MARLEY®

MANUAL

Series 220 Steel Double-Flow Cooling Tower

Installation, Operation, and Maintenance Instructions

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OPERATION & MAINTENANCE INSTRUCTIONS — SERIES 220 STEEL DOUBLE-FLOW

Series 220
Cooling Tower

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Marley Series 220 Cooling Tower

Installation, Operation, and Maintenance Instructions

The Marley Series 220 cooling tower purchased for this installation represents the current state of the art in crossflow, induced draft cooling tower design. Thermally and operationally, it is the most efficient cooling tower of its class.

These instruction – as well as those offered separately on motors, fans, Geareducers®, couplings, drive shafts, float valves, etc. – are intended to assure that the tower serves you properly for the maximum possible time. Since product warrantability may well depend upon your actions, please read these instructions thoroughly prior to operation.

If you have questions about the operation and/or maintenance of this tower, and you don't find the answers in this manual, please contact your Marley sales engineer. *When writing for information, or when ordering parts, please mention tower serial number shown on the nameplate.*

Tower Location

Space available around the tower should be as generous as possible to promote ease of maintenance – and to permit freedom of airflow into and through the tower. If you have questions about the adequacy of the available space and the intended configuration of the tower, please contact your Marley sales engineer for guidance.

Prepare a stable, *level* support foundation for the tower, utilizing weight, wind load, and dimensional information appearing on appropriate Marley submittal drawings. *Supports must be level to insure proper operation of the tower.*

Caution

The cooling tower must be located at such distance and direction to avoid the possibility of contaminated tower discharge air being drawn into building fresh air intake ducts. The purchaser should obtain the services of a Licensed Professional Engineer or Registered Architect to certify that the location of the tower is in compliance with applicable air pollution, fire, and clean air codes.

Tower Shipment

Unless otherwise specified, Series 220 towers ship by truck (on flat bed trailers), which lets you receive, hoist, and install the tower in one continuous operation. Single cell towers ship on one truck. Multi-cell towers, depending on their size, may require more than one truck. Responsibility for the condition of the tower upon its arrival belongs to the trucker – as does the coordination of multiple shipments, if required.

Receiving Tower

Prior to unloading the tower from the delivering carrier, inspect the shipment for evidence of damage in transit. If damage is apparent, note the freight bill accordingly. This will support your future recovery claim.

Find and remove the installation instruction drawings, located in a container shipped in the cold water basin.

Hoisting Tower

Models 223-800 and 223-900 consist of two modules per cell. The upper module includes heavy duty hoisting clips at the top of the module. The hoisting clips for the lower module are located near its bottom. All other models ship in a single module, with hoisting clips located at the top of the tower. A hoisting instructions decal is located on the casing, near the tower centerline. Remove tower from the carrier and hoist into place according to the instructions on the decals.

If hoisting and installation are to take place simultaneously, hoist the bottom section first. (This is the section including the cold water basin.)

Caution: Hoisting clips are provided for ease of unloading and positioning tower. For overhead lifts or where additional safety is required, safety slings should also be placed under the tower.

Tower Installation

Note: These installation instructions are intended to help you prepare before your tower arrives. If discrepancies exist between these instructions and those shipped with the tower, the instructions shipped with the tower will govern.

1. Place tower (or bottom section) on your prepared supports, aligning anchor bolt holes with those in your supporting steel. (Make sure that the orientation agrees with your intended piping arrangement.) Attach section to supporting steel with four 1/2" diameter bolts (5/8" diameter bolts for models 223-800 and 223-900).

2. On models 223-800 and 223-900, apply strip sealer around top peripheral bearing surface of bottom section according to drawing instructions.

3. Unbolt and remove all shipping skids from top section.

Place top section on top peripheral bearing surface of bottom section, aligning mating holes as it is set in place. (Make sure that the orientation of the top section agrees with your intended piping arrangement. Sections are 180° reversible with respect to each other.) Attach top section to bottom section with self-tapping screws provided – according to drawing instructions.

Note: If tower purchased is one cell only, ignore steps 4 through 8.

4. Unbolt endplate from basin of the cell just installed. (It is located in the basin side.) In its place, attach basin equalizer flume – using sealer and self-tapping screws provided – according to drawing instructions. (Gasketing will have been pre-glued to the flume at the factory.)

5. Set 2nd tower (or bottom section of 2nd cell) in place, *except do not attempt to align anchor bolt holes.* This tower or section should be temporarily located sufficiently clear of the first tower cell to allow working clearance for the next step – and to avoid damage to the equalizer flume just installed on cell #1.

6. Apply sealer to exposed flange on flume previously installed on cell #1. Unbolt appropriate endplate from basin of cell #2. Carefully jack 2nd cell along supporting steel to properly align anchor bolt holes (holes in basin side and flume flange should also align). Attach 2nd cell to supporting steel with four 1/2" (or 5/8" as appropriate) diameter bolts. Attach flume to 2nd cell basin according to drawing instructions.

   Note: It is important that the cells be firmly anchored before the flume is affixed to the 2nd cell. Otherwise, undue stress may be applied to the flume during the attempt to align anchor bolt holes.

