MARLEY®

thermal science

# Keep Cooling Towers Running Strong

## A MECHANICAL MAINTENANCE GUIDE

The cooling tower is the operational portal to the natural evaporative "heat sink" for a commercial or industrial cooling system. Its health, or lack thereof, can severely affect the cooling potential of your process.

Because the cooling tower is the open end of a cooling system, it has unique maintenance requirements. The most essential subsystems of a cooling tower are the airflow, water flow and structural elements.

Each has distinctive characteristics that must be reviewed, diagnosed and monitored on an ongoing basis to avoid operational problems. The most difficult of these would be the loss of the cooling tower fan at peak heat load, but smaller structural component problems can also lead to dramatic system failures.

## Inspecting the Airflow System

The fan and its drive components — motor, gear reducer, driveshaft — are a cooling tower's venting system. Inefficient airflow limits the ability to dissipate significant heat loads, and significant damage can occur without regular maintenance.

The fan and its drive components are a cooling tower's primary moving parts and are subject to more wear-and-tear than any other parts of the cooling tower. Lack of proper maintenance to the airflow system is the most common cause of cooling tower downtime.

Following are the important inspection and servicing procedures to keep in mind regarding cooling tower mechanicals:

**Motor Inspection:** Semiannually inspect the mechanical integrity, bearing lubrication and insulation integrity of the cooling tower's fan motor. Inspect the motor housing for damage or looseness, and remove any oil, dust or scale deposits from the motor.

Use the following table as a guide for determining the greasing periods for ball bearing motors:

| Duty | 1-30 horsepower | 40-250 horsepower |
|---|---|---|
| Intermittent | 12 months | 12 months |
| 8-16 hours per day | 12 months | 6 months |
| Continuous | 8 months | 4 months |

Use bearing grease recommended by the motor manufacturer or use another suitable grease for ball bearing motors used on cooling towers. Bearings can be checked for roughness by turning the outer race slowly with your fingers while holding the inner race. If the bearing feels rough or binds in spots, it should be replaced.

Check the insulation resistance of the motor once a year. Using a megohmmeter (with the motor off), apply potential to the winding for one minute before taking a reading.

**Gear Reducer Inspection:** Semiannually inspect the mechanical integrity and oil level of the cooling tower's gear reducer. Entering the cooling tower cell, lockout and tag the motor control for the applicable fan cell motor. Be sure to check that all the assembly bolts and cap screws are tight.

To ensure that the oil plugs and pipe connections are free from leaks, verify that their connections are in place. It also is necessary to ensure the vent on the gear reducer is clear. Inspect the mechanical equipment anchor bolts, drive shaft coupling bolts and coupling screws. Tighten as required. It also is important to check the exterior of gear reducer for rust or chipped paint. If needed, touch it up with a coat of epoxy paint.

To check the gear reducer oil level, shut down the unit and allow five minutes for the oil level to stabilize. If additional oil is required, it is a good idea to note the amount added in the maintenance log book for future reference.

**Drive Shaft Inspection:** Semiannually inspect the driveshaft for corrosion, cracking of rubber bushings and couplings, and looseness of hardware. Replace all rubber components showing excessive deterioration, and tighten all loose nuts and bolts. If vibration readings indicate an imbalance or misalignment, follow the instructions found in the manufacturer's service manual.

**Fan Inspection:** Semiannually inspect mechanical integrity, blade-pitch angle, torque settings and blade-tip clearance. To inspect the fan, enter the cooling tower cell, and lockout and tag the motor control for the applicable fan cell motor. Inspect the fan guard for damage and missing fasteners, and replace any missing components.

It is important to visually inspect each fan blade carefully for damage and corrosion. Remove any accumulated scale or dirt. Check to see that the drain holes (if present) of the blade are clear, and rotate the fan to ensure that the blade tips don't make contact with the fan's cylinder walls.

