fan operation should not need to exceed 1 or 2 minutes. Monitoring is required to determine the time required to melt accumulated ice.

⚠ **Warning**

Operating the fan in reverse at half speed for prolonged periods during subfreezing weather can cause severe damage to fans and fan cylinders. Ice can accumulate inside fan cylinders at fan blade plane of rotation and fan blade tips will eventually strike this ring of ice, damaging the fan blades or cylinder. Ice can also accumulate on fan blades and be thrown off, damaging fan cylinder or blades. Allow a minimum of 10 minute delay between reverse operation and forward operation during subfreezing weather to permit ice to dissipate from fan blades and fan cylinders. See Fan Drive Caution note on page 12 for fan speed change and reversing precautions.

3. With no heat load on the circulating water, icing cannot be controlled effectively by air control during freezing weather. **Towers must not be operated with reduced water rate and/or no heat load during freezing weather.** If the circulating water system cannot be shut down, water returning from the process should be made to bypass the tower. If a bypass is used, **all** water must be bypassed without modulation. If the water bypass is directly into the tower's cold water basin, its design must be approved by SPX Cooling Technologies.

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.
If tower basin is drained, verify that all basin heaters have been shut off either by automatic cutoff or disconnect switch.

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

Water Treatment and Blowdown

Maintaining Water Quality:

The steel used in MD towers has been galvanized with a heavy zinc coating averaging 2.0 mils in thickness. The MD stainless steel option is even more corrosion resistant than galvanized steel in certain environments. Other materials used (PVC fill, drift eliminators, and louvers, aluminum fans, etc.) are selected to offer maximum service life in a "normal" cooling tower environment, defined as follows:

Circulating water with a pH between 6.5 and 8; a chloride content (as NaCl) below 500 mg/L; a sulfate content (SO4) below 250 mg/L; total alkalinity (as $CaCO_3$) below 500 mg/L; calcium hardness (as $CaCO_3$) above 50 mg/L; a maximum inlet water temperature not to exceed 125°F (51.7°C); no significant contamination with unusual chemicals or foreign substances; and adequate water treatment to minimize scaling.

- Startup Conditions: The water conditions during the initial tower operation are crucial in preventing premature corrosion of galvanized steel (white rust). For at least the first eight weeks of operation, pH should be controlled between 6.5 and 8.0 with hardness and alkalinity levels between 100 and 300 mg/L (expressed as $CaCO_3$).
- Chlorine (if used) shall be added intermittently, with a free residual not to exceed 1 mg/L—maintained for short periods. Excessive chlorine levels may deteriorate sealants and other materials of construction.
- 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).
- Many proprietary chemicals exist for control of scale, corrosion, and biological growth and should be used prudently. Also, combinations of chemicals may cause reactions which reduce treatment effectiveness, and certain chemicals such as surfactants, biodispersants and antifoams may increase drift rate.

Note

Unless you purchased a stainless steel MD, the structure of your MD tower consists primarily of galvanized steel, therefore your water treatment program must be compatible with zinc. In working with your water treatment supplier, it is important that you recognize the potential effects on zinc of the specific treatment program you choose.

operation

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 Pneumophila, to avoid the risk of sickness or death. Service personnel must wear proper personal protective equipment during decontamination. 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. See Tower Startup instructions on page 12.

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 makeup 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 shows

the minimum amount of blowdown (percent of flow) required to maintain different concentrations with various cooling ranges*:

Cooling Range	Number of Concentrations						
	1.5X	2.0X	2.5X	3.0X	4.0X	5.0X	6.0X
5° F (2.78° C)	.78	.38	.25	.18	.11	.08	.06
10° F (5.56° C)	1.58	.78	.51	.38	.25	.18	.14
15° F (8.33° C)	2.38	1.18	.78	.58	.38	.28	.22
20° F (11.11° C)	3.18	1.58	1.05	.78	.51	.38	.30
25° F (13.89° C)	3.98	1.98	1.32	.98	.64	.48	.38
Multipliers are based on drift of 0.02% of the circulating water rate.							

* Range = Difference between hot water temperature coming to tower and cold water temperature leaving tower.

EXAMPLE: 700 GPM circulating rate, 18°F cooling range. To maintain 4 concentrations, the required blowdown is 0.458% or .00458 times 700 GPM, which is 3.2 GPM.

If tower is operated at 4 concentrations, circulating water will contain four times as much dissolved solid as the makeup water, assuming none of the solids form scale or are otherwise removed from the system.

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.

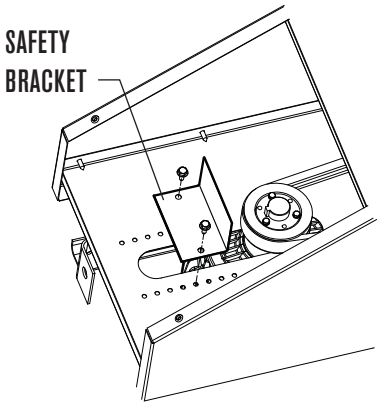
Belt Tensioning

⚠ Warning

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

On the **MD5008** and **MD5010**, the fan motor and belt adjustment mechanism is located outside the tower. Remove the motor protection hood by loosening the two thumbscrews on top and hinge the hood up and out of the way. Also, remove the motor sheave safety bracket and set aside. See the following images.

maintenance

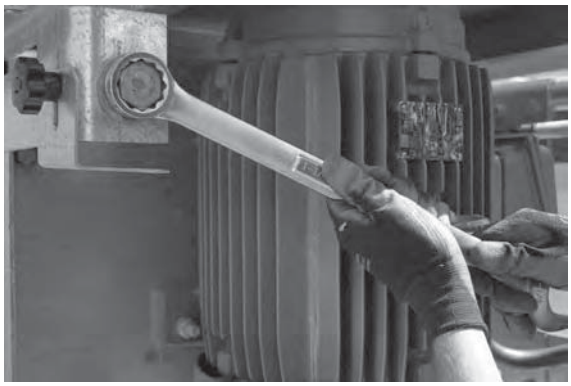


On the **MD5016** the motor is located inside the tower plenum. Open the access door (see Access Door Opening Procedure) and hinge out of the way.

⚠ Caution

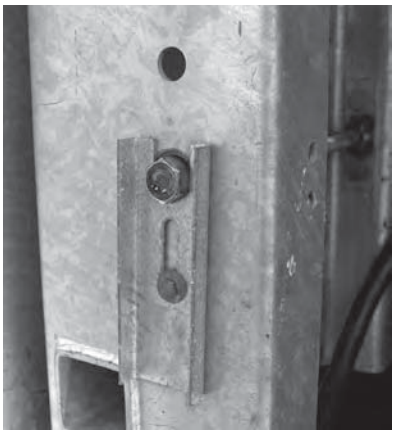
Any bolts removed functioning as mechanical or structural hardware should be replaced with the torques specified below.

Fastener Torque Values				
Machine Bolt Size	**Galvanized**		**Stainless**	
	$ft{\cdot}lb_f$	N·m	$ft{\cdot}lb_f$	N·m
8mm	8	10	15	20
10mm	15	20	30	40
12mm	25	35	50	65
16mm	65	85	120	160
20mm	125	170	230	315



Belt tension on all models is adjusted by turning a large threaded rod that drives the motor mounting plate away from (or toward) the fan centerline. To turn this rod, the rod retention bracket must first be moved. On the models with motors located externally loosen the thumbscrew holding this bracket in place and rotate the bracket away from the assembly. On models with the motor located in the plenum the rod

retention is held in place with fasteners. Loosen fastener and slide the bracket away from the adjusting rod. Turn the rod clockwise to drive the motor away from the fan (tighten belts) or counterclockwise to drive the motor toward the fan (loosen the belts). There is no need to loosen any other hardware to adjust the belt tension. After belt tension is adjusted to a satisfactory position, install the rod retention bracket with the thumbscrew and replace any safety hoods.