7. Repeat steps #2 and #3 for 2nd top section on models 223-800 and 223-900.

8. Repeat steps 4 through 7 for any remaining cells.

9. Attach your cold water supply piping to the cold water basin suction connection in accordance with drawing instructions. *Do not support your pipe from the tower or outflow connection – support it externally.* Normally, one of the following three outflow arrangements is provided:

   Side suction connection: This is a factory-installed, galvanized pipe nipple (6" diameter or larger, as appropriate) extending horizontally from the side of the cold water basin. It is both beveled for welding – and grooved for a mechanical coupling. If a weld connection is used, it is recommended that the weld area be protected against corrosion. Cold galvanizing is suggested, applied according to the manufacturer's instructions.

   Bottom outlet connection: This is a factory-installed screened circular opening in the cold water basin floor of one or more cells. Attachment requires that your pipe be equipped with a 125# ANSI B16.1 flange.

   Depressed sump connection: Unless otherwise specified, sumps are manufactured of heavy duty GRP (glass reinforced polyester) construction. Because of their size, they are attached upside down in the basin to prevent damage in shipment. They must be inserted into the square opening prepared in the floor of the cold water basin of one or more cells – sealed against leakage, and attached by machine bolts, according to the installation drawing included. An appropriately-sized circular opening in the vertical face of the sump has been drilled to accept a 125# ANSI B16.1 flange connection.

10. Attach make-up water supply piping to appropriately-sized float valve connection located in cold water basin side wall. If you wish to conduct overflow and drain water to a remote discharge point, make those connections at this time also.

11. Attach your warm water return piping (riser) to the inlet connections of the tower. *Do not support your pipe from the tower – support it externally.*

    Note: Efficient tower operation requires uniform flow to all distribution basins. You can address this need by installing regulator valves in your riser piping to each basin or by equipping your tower with Marley HC flow control valves.

12. Wire motor in accordance with wiring diagram. For maintenance/safety purposes, *provide a lock-out type disconnect switch located such that it is visible from the mechanical equipment region of the tower.* In addition to this disconnect switch, the motor should be wired to main power supply through short circuit protection, and a magnetic starter with overload protection.

Tower Start-Up

Water System:

1. Remove any and all accumulated debris from tower. Pay particular attention to inside areas of cold water basin, hot water basins, louvers, and drift eliminators. Make sure that cold water suction screens are clear and properly installed.

2. Fill the water system to an approximate depth of 2-1/8" in the area of the cold water basin under the fill (3-1/8" depth in models 223-800 and 223-900). This is the recommended operating water level. Adjust the float valve so that it is essentially closed at that level. Continue filling the system until the water reaches a level approximately 1/8" below the lip of the overflow.

   Note: If tower is equipped with a standard side-suction connection, vent any accumulated air from the top of the suction hood by removing one or both tap screws provided at that location. Replace these tap screws when venting is complete.

3. Completely open all hot water flow control valves. Start your pump(s). Observe system operation. Since the water system external to the tower will have been filled only to the level achieved in the cold water basin, a

certain amount of "pump-down" of the basin water level will occur before water completes the circuit and begins to fall from the fill. The amount of initial pump-down may be insufficient to cause the float valve to open. However, you can check its operation by pressing down on the operating lever to which the stem of the float valve is attached.

4. After reaching design water flow rate, adjust the valves to equalize hot water depth in the distribution basins. Each basin should have from 2.8 to 5.4 inch water depth, with uniform depth from basin to basin. Fix valves in this position when depth is correct.

   Uniform distribution depth of 2.8 to 5.4 inches is essential to efficient tower operation. Contact your Marley sales engineer if you are considering a change in circulating water flow rate that would prevent operation within these limits.

5. Continue pump operation for about 15 minutes, after which it is recommended that the water system be drained, flushed, and refilled.

Mechanical Equipment:

Caution: Always make certain that mechanical equipment is inoperable during periods of maintenance – or during any situation of possible endangerment to personnel. If your electrical system contains a disconnect switch, lock it out until the period of exposure to injury is over.

1. Check oil level in accordance with the operating instructions for the Geareducer. (Although Geareducer was filled to the proper level at the factory, tipping during shipment and hoisting may have caused some loss of oil.) If oil is required, fill Geareducer to the proper level. Check at dipstick (standpipe located on fan deck, if so equipped) to confirm that the proper level is indicated.

2. Spin the fan manually to assure that all fan blades properly clear the inside of the fan cylinder. Observe the action of the coupling (or drive shaft couplings) to be sure that the motor and Geareducer are properly aligned. If necessary, correct the alignment in accordance with the included manual. When satisfactory, isntall top fan ring and fan guard accroding to the installation drawing shipped with the tower..

3. Momentarily energize ("bump") the motor and observe rotation of the fan. The fan should rotate in a counterclockwise direction when viewed from below. If rotation is backwards, shut off the fan and reverse two of the three primary leads supplying power to the motor.

   Note: If tower is equipped with a two-speed motor, check for proper rotation at both speeds. Check also to see that starter is equipped with a 20 second time delay which prevents direct switching from high speed to low speed. This delay will allow the fan to slow down, and will prevent abnormal stress from being applied to the mechanical equipment and the electrical circuit components.