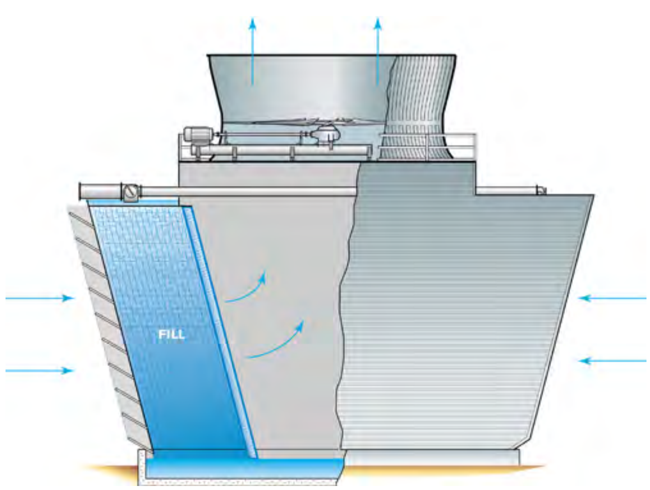
To check the performance of the motor load, run the fan until the motor and gearbox have reached operating temperature (approximately 30 minutes). Record the average voltage and amperage readings of all three lines for use in calculating the motor horsepower by the following equation:

$$\text{horsepower} = \frac{(\text{actual volts x actual amps})}{(\text{nameplate volts x nameplate amps})} \text{ x nameplate horsepower}$$

The calculated horsepower should equal, but not exceed, the specified contract horsepower. Measurements used in the above calculations must be made with hot water flowing through the cooling tower. To obtain contract horsepower, repitch the fan blades as required. For specific guidelines on repitching, refer to the manufacturer's fan service manual.

**Vibration motor survey:** Horizontally attach the magnetic base of the accelerometer to the motor housing, and output the shaft centerline as close as possible.

Using a handheld vibration analyzer, observe the frequency domain spectrum of the vibration signal in units of velocity. It is important to use the spectrum chart for proper analysis. To identify the frequencies for the unit model number, refer to the critical vibration frequencies section in the manufacturer's service manual.




*Crossflow Design*

**Vibration Gear Reducer Survey:** Monitor vibration of an operating gearbox from outside the cooling tower cell with the use of an accelerometer permanently mounted to the gearbox casing. The ideal mounting location is horizontal in the casing surrounding the fan shaft bearing. For specific information, refer to the critical vibration frequencies section of the manufacturer's service manual.

## Check the Water Flow Path

The water flow path includes the hot water basin, nozzles, fill (heat transfer media), cold-water basin, makeup and flow control valves at the cooling tower. For maximum performance, the flow must be equally distributed, unimpeded and near recommended design.

In order to prevent substantial loss of cooling or fill collapse, the following inspections should be done semiannually:

**Splash Fill.** It is important to check the condition of the splash bars — look for sagging, fallen, misplaced, broken or decaying splash bars, and excessive buildup of scale. Ensure all supporting grids are in place and evenly spaced.

Be sure to check the coating on steel grids, the condition of the welds on stainless wire grids and the condition of fiberglass or polypropylene grids. Replace any grids showing excessive deterioration. Also, remember to examine the cooling tower members, which support the grid itself.

**Film Fill.** Look for buildup of scale, algae or other contaminants, as well as erosion, sagging, torn sheets or evidence of ice damage. Also examine the condition of the support members.

**Drift Eliminators.** The cleanliness and effectiveness of drift eliminators are critical in preventing the spread of Legionella pneunophila bacteria. Make certain all air passages are clear of debris and all the components are properly installed. It is also critical to check the condition of the seals to assure that water can't bypass the eliminators through deteriorated or missing seals. Wood blades and frames are subject to severe conditions and should be checked for rot and decay.

**Hot and Cold Water Basin and Nozzle inspection.** Each quarter, inspect the hot water basins on crossflow cooling towers and cold-water collection basin and nozzles. Look for deterioration of the basic material, and check wood for decay and steel for corrosion. Also, look for leaks between adjoining panels to prevent hot water streams from bypassing the fill.

Inspect the integrity of the basin support members to ensure their integrity for continued service, including the tightness of bolted joints in steel or fiberglass basins. Check the iron distribution piping for corrosion and loss of coating material. Spot-check for leaks and tightness of bolted joints, and look for signs of deterioration on PVC or fiberglass distribution pipe.

Inspect the flow control valve components on crossflow cooling towers for corrosion or signs of wear. Operate the valve manually through its full range of travel, and reset the valves to balance the water flow to all basin sections. Temporarily remove the nozzles and to check for clogging or signs of internal wear.

Be sure that all counterflow nozzle components such as removable splash plates are in place and working properly. Also, look for any loss of material resulting from corrosion or erosion, and check for adequate connection to the branch pipe. Any debris found in the cold-water collection basin must be removed. Because buildup of

*Use a handheld vibration monitor to check mechanical operation*

sludge and accumulated debris provides an ideal breeding ground for bacteria, remove any buildup. Also, check the condition of the sump, sump screen and anti-cavitation device (if one is used). The sump screen should be free of trash.