Ideal tension is the lowest tension at which the belt will not slip under peak load conditions. Check tension frequently during the first 24-48 hours of run-in operation. Overtensioning shortens belt and bearing life. Keep belts free from foreign material which may cause slipping. Never apply belt dressing as this will damage the belt and cause early failure. Specific tools are made to measure the tension of a V-belt drive system. A Dodge® V-Belt Tension Tester, Browning® Belt Tension Checker or equivalent an alternative should be used for tensioning V-belts. Check with you local belt supplier.

Belt tension is measured by applying a force perpendicular to the belt at the center point between motor and fan sheaves. The belt should deflect 1/64 of the entire span, (measured sheave centerline to sheave centerline) when the pressure shown in the table below is applied. Because belt tension is a function of the motor sheave

to determine the diameter. If diameter markings are unreadable, measure the sheave diameter at the **bottom** of the sheave grooves.

New belts (operating less than 8 hours) should be tensioned to the maximum value. Tension after this period should use no less than the minimum value. If the belt span was measured in inches, then use the pounds of force values. If the belt span was measured in centimeters, then use the kilograms of force values. If specific tensioning instructions are provided with your tensioning tool, those instructions should be used instead.

Motor Sheave diameter	**Used V-Belt** minimum	**New V-Belt** maximum
3.4" - 4.2"	4.9 lb	7.2 lb
85cm - 105cm	2.2 kg	3.3 kg
4.4" - 5.6"	7.1 lb	10.5 lb
106cm - 140cm	3.2 kg	4.8 kg
5.8" - 8.6"	8.5 lb	12.6 l
141cm - 220 cm	3.9 kg	5.7 kg

Sheave Alignment

⚠ **Warning**

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

- The motor sheave is to be positioned as close as possible to the motor in order to minimize torque on the motor bushings.
- The motor and fan sheaves may have grooves that are not used. The bottom surface of the motor and fan sheaves must be aligned within ⅛" of each other and level within ½° (⅛" in 12") in order to not adversely affect belt and sheave life.
- Alignment can be achieved by placing a straight edge across the top of the sheaves making sure that it is level and measuring down to the bottom surface of both sheaves at four points. See photo.
- The number of grooves on the motor and fan sheaves may not match each other, or the number of grooves on the belt. Always install the belts on the highest grooves on the fan sheave. Doing so will reduce the force on the fan shaft bearings, thus increasing their life.

Sheave Assembly Bolt Torque		
Busing Type	$ft{\cdot}lb_f$	N·m
SD	5	10
SK	15	20
SF	25	30
E	35	50

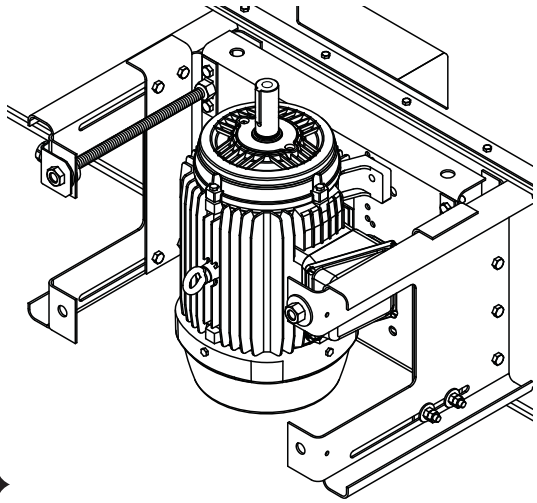
⚠ Warning

Fan Motor Access and Removal

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

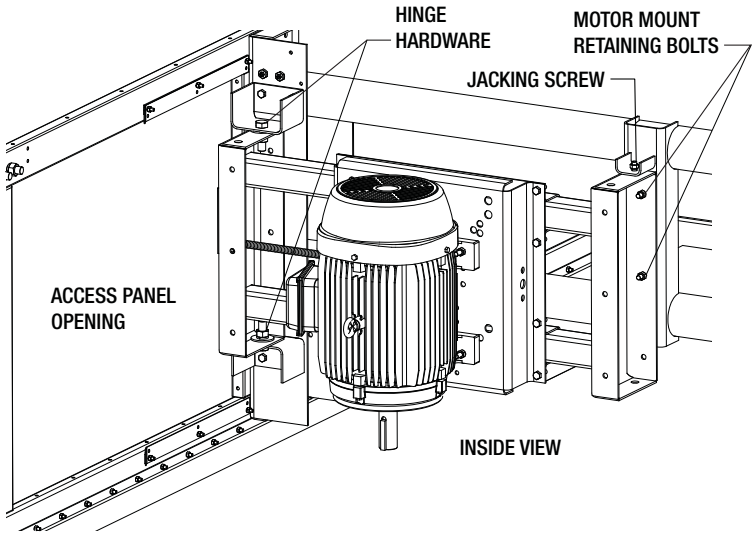
The MD fan motors are located inside or outside the tower, depending on the model. The **MD5008** and **MD5010** fan motor is located outside the tower. The motor is fully accessed by removing the motor protection hood. Remove motor protection hood and the drive belt by following the instructions in the **Belt Tensioning** section.

The **MD5008** and **MD5010** motors are oriented with the shaft up. The motor may be hoisted by threading an eye bolt into the motor shaft and lifting with a hoist. To remove the motor fastener hardware, lift on the motor slightly with the hoist to remove the weight from the fasteners, loosen and remove all hardware.



maintenance

The **MD5016** fan motor is located inside the tower. The motor can be accessed through the mechanical access panel. See the **Access Door Operation** section for instruction on opening the access panel. For greater access to the motor, the motor mounting system can be swung outside the tower to facilitate maintenance and removal. Remove the drive belt by following the instructions in the **Belt Tensioning** section. Loosen the motor mount system retaining bolts shown in the image. It is not necessary to loosen any hardware other than what is indicated. Hinge the motor mounting system 90° out through the access panel.



The **MD5016** motor is installed with the shaft down. There is no acceptable location on the motor to hoist with the motor in this orientation. The motor should be hoisted by leaving it attached to the motor mount mechanism and removing the entire mechanism from the torque tube. After swinging the mount outside of the tower, attach the mount to a hoist with straps or chains. Lift slightly on the mount with the hoist to remove the weight from the hinge fasteners, then loosen and remove hinge hardware. Only remove the hardware shown.

⚠ Caution

Depending on the motor frame size, the center of gravity of the motor assembly mount may be off center. Always hoist from the top of the motor mount

If the motor is removed from the mounting plate, it should be reinstalled at the torques specified on the following page—do not lubricate the bolts. Reassemble the mechanical system, following the instructions above in reverse. When fastening the motor mount mechanism to the torque tube, first insert

the fasteners closest to the access panel that acts as a hinge. After tightening this hardware, swing the motor in and attach it to the torque tube. Due to the weight of the motor cantilevered on the hinge, the motor mechanism may sag. When attaching to the torque tube, it may be necessary to align the holes with the jacking screw shown in the image.

Motor Mounting Bolt Torque				
Machine Bolt Size	Galvanized		Stainless	
	$ft{\cdot}lb_f$	N·m	$ft{\cdot}lb_f$	N·m
10mm	15	20	30	40
12mm	25	35	50	65
16mm	65	85	120	160
20mm	125	170	230	315

Cold Water Basin Access / Air Inlet Louver Removal

Some maintenance procedures require access to components located in the cold water collection basin. All maintenance procedures can be performed from the perimeter of the tower therefore there is no reason to enter basin. To access the basin, one of the air inlet louver frames must be removed. To remove, loosen the thumbscrews indicated in the image below and push the louver retaining bracket up and to the left to move out of the way of the louver frame. Tip the top of the frame out from the tower, then remove. Louver frames are not the same size, if more than one louver frame is removed, the original location should be noted.