4. Run the motor and observe the operation of the mechanical equipment. Operation should be stable, and there should be no evidence of oil leakage.

   Note: If the water supply system is not being operated – or if there is no heat load on the system – motor amps read at this time may indicate an apparent overload of as much as 10–20%. This is because of the increased density of unheated air flowing through the fan. Determination of an accurate motor load should await the application of the design heat load.

Tower Operation

General:

The cold water temperature obtained from an operating cooling tower will vary with the following influences:

1. **Heat load:** With the fan in full operation, if the heat load increases, the cold water temperature will rise. If the heat load reduces, the cold water temperature will reduce.

   Note that the number of degrees ("range") through which the tower cools the water is established by the system heat load and the amount of water being circulated, in accordance with the following formula:

$$\text{Range (°F)} = \frac{\text{Heat load (Btu/hr)}}{\text{GPM x 500}}$$

   The cooling tower establishes *only* the cold water temperature attainable under any operating circumstance.

2. **Air wet-bulb temperature:** Cold water temperature will also vary with the wet-bulb temperature of the air entering the louvered faces of the tower. Reduced wet-bulb temperatures will result in colder water temperatures. However, the cold water temperature will not vary to the same extent as the wet-bulb. For example, a 20°F reduction in wet-bulb may result in only a 15°F reduction in cold water temperature.

3. **Water flow rate:** Increasing the water flow rate (GPM) will cause a slight elevation in cold water temperature, while reducing the water flow rate will cause the cold water temperature to lower slightly. However, at a given heat load (see formula above), GPM reductions *also* cause an increase in the incoming hot water temperature. Use care to prevent the hot water from exceeding 125°F, in order to prevent damage to the tower components.

4. **Air flow rate:** Reducing air flow through the tower causes the cold water temperature to rise. *This is the approved method by which to control leaving water temperature.*

   If your tower is equipped with a single-speed motor, the motor may be shut off when the water temperature becomes too cold. This will cause the water temperature to rise. When the water temperature then becomes too warm for your process, the motor can be restarted.

When operating in this mode, however, *care must be taken not to exceed a total acceleration time of 30 seconds per hour.* From a dead stop, determine the number of seconds it takes the fan to arrive at full speed. Divide this number into 30 to determine the allowable number of starts per hour. Considering the normal fan and motor sizes utilized on the QuadraFlow tower, anticipate that approximately 4 to 5 starts per hour are allowable.

If your tower is equipped with a two-speed motor, greater opportunity for temperature control is afforded you. When the water temperature becomes too cold, switching the fan to half-speed will cause the cold water temperature to rise – *stabilizing* at a temperature some 5-15 degrees higher (depending upon a combination of all operating factors). With a further reduction in water temperature, the fan may be cycled alternately from half-speed to off – subject to the same constraint of *30 seconds of allowable acceleration time per hour* as outlined above.

If your tower consists of two or more cells, cycling of motors may be shared between cells, increasing your steps of operation accordingly.

For greater insight on cold water temperature control, please read Technical Report #H-001-A ("Cooling Tower Energy and its Management") available from your Marley sales engineer.

Wintertime operation:
During operation in sub-freezing weather, the opportunity exists for ice to form in the colder regions of the tower. *Your primary concern is to prevent the formation of destructive ice on the cooling tower fill.* Your understanding of cold weather operation will be enhanced if you read Technical Report #H-003 ("Operating Cooling Towers in Freezing Weather"), augmented by the following guidelines:

1. *Do not allow the tower's leaving water temperature to drop below a minimum allowable level – (about 40°F) – established as follows:*

   During the coldest days of the first winter of operation, observe whether any ice is forming on the louver face, particularly near the bottom part of the louver face. If hard ice is present on the louvers, an appropriate elevation in the allowable cold water temperature is *mandatory.* If the coldest possible water is beneficial to your process, ice of a mushy consistency can be tolerated – but routine periodic observation is advisable.

   If the minimum allowable cold water temperature is established at or near maximum heat load, it should be safe for all operating conditions. However, if established at reduced load, *increased heat loads may re-introduce the potential for icing.*

   Having established the minimum allowable cold water temperature, maintaining that temperature can be accomplished by fan manipulation, as outlined in Item #4 under "Tower Operation". However, *in towers of more than one cell, the limiting temperature established applies to the water temperature of the cell or cells operating at the highest fan speed – not necessarily the net cold water temperature produced by the entire tower.*

2. As cold air enters the louvers, it causes the falling water to be drawn inward toward the center of the tower. Thus, under fan operation, the louvers and lower periphery of the tower structure remain partly dry, seeing only random splashing from within the tower – plus normal atmospheric moisture from the entering air. Such lightly wetted areas are most subject to freezing.

   Although ice is unlikely to cause structural damage, it may build up sufficiently to restrict the free flow of air through the louvers. This will have the effect of reducing the tower's thermal performance efficiency. When excessive ice forms on the louvers, stop the fan for a few minutes. With the fan off, the increase in the water temperature and the action of the cascading water will reduce the ice build-up on the louvers. In extreme cases, brief fan reversal will also help to remove ice. Reverse fan operation should not exceed 15 to 20 minutes.