Note any corrosion or loss of metal in cold-water basin components. Inspect wood, steel and fiberglass basins for signs of leaks or breakdown of sealing material.

**Makeup Valve Inspection and Test.** Semiannually inspect and test the makeup valve to ensure cooling system water supply. Operate the float valve or float switch manually to make sure that it opens and closes properly. Inspect all the valve components for excessive deterioration.

## Monitor Structural Integrity

The cooling tower structure provides the housing, and the air and water seal that allow the cooling tower to function. Deterioration of this shell threatens the entire cooling tower system and allows bypass of both air and water, reducing efficiency.

Semiannually inspect the structure of the system. Consider cooling tower age, past servicing or repair, plant capacity needs, desire for more capacity and the future service life of the unit being observed. Also, check the following:

**Casing.** Look for leaks, cracks, holes or general deterioration, including air leaks between adjoining panels. Make sure that the hardware is tight and in good condition, and inspect steel casing for corrosion or scale buildup. Examine wood casing for signs of wood decay, including soft rot or plywood delamination.

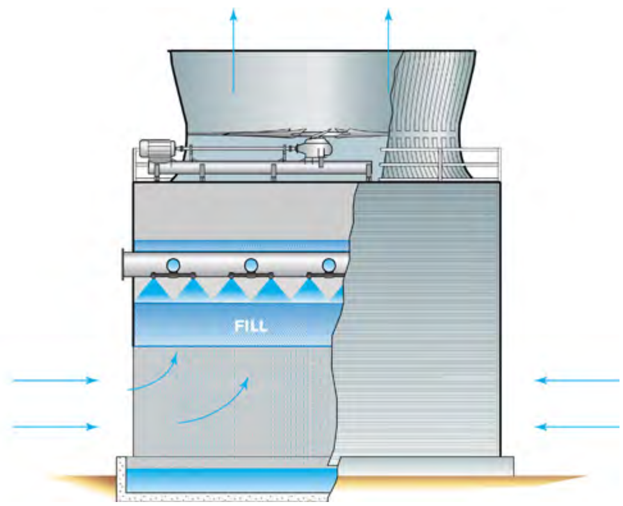
Make sure that access doors are in good working order and that they shut tightly when the cooling tower is in operation.

**Structure.** Inspect the structure of a steel cooling tower for evidence of corrosion, particularly for any loss of metal. Spot-check the tightness of bolted joints, and look for signs of corrosion near welded joints on galvanized steel cooling towers.

On wood structure cooling towers look for signs of wood deterioration, including through-cracks, fractures or decay in wood members. Inspect wood members both visually and by tapping with a hammer. A dull, low-pitch sound indicates softness, while a higher-pitched sharp sound indicates good, solid wood. If you find soft spots, probe with an ice pick or similar device.

Pay particular attention to the wood around steel or cast iron fasteners and connectors, as well as the bottom of columns, as these are the primary load-bearing surfaces and connections for the overall cooling tower. Spot-check the tightness of bolted structural joints, and inspect the joint connectors for evidence of corrosion or other signs of deterioration.

Check the assembled joints of a fiberglass or plastic cooling towers structures to be sure that hardware is tight and in good condition. Look for evidence of tearing or cracking in the structure, and check and adjust loose tension rods.




*Counterflow Design*

Search for steel corrosion or wood decay on the fan deck, stairway, ladder and handrail. Make sure the fan deck support members are in good condition and connections between the fan deck and the supports are tight. Also, ensure all connections between the ladder and the cooling tower are tight and in good condition.

Loose fan deck overlays are a tripping hazard, so check for air leaks between the adjoining panels. Be sure that overlays are properly attached and overlay material is in good condition.

It's important to monitor the condition of louvers, which typically are made of plywood, steel, fiberglass and cellular configurations molded on fill sheets. Make sure all louvers are in place, and look for any deterioration of the base material, such as wood rot or corrosion.

Check for scale buildup or biological growth to prevent harmful bacteria from growing. Check condition of louver support members as well as the connections between the louvers (supports) and the cooling tower. Note the material, arrangement and vertical spacing for future reference.

Check the overall condition of the material of the fan cylinder, paying particular attention to any welds in steel shrouds. Review the condition and tightness of all assembly and hold-down hardware, and look for any leaks between adjoining fan cylinder segments.

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