⚠ Caution

Collection basing floor has uneven surfaces and has the potential to be slippery. Care should be taken if entering the basin.

maintenance

Access Door Operation

⚠ Warning

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

To allow access to the mechanical system, eliminators, water distribution system and fill surface, a access door is provided toward the top of the tower. To open, follow the following steps:

1. Remove any lock that is securing the door shut.
2. Loosen and remove the locking knob at the center of the access door panel.
3. Slide the panel with the handle sideways as far as it will travel.
4. Push the panel toward the inside of the tower. The panel will hinge to the side.

Drift Eliminator Removal and Replacement

The drift eliminators may be removed for cleaning, replacement or access to the distribution system. The eliminators are held in place by a press fit, so there is no need to remove any fasteners. However, eliminators are formed so that they nest with each other and form a monolithic barrier. Individual packs of eliminator are formed into 2'-0 wide sections that span from the casing wall to the centerline of the tower, just under the mechanical torque tube. It is recommended that personal protection is used when handling the eliminator pieces, sharp edges and corners can cause abrasions.

To remove the eliminator, stand inside the access panel and lift with two hands on an eliminator section, this will indicate where one section stops and another starts. Lift the eliminators at that intersection, removing two packs at one time (see image). Once the first two packs are removed, the remaining packs should be easily removed. Pay close attention to the orientation and placement, they are not symmetrical. Each pack should be replaced at the location which it was removed. Repeat this process for the second half of the tower.

Note

Proper eliminator pack replacement is essential to tower operation. Incorrect installation may result in excessive drift rates and fan inefficiency! To ensure packs are reinstalled in the correct orientation, it is recommended that one pack is left in its original location inside the tower as a reminder of pack orientation. Place packs in the tower in the order they were removed. Packs should nest tightly with each other, leaving a level surface with no gaps. The last two packs should be installed at the same time. Place the final two packs according to the image above, and push down to complete.

maintenance

Distribution System Maintenance

To keep your MD cooling tower operating at peak performance, it may be necessary to clear the spray system of debris or sediment. To access the spray system, remove the drift eliminators as explained in the previous section. Observe the spray system with full flow on the unit. Each nozzle should produce a cone pattern spray which overlaps the adjacent nozzle patterns—see image.

If a nozzle appears clogged or is not producing a cone patter, remove the nozzle and clean all surfaces. To remove the nozzle, pull down sharply on the plastic component, leaving the rubber grommet seated in the PVC pipe. Inspect the nozzle for cleanliness or broken pieces. Each nozzle should have a turbulator inside the outer shell—see image. If the nozzle appears broken or damaged, consult your Marley representative for replacement parts. Insert the nozzles by pressing it back into place inside the rubber grommet. It may be necessary to wet the nozzle and grommet to facilitate assembly.

It may also be necessary to remove an entire branch arm from the spray system. Each arm is held in place with a retention strap bolted to the branch arm supports. Remove the bolts attaching the strap to the support and pull sharply on the branch arm to disengage from the header box. It may be necessary to rotate the branch arm while pulling out from the header box.

maintenance

When branch arms are removed, access to the interior of the spray header box is available to clean and remove any debris or sediment. A drain nozzle at the centerline of the header box is intended to drain water from the system at shutdown, as well as be removed to wash out the header box if necessary. Be sure to replace this nozzle if removed.

Reinstall the branch arms to the header, engaging them far enough to align the bolts of the tie down strap to the spray system supports. It may be necessary to wet the rubber grommet and pipe to facilitate assembly. Ensure that all nozzles are aligned to the bottom of the branch arm.

Schedule of Tower Maintenance

Some procedures may require maintenance personnel to enter the tower. Each cell has an access door for entry into the tower. All tower maintenance can be performed from this location. An optional mechanical access platform is designed and intended solely for personnel to gain access to the motor and access door. Upon entering the tower, the eliminators and fill may be used as a walking surface for tower inspection and typical maintenance. For those instances of frequent or prolonged servicing, it is necessary to protect the surface with plywood or planking. The fan deck and fan guard are not designed as a walking or working surfaces. There are no maintenance procedures that require access to top of the tower.

⚠ Warning

The purchaser or owner is responsible for providing a safe method for entering or exiting the access door.

Included with this instruction packet are separate User Manuals on each major operating component of the tower, and it is recommended that you read them thoroughly. Where discrepancies may exist, the separate User Manuals will take precedence. The following is recommended as a minimum routine of scheduled maintenance:

⚠ Warning

Always shut off electrical power to the tower fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

maintenance

Weekly: Inspect for bacterial growth and general operation conditions. Bacterial growth should be reported to your water treatment expert for immediate attention.

Monthly (Weekly at start up): Observe, touch, and listen to the tower. 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. Observe operation of the motor, belt, sheaves 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.

Inspect air inlet louvers, drift eliminators and basin trash screens and remove any debris or scale which may have accumulated. Replace any damaged or worn out components. Use of high-pressure water may damage the eliminator, fill and louver material.

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

View the water pattern as it exits the fill section. Consistent coverage indicates that all nozzles are flowing properly. If there are dry spot in the fill or inconsistent coverage, this may be evidence of a clogged nozzle. Inspect nozzles for blockage.

Every 3 months: Lubricate fan shaft bearings. Each cell is equipped with extended lube lines protruding through the casing adjacent to the access door. While rotating equipment by hand, grease the bearings until a bead forms around the seals—a maximum charge of 0.75 ounces is recommended. Mobil SHC 460 grease is recommended.

Semi-Annually: Check belt tension and condition. Adjust tensions as necessary.

Clean and disinfect cooling tower with biocides. Systems with biofouling, high general bacterial counts, or positive cultures of legionella may require additional cleaning. Refer to "Cooling Tower Cleaning" section—page 20. Consult your water treatment expert as to prudent biological evaluation testing.

For those regions that require semi-annual fill removal and cleaning, remove the fill through the fill access hatch (regional option) or the mechanical access panel. Note the orientation and location of fill blocks. They must return into the tower in the same location from which they were removed. Failure to do so may result in diminished thermal capacity.

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

Lubricate motor according to the manufacturer's instructions. Check to see that all bolts are tight in the fan and mechanical equipment region, including the fan cylinder and fan guard. Refer to Component User Manuals for torque values.

Inspect the spray system and nozzles for any blockage. Nozzles can be removed from the grommet by pulling sharply down on the nozzles. To replace the nozzles, wet the surface of the nozzle and grommet and push nozzle back into place.

Seasonal Shutdown Instructions

When the system is to be shut down for an extended period of time, it is recommended that the entire system (cooling tower, system piping, heat exchangers, etc.) be drained. Leave the basin drains open.

During shutdown, clean the tower (see Warning, page 20) and make any necessary repairs. Pay particular attention to mechanical equipment supports.

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 casing and structural bolted connections and tighten as required.

Fan: Check fan assembly bolting and tighten as required. Use torque values prescribed in the Fan User Manual.

Fan shaft bearings: Lubricate fan shaft bearings at close of each operating season—see page 32.

Clean and lubricate motor at close of each operating season (refer to motor manufacturer's recommendations.) Check motor anchor bolts and tighten as required.

⚠ Warning

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 User Manual"** Manual 92-1475).

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 representative for additional information.

maintenance

SPX Cooling Technologies Services

Our interest in your MD 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 sales representative.