Intermittent wintertime operation:
If periods of shutdown (nights, weekends, etc.) occur during freezing weather, measures must be taken to prevent the water in the cold water basin – and all exposed pipework – from freezing. Several methods are used to combat this, including automatic basin heater systems available from Marley. Unless some means of freeze prevention is incorporated into your system, *the tower basin and exposed pipework should be drained at the beginning of each wintertime shutdown period.*

It is recommended that you discuss your freeze prevention options with your local Marley sales engineer.

Water Treatment and Blowdown

Maintaining water quality:
The steel used in the Series 91000 Compac II tower has been galvanized with a heavy zinc coating averaging 1.9 mils in thickness. Other materials used (PVC fill, drift eliminators, and louvers; aluminum fans; cast iron Geareducer; etc.) are selected to offer maximum service life in a "normal" cooling tower environment, defined as follows:

- Circulating water with a pH between 6 and 8; a chloride content (as NaCl) below 750 ppm; a sulfate content (SO_4) below 1200 ppm; a sodium bicarbonate content ($NaHCO_3$) below 200 ppm; a maximum inlet water temperature not to exceed 125°F; no significant contamination with unusual chemicals or foreign substances; and adequate water treatment to minimize scaling.

- Chlorine (if used) shall be added intermittently, with a free residual not to exceed 1 ppm – maintained for short periods.

- An atmosphere surrounding the tower no worse than "moderate industrial", where rainfall and fog are no more than slightly acid, and they do not contain significant chlorides or hydrogen sulfide (H_2S).

Cooling tower cleaning:

> **Warning**
>
> ***Any evaporative-type cooling tower must be thoroughly cleaned on a regular basis to minimize the growth of bacteria, including Legionella Pneumophilia, to avoid the risk of sickness or death. Service personnel must wear proper personal protective equipment. Do NOT attempt any service unless the fan motor is locked out.***

Operators of evaporative cooling equipment, such as water cooling towers, should follow maintenance programs which will reduce to an absolute minimum the opportunity for bacteriological contamination. Public Health Service officials have recommended that "good housekeeping" procedures be followed, such as: regular inspections for concentrations of dirt, scale, and algae; periodic flushing and cleaning; and the following of a complete water treatment program including biocidal treatment.

The visual inspection should take place at least once a week during the operating season. The periodic flushing and cleaning should be done before and after each cooling season, but in any event at least twice a year. The louvers, drift eliminators, and easily accessible fill surfaces should be flushed by use of a moderate-pressure water nozzle, being careful not to cause physical damage. A reliable water treatment program should be installed and maintained. Filtration devices may be employed to reduce the suspended solids concentrations, thus increasing the effectiveness of the water treatment program.

Blowdown:
A cooling tower cools water by continuously causing a portion of it to evaporate. Although the water lost by evaporation is replenished by the make-up system, it exits the tower as pure water – leaving behind its burden of dissolved solids to concentrate in the remaining water. Given no means of control, this increasing concentration of contaminants can reach a very high level.

In order to achieve water quality which is acceptable to the cooling tower (as well as the remainder of your circulating water system), the selected water treatment company must work from a relatively constant level of concentrations. This stabilization of contaminant concentrations is usually accomplished by *blowdown*, which is the constant discharge of a portion of the circulating water to waste. As a rule, acceptable levels on which to base a treatment schedule will be in the range of 2-4 concentrations. The following table gives *approximate* rates of blowdown (percent of total water flow rate constantly wasted) to achieve those concentrations at various cooling ranges*:

	Blowdown Rate	
Cooling Range (°F)	Two Concentrations	Four Concentrations
10	0.7%	0.17%
15	1.1%	0.30%
20	1.5%	0.43%

* ("Range" = Difference between hot water temperature entering the tower & cold water temperature leaving the tower.)

Note: When water treatment chemicals are added, they should not be introduced into the circulating water system via the cold water basin of the cooling tower. Water velocities are lowest at that point, which results in inadequate mixing.

Schedule of Tower Maintenance

Included with this instruction packet are separate Service Manuals on each major operating component of the tower, and it is recommended that you read them thoroughly. *Where discrepancies may exist, the separate Service Manuals will take precedence.*

The following is recommended as a minimum routine of scheduled maintenance: *(Remember to lock out disconnect switch if your routine can involve physical contact with the mechanical equipment.)*

Daily: Observe, touch, and listen to the tower for a few moments each day. Become accustomed to its normal appearance, sound, and level of vibration. Abnormal aspects relating to the rotating equipment should be considered reason to shut down the tower until the problem can be located and corrected.

Weekly: Observe operation of the motor, coupling (or drive shaft), Geareducer and fan. Become familiar with the normal operating temperature of the motor, as well as the sight and sound of all components as a whole.

Shut off the fan for a few minutes, check the level of oil in the Geareducer. Add oil as necessary. Check system for leaks if the amount of oil required appears unusual. (If oil is added at the external fill port, allow adequate time for the level to stabilize before reading final level.)

