an algaecide becomes less at high pH values; operators having algae trouble when using chlorine will find that the trouble is usually caused by high pH of the water. Chlorine should be used with caution because it is corrosive to metals and destroys all organic matter, including wood.

Copper sulphate is normally applied as a shock treatment to control algae. A concentration of 2 to 3 ppm usually controls algae formation, but in some cases 10 ppm may be required. A high pH will precipitate the copper sulphate making this treatment less effective. Also copper sulphate is corrosive to metals so should not be used in excess of one ounce for each 750 gallons of water in the system; in many cases one-tenth to two-tenths ounce is sufficient dosage.

A concentration of 30 to 40 ppm (one ounce for each 150 gallons of water in the system) of sodium pentachlorophenate will usually control algae. It is generally used as an intermittent or "shock" treatment. This chemical is a fungicide when used in a concentration of 300 to 400 ppm, thus providing some protection to the wood as it destroys the algae and slime; it is also more tolerant to changes in pH.

Sodium pentachlorophenate treatment costs more than chlorine or copper sulphate, but it often does a better job of controlling algae and slime on inaccessible parts, such as the drift eliminators. These parts should be sprayed occasionally with copper sulphate or sodium pentachlorophenate, especially when a chlorine water treatment is used.

WOOD DETERIORATION. There are two types of wood deterioration, chemical and microbiological. The chemical deterioration is a result of constituents in the water reacting with some components of the wood. Alkaline components usually do the most damage, and sodium

carbonate is the alkaline component which causes the most trouble. The alkalies remove the lignin from the wood, causing what is called "delignification." While it is best to maintain a pH of 7 to 7.5, pH is not a true indication of the amount of alkali salts in the water. Oxidizing agents attack the wood in a similar manner, therefore such algaecides as chlorine should be used with caution.

The microbiological deterioration is caused by organisms which destroy the wood by utilizing it as food. Redwood contains natural extractives which are toxic to these organisms; however, alkali and oxidizing agents which cause chemical attack also remove these toxic extractives and render the wood susceptible to decay. Once decay starts it can spread throughout the tower, hence affected parts should be removed. There is a "double-diffusion" wood preservative treatment which arrests and controls decay. If wood deterioration does occur in a Marley cooling tower, consult The Marley Cooling Tower Company, Mission, Kansas.

SPARE PARTS

1. One Geareducer assembly complete.
2. One drive shaft assembly complete.
3. One fan-wheel assembly complete.

TOWER TROUBLE TIPS

1. Unusual noise or vibration may indicate:
   a. Lack of lubrication, excessive wear, or corrosion in motor bearings.
   b. Worn flexible couplings of drive shaft.
   c. Excessive misalignment between electric motor and Geareducer.
   d. Inadequate or unsuitable lubrication, faulty seals, excessive moisture (including rust and corrosion), or excessive wear (backlash and end play) in Geareducer.
   e. Non-uniform pitch of the fan blades. Fan blades incorrectly assembled by blade number, see "Fan Assembly and Pitching Instructions."
   f. Loose fan-hub cover.
   g. Loose bolts in fan cylinder assembly.
   h. Loose connections in bolted joints of tower framing, particularly under Geareducer or electric motor.
2. Scale or foreign substances in the water indicates insufficient blowdown or inadequate water treatment.