Replacement parts: A complete stock of 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, you would obviously benefit from anticipating your need in advance, thus avoiding 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 SPX 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, we recognize 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.

maintenance schedule

Maintenance Service	Monthly	Semi-annually	Seasonal Startup or Annually
Inspect General Condition and Operation	x		x
Observe Operation of:			
Mechanical–motor, fan and drive mechanism	x		x
Makeup valve (if equipped)	x		x
Inspect for unusual noise or vibration	x		x
Inspect and Clean:			
Air inlet	x		x
PVC drift eliminators	x		x
Nozzles	x		x
Fan motor exterior	x		x
Check:			
Collection water basin level	x		x
Blowdown–adjust as required	x		x
Lube lines:			
Check for oil leaks in hoses or fittings	x	R	x
Belt drive:			
Fan shaft bearing lubrication (every 3 mo.)		every 3 months	every 3 months
Check and tighten support fasteners			x
Check shaft, sheave and belt alignment			x
Check belt tension and condition		x	x
Check sheave bushing fastener torque			x
Fan:			
Check and tighten blade and hub fasteners			x
Check fan blade pitch and tip clearance			x
Check fan cylinder for loose fasteners			x
Motor:			
Lubricate (grease as required)			R
Check mounting bolts for tightness			x
Operate at least	3 hours a month	3 hours a month	3 hours a month
Basin Heater (if equipped):			
Check for proper operation of temp/low water level sensor			x
Inspect/clean buildup of contaminant from sensor		x	x
Structure:			
Inspect/tighten all fasteners		x	x
Inspect and touch up all metal surfaces			x

R — Refer to Component User Manual

Note: It is recommended at least weekly, that the general operation and condition be observed. Pay attention to any changes in sound or vibration that may signify a need for closer inspection.

additional information

Increased load requirements: MD towers are designed so 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: SPX Cooling Technologies routinely rebuilds and upgrades cooling towers of all materials and manufacture. 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.

Each MD tower includes a document package containing general orientation drawings, **"MD Field Installation Manual"** Assembly Instructions, and tower component manuals. **These documents contain important information relating to safe installation and operation of the cooling tower.** Field installation is always required for fan guards, piping inlets and piping outlets. Some optional accessories, such as valves, handrails, ladders and safety cages may also require field installation. If installation details are not covered in the **"MD Field Installation Manual"** a separate installation drawing or manual for each purchased option is included in the document package along with bills of material. If you have purchased an option and can't find the appropriate installation drawing, contact your local Marley sales representative before proceeding.

In addition to these specific documents, SPX publishes numerous technical reports including more detailed information on a variety of cooling tower operation and service topics. Your Marley sales representative will be happy to give you copies of these reports at no charge.

For complete parts and service assistance, contact the Marley sales representative in your area. If you need help locating the office nearest you, please phone 913 664 7400 or check the internet at spxcooling.com.

troubleshooting

Trouble	Cause	Remedy
Motor Will Not Start	Power not available at motor terminals	• Check power at starter. Correct any bad connections between the control apparatus and the motor.
		• Check starter contacts and control circuit. Reset overloads, close contacts, reset tripped switches or replace failed control switches.
		• 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 defectve	Look for broken bars or 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 voltages 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
Motor Runs Hot	Wrong voltage or unbalanced voltage	Check voltage and current of all three lines against nameplate values.
	Overload	Check fan blade pitch. See Fan Service Manual. Check for drag in fan drive train as from damaged bearings.
	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 or speed changes	Limit cumulative acceleration time to a total of 30 seconds/hr. Set on/off or speed change set points farther apart. Consider installing a Marley VFD drive for fine temperature control.
	Deterioration of grease, or foreign material in grease	Flush bearings and relubricate.
	Bearings damaged	Replace bearings
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 person check motor.
Wrong Rotation (Motor)	Wrong sequence of phase	Switch any two of the three motor leads.

troubleshooting

Trouble	Cause	Remedy
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.
	Gears	Correct tooth engagement. Replace badly worn gears. Replace gears with broken or damaged teeth.
Unusual Fan Drive Vibration	Loose bolts and cap screws	Tighten all bolts and cap screws on all mechanical equipment and supports.
	Unbalanced drive shaft or worn couplings	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.
	Fan	Make certain all blades are as far from center of fan 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 shaft with dial indicator. Replace if necessary.
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.
Scale or foreign substance in circulating water system	Insufficient blowdown	See "Water Treatment" section of this manual
	Water treatment deficiency	Consult competent water treating specialist. See "Water Treatment" section of this manual
Cold Water Temperature Too Warm (See "Tower Operation")	Entering wet bulb temp. is above design	Check to see if local heat sources are affecting tower. See if surrounding structures are causing recirculation of tower discharge air. Discuss remedy with Marley representative.
	Design wet bulb temp. was too low	May have to increase tower size. Discuss remedy with Marley representative.
	Actual process load greater than design	May have to increase tower size. Discuss remedy with Marley representative.
	Overpumping	Reduce water flow rate over tower to design conditions.
	Tower starved for air	Check motor current and voltage to be sure of correct contract horsepower. Re-pitch fan blades if necessary. Clean louvers, fill and eliminators. Check to see if nearby structures or enclosing walls are obstructing normal airflow to tower. Discuss remedy with Marley representative.
Excessive Drift Exiting Tower	Faulty drift elimination	Check to see that integral fill, louvers, and eliminators are clean, free of debris, and installed correctly. If drift eliminators are separate from fill, make sure they are correctly installed in place. Clean if necessary. Replace damaged or worn out components.

SPX®
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MD 5000
user manual

SPX COOLING TECHNOLOGIES, INC.
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OVERLAND PARK, KANSAS 66213 USA
P: 913 664 7400
F: 913 664 7439
spxcooling@spx.com

ISSUED 09/2012 M08-1616D

Project: U S Govt - V A Hospital
2615 EAST CLINTON AVENUE
FRESNO CA 93703-2223

For: Norman S. Wright Company
99A South Hill Drive
Brisbane CA 94005

Performance Conditions:
Flow Rate: 3,600.00 GPM Hot Water: 95.00F Cold Water: 85.00F Wet Bulb: 74.70F
Motor Capacity per Cell: 30.00 HP Motor Output per Cell: 30.00 HP
Fan Speed RPM: 233.00 Trial Fan Pitch Degrees: 16.50

Order No: 10101823 Model No: MD5018SCF2LCGF PO No: MP150074-0001
Sales Office Order No: MP150074-0001

Please contact your local sales representative if you have any questions:

Norman S. Wright
4901 Warehouse Way
Sacramento CA 95826-4905
Phone:
Fax:
Email: kli@norman-wright.com

Your local sales representative will be happy to quote current parts price and lead time upon request. Go to http://spxcooling.com for a full list of representatives.

This package contains the following user manuals:

Manual	Rev	Description
07-1205	A	OM-CPLG MC07 MC09&MC11
08-1616	D	MD SERIES USER MANUAL
2010-1241		Marley M-5 Vibration Switch User Manual
2012-1165		Marley Ultra Quiet Fan User Manual
92-1184	B	WHITE RUST SERVICE MANUAL
92-1308	A	DM-MDT-C DOWNTIME MANUAL
92-1475	A	SM-MOTOR-M MOTOR IOM MANUAL
99-1260	E	OM-GRDR 2200 - 2250 - 2400
SPEC_LLC_09		Liquid Level Control Panel Specification

/ **Marley M-5** *Vibration Switch* /

User Manual 2010-1241

Marley®
AN SPX BRAND

Installation

This bulletin should be used by experienced personnel as a guide to the installation of the Marley M-5 vibration switch. Selection or installation of equipment should always be accompanied by competent technical assistance.

⚠ Caution

Before proceeding to install and wire the unit, read and thoroughly understand these instructions. The switch model number should be checked to confirm that you have the correct hazardous area rating for your application.

Installation

1–The sensitive axis of the vibration switch is perpendicular to the mounting base. The preferred mounting is with the sensitive axis in the horizontal plane, since most machines vibrate more in that plane. Mount the switch solidly to the frame of the machine. In most cases the switch or mounting bracket will come preinstalled.

2–Remove the cover and wire the switch(es) into the alarm or shutdown circuit. Do not exceed switch contact ratings listed in the specifications. Keep field wiring away from the moving part of the mechanism.

3–Observe all local electrical codes.