Inspect louvers, and remove any debris which may have accumulated. Observe operation of the float valve. Depress the operating lever to make sure that the valve is operating freely. Inspect the suction screen for plugging. Remove any debris that may have accumulated.

Check for any build-up of silt on the floor of the cold water basin. Mentally note the amount, if any, so future inspections will enable you to determine the rate at which it is forming.

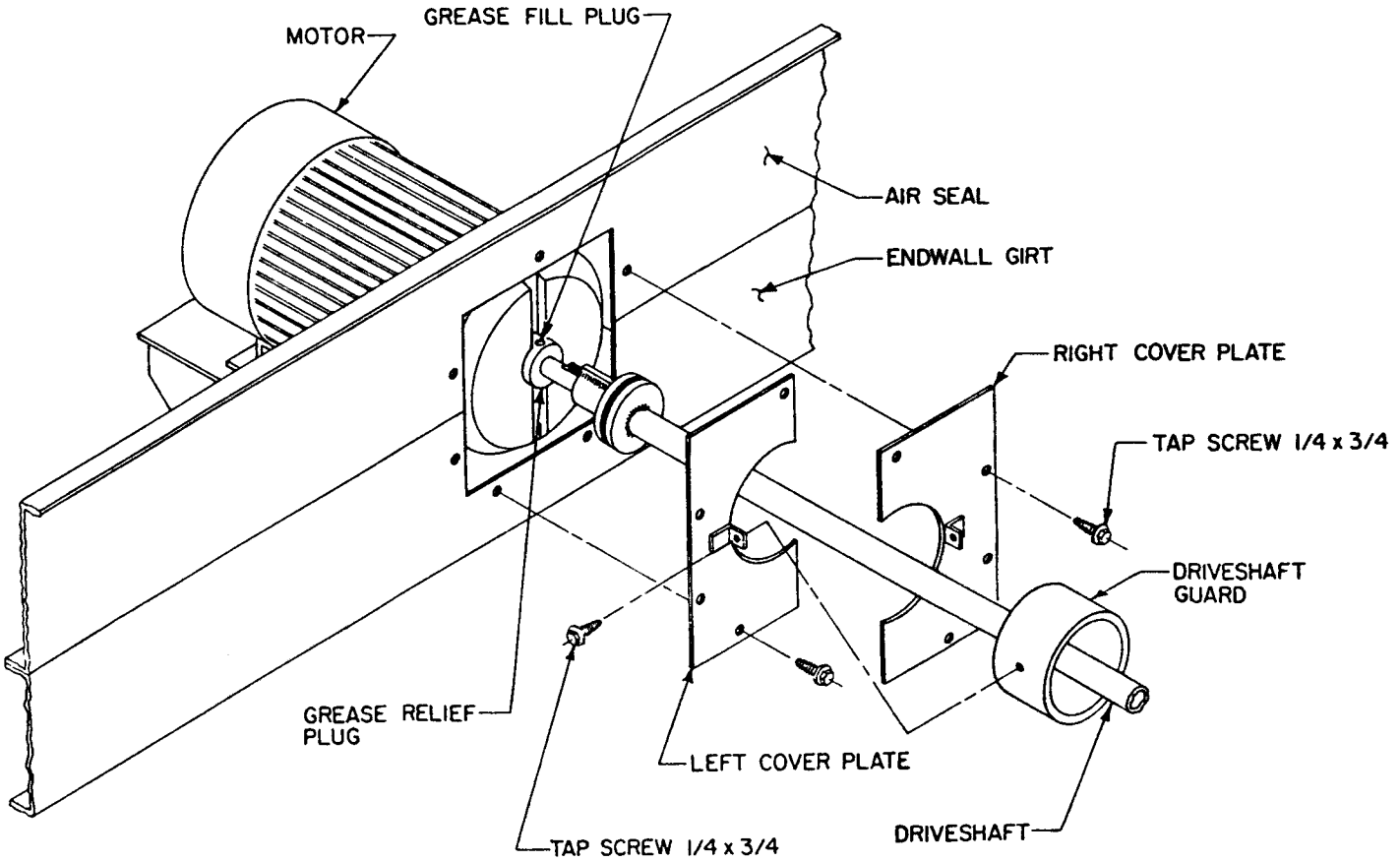
Monthly: Check Geareducer oil sample for presence of water and/or sludge. Make sure vents are open. (See Geareducer Manual.)

Semi-Annually: Drain Geareducer and refill with fresh oil, as outlined in the Geareducer Manual. If sludge is present in the oil removed, flush Geareducer before refilling.

Re-lubricate motor according to the manufacturer's instructions. See page 8 for towers with the motor located outside the plenum.

Motor Re-Lubrication Instructions

(for towers with motor located outside the plenum)



Caution: Open and lock out disconnect switch to make certain motor cannot be started.

1. Remove guard and cover plates as shown above. Opposite end motor bearing is accessible from outside the tower.

2. Remove grease fill and relief plugs at both shaft extension end and opposite end bearings and remove hardened grease, using clean wire.

3. Insert grease fittings in grease fill openings and add grease until grease is forced out through relief openings.

4. Replace fill plugs and operate mechanical equipment 30 minutes to one hour to purge excess grease at grease relief opening.

5. Reinstall grease relief plugs and reinstall guard and cover plates.

6. Resume normal tower operation.

Check to see that all bolts are tight in the fan and mechanical equipment region, including the fan cylinder and fan guard. (Use torque settings prescribed on the fan nameplate.)

Visually inspect the drift eliminators. Remove any accumulated debris or scale.

If basin silt level is significant, drain the basin and clean it out. Refer to "Cooling Tower Cleaning" section above.

Annually: Inspect the tower thoroughly, making maximum use of instructions given in the separate service manuals. Check structural bolted connections and tighten as required. Make preventive maintenance repairs as necessary.

Seasonal Shutdown Instructions

Drain the tower basin(s) and all exposed piping. Leave the basin drains open.

During shutdown, clean the tower and make any necessary repairs. Pay particular attention to mechanical equipment supports and coupling (or drive shafts).

Following each year's shutdown and cleaning, inspect the tower's metal surfaces for evidence of the need to apply a protective coating. Do not misinterpret grime – and transient rust from the piping system – as a need to have the tower painted. If relatively bright metal can be exposed by cleaning, consider that the galvanizing has remained effective. Unless there is evidence of a generalized failure of the galvanizing, localized touch-up should be all that is required.

Note: To the extent that the galvanizing (zinc coating) still exists, paint will not adhere to it readily. Contact the manufacturer of the coating you intend to use for instructions.

Tower framework: Check structural bolted connections and tighten as required.

Geareducers:

1. At shutdown, operate Geareducer until oil is warm, then drain and refill in accordance with the Geareducer service manual.

2. Each month during shutdown, drain any water that may have condensed inside the Geareducer and lubrication system. Check oil level and add oil if necessary. Operate Geareducer to re-coat all interior surfaces with oil (see "electric motors" below).

3. Check Geareducer anchor bolts and tighten as required.

4. At next season start-up, operate Geareducer until oil is warm; drain and refill.

Fans: Check fan assembly bolting and tighten as required. (Use torque settings prescribed on the fan nameplate.)

Electric motors: Clean and lubricate motor at close of each operating season. (Refer to motor manufacturer's recommendations.) Check motor anchor bolts and tighten as required. (See Page 8 for towers with motor located outside the plenum.)

Do not start motor before determining that there will be no interference with free rotation of the fan drive.

The motor should be operated for three hours at least once a month. This serves to dry out windings and re-lubricate bearing surfaces. (Refer to Marley electric motor service manual.)

At start of new operating season, make sure bearings are adequately lubricated before returning motor to service.

Prolonged Shutdown

If shutdown period is longer than seasonal, contact your Marley sales engineer for additional information.

Marley Services

Marley's interest in your Series 220 cooling tower *does not* end with the sale. Having conceived, designed, and manufactured the most reliable and longest-lasting cooling tower of its class, we want to make sure that you gain the maximum possible benefit from its purchase.

Therefore, the following services are available which are intended to – assure the maximum possible service life under your operating conditions – tailor the operating characteristics to your specific needs – and maintain consistently optimum thermal performance capability. They are available by contacting your Marley Cooling Tower Company sales engineer.

Replacement parts: With the exception of the motor, *every component of your tower is designed and manufactured by The Marley Cooling Tower Company.* We do this because commercially available components have not proved capable of withstanding the harsh environment of a cooling tower – nor do they contribute their share to the thermal capability and operating characteristics intended.

A complete stock of *all* parts and components is maintained at one or more of the various Marley plants. In cases of emergency, they can normally be shipped within 24 hours – by air freight if necessary. However, we would obviously prefer that you anticipate their need in advance, and avoid the cost of special handling.

Be sure to mention your tower serial number (from the tower nameplate) when ordering parts.

Periodic maintenance: You may wish to contract with Marley for regularly scheduled visits – for the purpose of inspecting and reporting your tower's condition – to make recommendations intended to prevent emergencies – and to perform maintenance considered outside the norm.

This service is not intended to replace the important function performed by your maintenance staff. Their attention assures the tower's routine operating performance, and is invaluable. However, Marley recognizes that the unusual manner in which a cooling tower performs its function – as

well as the unique forces which act upon it – may be considerations which occasionally require the services of an expert technician.

Increased load requirements: Series 220 towers are designed such that cells of either equal or unequal capacity can be added in the future. This allows you to compensate for the load increases that normally occur with the replacement or addition of production equipment – and still retain continuity with respect to your cooling tower system.

Tower rebuilding: Marley routinely rebuilds and upgrades cooling towers of *all* materials and makes. If your tower ever reaches the limit of its service life, we recommend that you investigate the cost of rebuilding before you routinely order a new replacement tower.