4–All the power must be switched off before opening of the enclosure in an explosive atmosphere.

5–The Vibration Switch must be electrically connected by means of a flameproof cable gland or stopping box certified to EN 50018.

6–For ambient temperatures below +14°F and above +140°F use field wiring suitable for both minimum and maximum ambient temperature.

7–Reinstall the cover by first insuring the sealing gasket is in place and properly seated in the grove in the housing. Place the cover on the unit and install the four cover bolts. Torque the four bolts to 16 ft·lb. Caution should be used to not over-torque the bolts as this could damage the housing and compromise the seal.

8–The temporary conduit entry plugs are placed in the housing to provide physical protection for the threads during shipping. Once the unit is installed in the field these plugs must be replaced. These temporary plugs do not provide adequate environmental protection for the switch when installed in the field.

Installation

Vibration Switch Testing

⚠ Warning

The vibration switch is a safety circuit acting as a run permissive for the VFD or starter controlling the fan motor. Follow lockout / tagout procedures on the fan starting equipment.

⚠ Caution

A special tool is required to adjust the setpoint—do not attempt to adjust. Adjusting the setpoint will VOID the warranty. The setpoint is factory set at 1g which is more than sufficient to allow the mechanical equipment to get up to speed without tripping the motor. The default trip setting should allow for a full voltage start and operation at all speeds.

Note

During installation and testing, if a problem with either the sensitizing or desensitizing setting is suspected or you think the unit is defective, do not attempt to adjust the setpoint. Call 800-462-7539 or 281-940-1802 Field Service or 713-702-8805 Technical Assistance after hours for troubleshooting.

To test the operation of the electrical contacts in the vibration switch please follow one of the provided procedures below. The first test procedure is the recommended procedure to use without having to remove the switch cover.

Test 1 – Do not adjust the setpoint. Loosen the four mounting bolts on the vibration switch support—do not remove. Either lightly tap or shake the vibration switch thus triggering the unit indicating the unit is active. Retighten the mounting bolts and reset the unit.

Test 2 – Do not adjust setpoint. Remove the cover to expose the inside of the switch. Using a screwdriver, toggle the trip plate to force the electrical contacts open and closed. The trip plate is bright metal and measures 1¾" x 1" and is located towards the bottom of the switch. With the adjusting pin located to the left, the normally closed contact will be closed when the right hand side of the trip plate is depressed. Check continuity at the terminal points COMMON and NORM CLOSED or at the fan controller to confirm contacts are operational. A typical control circuit uses a closed contact to allow the fan to run. An open contact means excessive vibration has occurred shutting off the starter or VFD.

Installation

Note

As stated previously, adjusting the setpoint will void the warranty on this switch. If by either accident or intentionally, the setpoint is tampered with, the following instructions are provided indicating how to properly readjust the setpoint. If the proper setpoint cannot be achieved through these steps, then call for technical assistance. In order to adjust the setpoint, a special tool is required and may be furnished upon request from SPX Cooling Technologies.

Turning Setpoint Adjustment Too Far Counter-Clockwise

- If the setpoint adjustment is turned too far counter-clockwise (approximately 3-4 turns) the switch will trip and will not stay in a reset position after depressing the manual reset push-button.
- At approximately 11 turns the switch will trip and cannot be reset because the spring and adjusting rod have dislodged out of position. There is no mechanical stop position when turning counter clockwise. Repair of the internal mechanism can be accomplished in the field by removing the internal switch mechanism from the switch body. The switch mechanism is held in with three screws. Once removed the adjusting rod and spring may be put back into operating position.

Turning Setpoint Adjustment Too Far Clockwise

- The adjusting rod has a nylon stop bushing preventing the rod from being over turned. Once the adjustment bottoms out, the switch is at or beyond the maximum setting and may not trip on vibration.

Getting The Adjustment Position Back To Normal

- Once an adjustment is out of range and the rod and spring have not been dislodged the switch may be adjusted back to normal settings. With the switch cover removed rotate the adjusting rod clockwise until it bottoms out. Push the right hand side of the trip plate down to reset the switch. At this point the NORM CLOSED CONTACT is closed. Rotate the adjusting rod approximately two turns counter-clockwise slowly or until the trip bar moves up with a click. Then rotate the adjusting rod clockwise one full turn. If the cooling product fan start or run position trips the switch then rotate the adjusting rod clockwise in ⅛ increments until the trip holds in.

Installation

Electrical Reset and Startup Lockout

The optional electrical reset circuit consists of an electrical solenoid in series with a thermistor. If the rated voltage is continuously applied to the reset circuit at startup, the reset solenoid energizes for a fixed time interval (approximately 30 seconds), after which time the solenoid is automatically de-energized by the thermistor. This action provides a trip lockout during machine startup roughness. The voltage must be removed from the reset circuit when the fan motor is stopped to allow the thermistor to cool off. The switch mechanism can then be reset electrically by a momentary application of the reset voltage or it can be reset manually.

Note

If the fan motor is restarted immediately after a shutdown, the lockout period will be shortened because the thermistor will be hot. An increase in the ambient temperature will also shorten the lockout period.

Specifications

Function–Armature mechanism trips on high vibration and operates snap action switch(es).

Frequency Range–0 to 3600 RPM.

Reset–Local reset, plus optional remote reset electrical coil. See How to Order ("D").

Start Delay–Applying reset coil voltage at start up holds mechanism from tripping for 20-30 seconds, after which the switch is active. Requires electric reset option.

Temperature Range– -40°F to 160°F

Enclosure–High strength copper-free (4/10 of 1% max) aluminum alloy.

Environmental Rating–NEMA 4, IP 65 & CE Mark (NEMA 4X Optional).

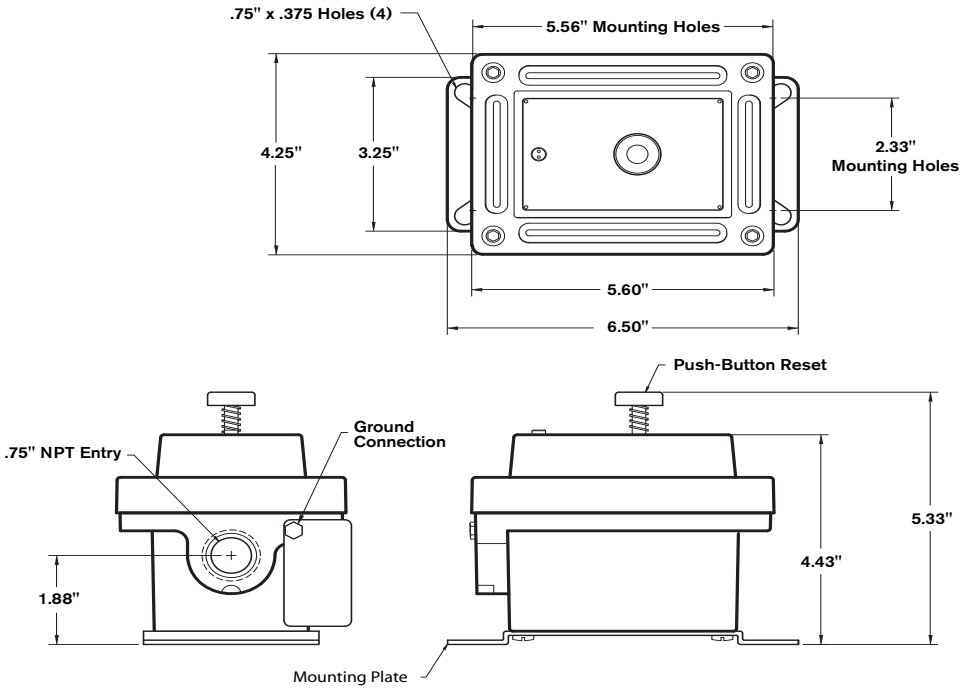
Switch Contact(s) Rating–15 amps, 125, or 480 VAC; ⅛ hp, 125 VAC; ¼ hp, 250 VAC; ½ amp, 125 VDC; ¼ amp, 250 VDC.

Hazard Rating–See How to Order ("A").

Weight–4.0 lb

Information

Schematic



Wiring

Dependent on switch configuration

DPDT Contacts 1 2 3 4 5 6 L (+) 7 Reset Coil N (–) 8 Reset Coil GRN Case	SPDT Contacts 1 2 3 L (+) 4 Reset Coil N (–) 5 Reset Coil GRN Case
DPDT Contacts 1 2 3 4 5 6	SPDT Contacts 1 2 3

Information

How To Order

For new or replacement vibration switches call 1-800-4Marley

M-5 ❑ ❑ ❑ - ❑ ❑ ❑ (A B C - D E F)

Example: **M-5 111-010**

A ❑ Hazard Rating

0 = None

1 = UL, cUL Explosion Proof, Class I, Div 1, Groups C and D
Class II, Div 1, Groups E, F and G

2 = UL, cUL Explosion Proof, Class I, Div 1, Groups B, C and D
Class II, Div 1, Groups E, F and G

B ❑ Contacts

1 = SPDT 2 = DPDT

C ❑ Full Scale Range

1 = 5g 2 = 2g 3 = 10g

D ❑ Reset Coil and Startup Delay

0 = None 1 = 115VAC 2 = 230VAC 3 = 24VDC 4 = 115VDC

E ❑ Wiring Entry/Mounting Plate (retro fit)

1 = ¾" NPT 6 = M20 x 1.5

F ❑ Environmental Rating

0 (or blank) = NEMA 4, IP65 1 = NEMA 4X, IP65

Tested for compliance with the applicable EC Electromagnetic Compatibility requirements

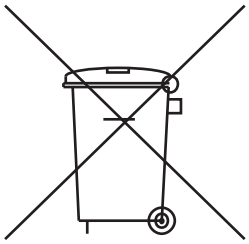
CE

note When Option **C** = 2, Option **D** cannot = 3 for operation in the horizontal axis.
When Option **A** = 1 or **A** = 2, Option **E** cannot = 6

Information

Environmental

Note



This electronic equipment was manufactured according to high quality standards to ensure safe and reliable operation when used as intended. Due to its nature, this equipment may contain small quantities of substances known to be hazardous to the environment or to human health if released into the environment. For this reason, Waste Electrical and Electronic Equipment (commonly known as WEEE) should never be disposed of in the public waste stream. The “Crossed-Out Waste Bin” label affixed to this product is a reminder to dispose of this product in accordance with local WEEE regulations. If you have questions about the disposal process, please contact SPX Cooling Technologies customer service.

SPX®
COOLING TECHNOLOGIES

7401 WEST 129 STREET | OVERLAND PARK, KANSAS 66213 UNITED STATES | 913 664 7400 | spxcooling@spx.com | **spxcooling.com**

M2010-1241

SPX®
WHERE IDEAS MEET INDUSTRY

USER MANUAL

Marley Ultra Quiet Fan

DESIGNED FOR INDUCED-DRAFT COOLING TOWER APPLICATIONS

M2012-1165 ISSUED 8/2012

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.

Marley®

safety and handling considerations

Safety

⚠ **Warning**

Because of the potential for property damage and/or danger to person(s), it is critical to follow the proper selection, installation and operating procedures.

Exposed rotating devices are potentially dangerous and can cause injury or death. They must be guarded in compliance with OSHA, ANSI and all other local standards for the specific application.

All personnel must follow applicable work safety standards, such as Lockout/Tagout procedures while working in or around power transmission devices.

Handling Considerations

1–Marley Ultra Quiet Fans are designed and manufactured to be very durable. They can provide years of service if handled properly.

2–Minor aesthetic imperfections, such as surface abrasions or scuffs may be present from manufacturing or handling and will not affect performance. Heavy, concentrated impacts may cause gouges, penetration or dents in the blades. If any damage is observed, the fan should not be placed into service. Only SPX Cooling Technologies, Inc. Engineering is authorized to evaluate any issues exceeding the above description of minor aesthetic imperfections.

3–The entire fan assembly should be inspected periodically or after any changes to the drive system components.

fan components

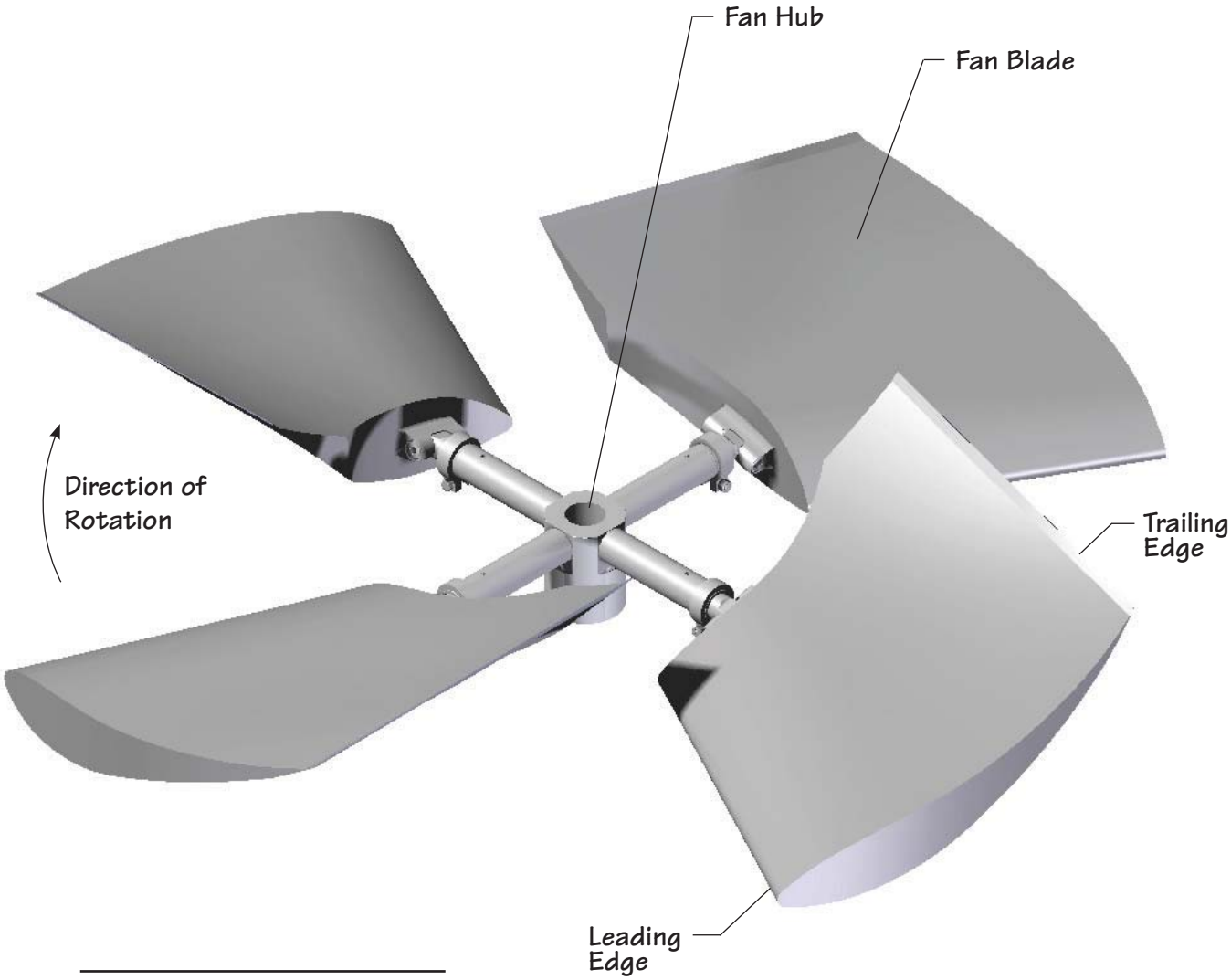


Figure 1
Typical Fan Assembly

Order No. _____

Trial Pitch Angle _____

Final Pitch Angle _____

Speed-rpm _____

Contract hp _____

Note

The following instructions apply to installations having straight bores or tapered output shafts without split taper bushings.