Tower Trouble Tips

Trouble	Cause	Remedy
Motor will not start	Power not available at motor terminals	1. Check power at starter. Correct any bad connections between the control apparatus and the motor. 2. Check starter contacts and control circuit. Reset overloads, close contacts, reset tripped switches or replace failed control switches. 3. If power is not on all leads at starter make sure overload and short circuit devices are in proper condition.
	Wrong connections	Check motor and control connections against wiring diagrams.
	Low voltage	Check nameplate voltage against power supply. Check voltage at motor terminals.
	Open circuit in motor winding	Check stator windings for open circuits.
	Motor or fan drive stuck	Disconnect motor from load and check motor and Geareducer for cause of problem.
	Rotor defective	Look for broken bars and rings.
Unusual motor noise	Motor running single-phase	Stop motor and attempt to start it. Motor will not start if single-phased. Check wiring, controls and motor.
	Motor leads connected incorrectly	Check motor connections against wiring diagram on motor.
	Bad bearings	Check lubrication. Replace bad bearings.
	Electrical unbalance	Check voltage and currents of all three lines. Correct if required.
	Air gap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
	Cooling fan hitting end bell guard	Reinstall or replace fan.
Fan noise	Blade rubbing inside of fan cylinder	Adjust cylinder to provide blade tip clearance.
	Loose bolts in blade clamps	Check and tighten if necessary. Check fan blade pitch. Refer to Fan Service Manual.
Scale or foreign substance in water system	Lack of or insufficient bleed-off	See "Water Treatment" section of this manual.
	Water treatment	Consult competent water treating specialist. See "Water Treatment" section of this manual.
Unusual fan drive vibration	Loose bolts and cap screw	Tighten all bolts and cap screws on all mechanical equipment and supports.
	Worn couplings or misalignment –or– Unbalanced drive shaft or worn couplings (Optional equipment)	Make sure motor and Geareducer shafts are in proper alignment and "match marks" properly matched. Repair or replace worn couplings. Rebalance drive shaft by adding or removing weights from balancing cap screws. See Drive Shaft Service Manual.
	Unbalanced fan	Be sure blades are properly positioned in correct sockets. (See match numbers.) Make certain all blades are as far from center of hub as safety devices permit. All blades must be pitched the same. See Fan Service Manual. Clean off deposit build-up on blades.
	Worn Geareducer bearings	Check fan and pinion shaft endplay. Replace bearings as necessary.
	Unbalanced motor	Disconnect load and operate motor. If motor still vibrates, rebalance rotor.
	Bent Geareducer shaft	Check fan and pinion shafts with dial indicator. Replace if necessary.

Tower Trouble Tips

Trouble	Cause	Remedy
Excessive water drift	Faulty drift elimination	1. See if all louvers and eliminators are in place and clean. 2. Check to see that nozzles are in place and clean of debris.
	Overpumping	Reduce water flow rate to tower to design conditions.
Cold water too warm (See "Tower Operation")	Overpumping	Reduce water flow rate to tower to design conditions.
	Not enough air	Check motor current and voltage to be sure of correct contract horsepower. Clean louvers, fill and eliminators.
Motor runs hot	Motor overload, wrong voltage or unbalanced voltage	Check voltage and current of all three lines against nameplate values.
	Wrong motor RPM	Check nameplate against power supply. Check RPM of motor and gear ratio.
	Bearings overgreased	Remove grease reliefs. Run motor up to speed to purge excessive grease.
	Wrong lubricant in bearings	Change to proper lubricant. See motor manufacturer's instructions.
	One phase open	Stop motor and attempt to start it. Motor will not start if single-phased. Check wiring, controls and motor.
	Poor ventilation	Clean motor and check ventilation openings. Allow ample ventilation around motor.
	Winding fault	Check with Ohmmeter.
	Bent motor shaft	Straighten or replace shaft.
	Insufficient grease	Remove plugs and regrease bearings.
	Too frequent starting	Limit cumulative starting time to a total of 30 seconds each hour.
	Deterioration of or foreign material in grease	Flush bearings and re-lubricate.
	Bearings damaged	Replace bearings.
	Incorrect fan blade pitch	Measure actual fan pitch and compare to that recommended. Correct, if necessary. See Fan Service Manual.
Motor does not come up to speed	Voltage too low at motor terminals because of line drop	Check transformer and setting of taps. Use higher voltage on transformer terminals or reduce loads. Increase wire size or reduce inertia.
	Broken rotor bars	Look for cracks near the rings. A new rotor may be required. Have motor service center check motor.
Wrong rotation (Motor)	Wrong sequence of phases	Switch any two of the three motor leads.
Geareducer noise	Geareducer bearings	If new, see if noise disappears after one week of operation. Drain, flush and refill Geareducer. See Geareducer Service Manual. If still noisy, replace bearings.
	Gears	Correct tooth engagement. Replace badly worn gears. Replace gears with imperfect tooth spacing or form.

Full-Service Local Representation

Here is a complete listing of the locations of Marley's sales and representative offices. If you need help determining the office for your area, please call toll-free **1-800-322-6200**.

Northeast Region
The Marley Cooling Tower Company
New York, NY (212) 421-3540
F. R. Foote Company, Inc.
Albany, NY (518) 482-7251
R. T. Forbes Company, Inc.
Boston, MA (617) 332-7535
The Bernard M. Packtor Company
Hamden, CT (203) 288-5241
The Johnston Equipment Co., Inc.
Rochester, NY (716) 244-3336

Mid-Atlantic & Appalachian Region
The Marley Cooling Tower Company
Philadelphia, PA (215) 627-7958
H. P. Rodgers, Inc.
Baltimore, MD (301) 252-0771
H & H Associates
Harrisburg, PA (717) 761-4370
Frank Howell Co., Inc.
Norfolk, VA (804) 495-3317
P. F. Sherman Company
Pittsburgh, PA (412) 561-8218
Frank Howell Co., Inc.
Richmond, VA (804) 788-1237
Frank Howell Co., Inc.
Roanoke, VA (703) 362-2025
John Robert Associates, Inc.
Washington, DC (301) 937-0212

Southeast Region
The Marley Cooling Tower Company
Atlanta, GA (404) 394-5330
Palmer & Lawrence, Inc.
Birmingham, AL (205) 252-9986
P.A.C.E., Inc.
Charlotte, NC (704) 376-8433
P.A.C.E., Inc.
Columbia, SC (803) 772-3060
P.A.C.E., Inc.
Greensboro, NC (919) 272-5161
P.A.C.E., Inc.
Greenville, SC (803) 242-5833
Thermal Equipment & Sales
Jacksonville, FL (904) 731-8543
Middleton & Associates, Inc.
Miami, FL (305) 661-3900
Aqua Air Products
Orlando, FL (305) 425-0573
R. M. Tugwell & Associates, Inc.
Pensacola, FL (904) 477-1200
P.A.C.E., Inc.
Raleigh, NC (919) 782-1085
Aqua Air Products
Tampa, FL (813) 885-4988

North Central Region
The Marley Cooling Tower Company
Chicago, IL (312) 574-9424
The Coon-DeVisser Co.
Detroit, MI (313) 399-6000
Hedrick Associates
Grand Rapids, MI (616) 454-1218
Chipley & Zeman, Inc.
Milwaukee, WI (414) 228-1300
Midwest Machinery Co.
St. Louis, MO (314) 647-3250

South Central Region
The Marley Cooling Tower Company
Houston, TX (713) 621-8723
Dreher & Associates, Inc.
Austin, TX (512) 327-3987
Tom Inglis Company
Corpus Christi, TX (512) 883-3833
Slack Buckner Systems
Dallas, TX (214) 340-9900
Slack Buckner Systems
Fort Worth, TX (817) 284-0964
Allen Equipment Co.
Jackson, MS (601) 956-0893
Woodbury-Beach Company
Little Rock, AR (501) 663-9421
T. J. O'Brien Engineering Co.
Memphis, TN (901) 274-9011
Fischer Engineering, Ltd.
New Orleans, LA (504) 831-6656
Zimmerman, Inc.
Shreveport, LA (318) 221-3549

Mid-America Region
The Marley Cooling Tower Company
Kansas City, KS (913) 642-9221
R. S. Stover Company
Davenport, IA (319) 386-5676
Therm-Air Sales Corporation
Fargo, ND (701) 282-9500
R. S. Stover Company
Marshalltown, IA (515) 753-5557
The Gorgen Company
Minneapolis, MN (612) 588-0823
Process Equipment Co.
Oklahoma City, OK (405) 848-5343
R. S. Stover Company
Omaha, NE (402) 339-4210
Process Equipment Co., Inc.
Tulsa, OK (918) 664-0312

Ohio Valley Region
The Marley Cooling Tower Company
Cincinnati, OH (513) 791-8602
The Craun-Liebing Co.
Cleveland, OH (216) 228-7900
Tower Equipment Company
Columbus, OH (614) 888-6066
Keller-Rivest, Inc.
Indianapolis, IN (317) 841-7750
Ferguson Equipment Co.
Knoxville, TN (615) 524-1491
P. L. Sherman Company, Inc.
Louisville, KY (502) 896-1351
Black and Wilson Associates
Nashville, TN (615) 383-6888

Rocky Mountain Region
James, Cooke & Hobson, Inc.
Albuquerque, NM (505) 344-7100
Clapper Company, Inc.
Billings, MT (406) 252-9385
J. L. Hermon & Associates, Inc.
Denver, CO (303) 792-5545
James, Cooke & Hobson, Inc.
El Paso, TX (915) 581-5458
Holbrook & Assoc., Inc.
Salt Lake City, UT (801) 943-2441

Northwest Region
Applied Equipment Company
Anchorage, AK (907) 561-4417
Oregon Air Reps, Inc.
Portland, OR (503) 221-0790
Peter A. Hartdegen Co., Inc.
San Francisco, CA (415) 653-7713
Olympic Engineered Sales, Inc.
Seattle, WA (206) 454-0701

Southwest Region
The Marley Cooling Tower Company
Los Angeles, CA (213) 283-0917
Mechanical Systems Corp.
Honolulu, HI (808) 671-2861
Ampco, Inc.
Las Vegas, NV (702) 877-6726
J. E. Redmond Electric Supply Co.
Phoenix, AZ (602) 244-0331
T&M Mechanical Sales Co., Inc.
San Diego, CA (619) 452-0531
J. E. Redmond Electric Supply Co.
Tucson, AZ (602) 884-9155

MARLEY®
the
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