It is convenient to preassemble the fan prior to installation on the driving shaft.

Marley Ultra Quiet fans are statically balanced as a complete assembly. However, the fan may be shipped unassembled. To ensure proper re-assembly, blades and hubs are match-marked.

1–Select a large open area corresponding to the fan diameter.

2–Position the fan hub in the center of the work area with the hub taper down. See **Figure 1**.

Note

Proper installation, with particular attention to tightening nuts to the specified torque, is essential to maintain the design integrity of these units.

3–Install one blade (with the trailing edge curved up): Clean any dirt or grease from the rod end and the surfaces of the resilient mounts. Align the rod end hole with the holes in the resilient mounts and insert the blade mounting bolt (first through the resilient mount with the recess to accept the bolt head, then through the rod end hole). See **Figure 2,** below. Screw the bolt into the second resilient mount lightly. A 3/4" drive torque wrench with a short extension may be used. The blade mounting bolt is supplied from the factory with grease on the threads and conical face. **Do NOT clean the grease from the bolt**.

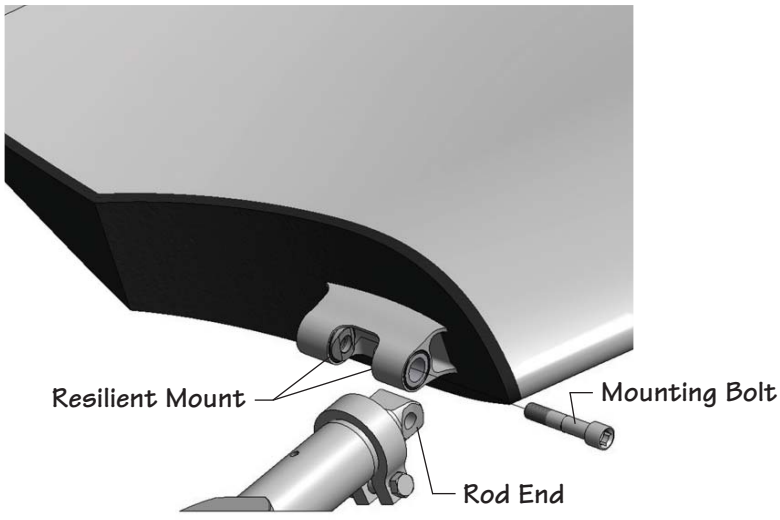


Figure 2
Blade Installation

4–Complete the installation of one blade by holding it so that the blade extends straight out from the hub tube. Holding the blade in this position, **tighten the bolt using a torque wrench set to 200 ft-lb (271 N·m) making sure the rod end and the resilient mounts seat.**

Figure 3
Completed Blade Connection

5–Install the rest of the blades so that they are identical with the first blade. See **Figure 3**, above, for completed blade connection. **Torque all bolts to 200 ft-lbs (271 N·m)**. If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

fan installation instructions (refer to **Figure 4**)

1–Be sure motor is locked out.

2–Clean the hub bore and driving shaft extension for the full length of the key.

3–Insert the key in the keyway. The top of the key must be below the top of the shaft by not more than 1/8" (3mm). The key is a tight fit across the width and must never be altered.

4–After cleaning, apply a coat of anti-seize compound to the engagement portion of the shaft.

5–Raise the fan assembly above the shaft and slowly lower the hub onto the shaft with the keyways aligned. Make certain the key does not slide down during installation.

6–Tighten 2 set screws to 30 ft-lb (41 N·m) over key.

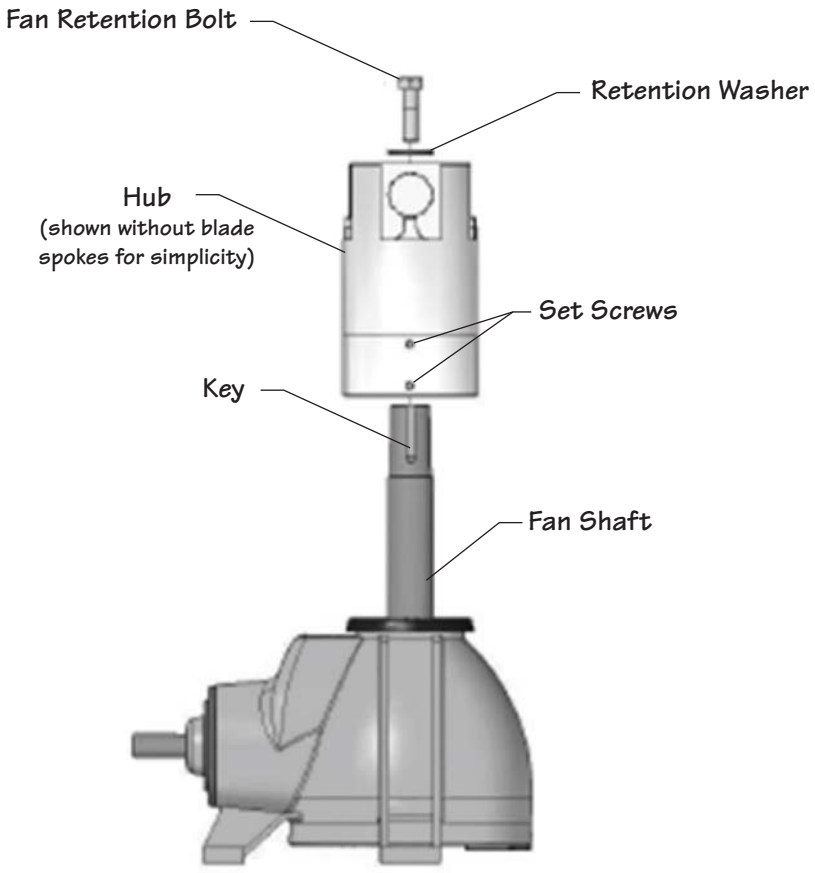


Figure 4
Hub to Shaft Assembly

7–Install the hub retention cap screw with lock washer. Torque hub retention cap screw to 50 ft-lb (68 N·m). If the standard hub retention cap screw is too short, locate longer cap screw in the Fan Retention Hardware Kit, along with new retention washer.

8–After installing the fan, manually rotate it while moving the blade tips up and down to be sure they clear the ring or throat at all points. When a blade is held in alignment with the blade tube (that is, straight outward from the hub), it should clear the fan ring by a distance adequate to provide for any relative motion between the fan wheel and the ring. Excess clearance between the blade tips and the ring however, should be avoided to prevent backflow, which seriously reduces fan efficiency. If clearance is excessive, the diameter may be adjusted at this time. See "adjust diameter" section on page 11.

9–Install air seal per instructions below.

Air Seal Installation

The air seal disc is a thin sheet metal disc. The installation of this disc is required to prevent the back flow of air through the center of the fan to maximize the fan's efficiency. See **Figure 5**, on following page.

1–Locate the air seal installation hardware in the plastic bag taped to one of the hub tubes.

2–Install the air seal studs on the appropriate side of the hub tube (air seal may be installed on either side of hub). Finger tighten.

3–Place one resilient washer on each stud as shown in **Figure 6**, on following page.

4–Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

5–Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not over tighten. Over tightness exists when the resilient washer has expanded in diameter larger than the diameter of the aluminum washer.

Figure 5
Assembled Ultra Quiet Fan

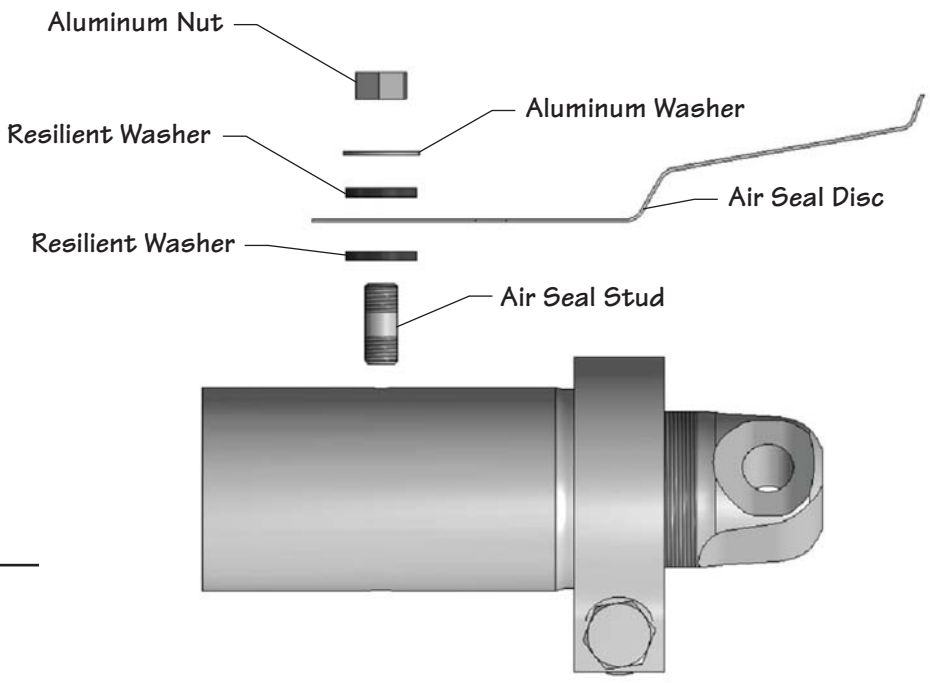


Figure 6
Air Seal and Hardware Items

adjust blade angle (if required)

Hubs are shipped from the factory with the rod end set for the blade angle indicated by the design performance. A change in blade angle is sometimes necessary however, to adjust to actual site conditions. Failure to adjust the blade angle when required may result in blade overload. To adjust, loosen the clamp nut just enough to allow the blade to be turned. Place an inclinometer on the flat surface of the root section as shown below in **Figure 7**. Turn the blade until the desired angle is achieved. Make a permanent record of the final angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be +/- 3°.

⚠ Caution

The fan is designed to consume the horsepower stated on the Fan Specification Sheet. Too great an increase in blade angle can cause serious blade overload which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened.

The maximum recommended blade angle is 30°. Retighten the clamp nut to 200 ft-lbs (271 N·m). Recheck each blade angle after tightening.

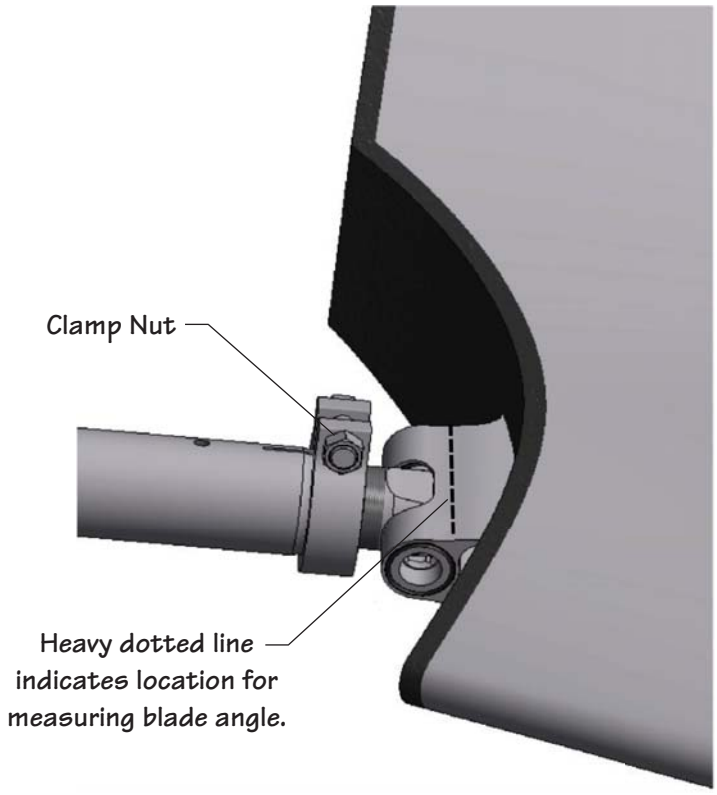


Figure 7
Pitch Measurement Location

adjust diameter (if required)

At times it may be necessary to adjust the fan diameter to suit a particular fan cylinder ring. The tip clearance of the blades should be in the range of the fan diameter as listed in **Table 1**, below. (Use **Figure 8** for reference.) If the tip clearance is found to be outside of this range the fan diameter can be adjusted.

First remove the fan blade. Then, loosen the clamp nut so that the rod end can be rotated in the hub tube. One complete revolution will increase or decrease the radius of the fan by .079" (2mm). Take care that the clevis is returned to the exact factory-set angle unless it is intended that the blade loading be changed as discussed in the previous section. A match mark may be made at a point on the threads and the tube before turning to assure that exactly one revolution is made. Tighten the clamp nut to 200 ft-lbs (271 N·m). Maximum adjustment possible is about +/- 0.75" (19mm) radially (1 1/2" on diameter). At least 1 1/2" (38mm) of rod end threads must remain in the tube (rod end threads must fully engage tube threads). Repeat adjustment for all fan blades so that the tip clearance is within the listed range.

Fan Diameter (ft)	A
5	3/8" (10mm)
5 1/2	3/8" (10mm)
6	3/8" (10mm)
7	7/16" (11mm)
9	1/2" (13mm)
10	5/8" (16mm)
11	5/8" (16mm)
12	11/16" (17mm)

Table 1
Blade Tip Clearance

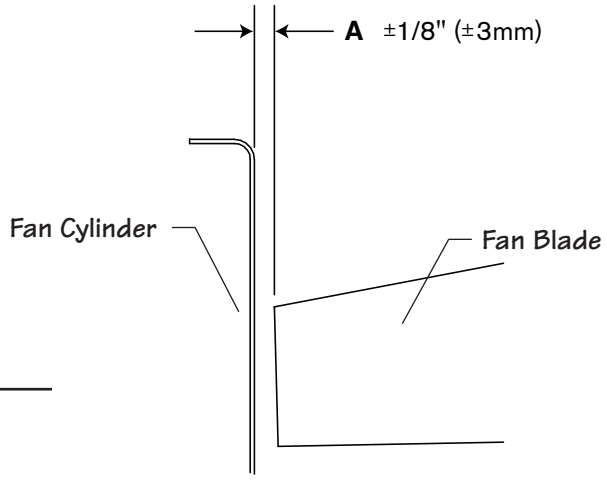


Figure 8
Blade Tip Clearance

fan maintenance and service

Maintenance

Preventative maintenance will prolong useful life and assure continued trouble-free operation. After the first week and subsequently at six month intervals:

- Torque all hardware to specifications referenced in this manual.
- Visually inspect the fan for airborne debris damage, contact with fan cylinder segments and corrosive attack. Correct any situations determined detrimental to fan operation.
- Remove any accumulated scale or dirt.
- Clear blade drain holes at fan tip.

Service

Proper identification of your fan is necessary to ensure you receive correct replacement parts. The Marley cooling tower serial number can be used to determine the fan and any components installed and maintained as original equipment on a Marley cooling tower. Please provide the Marley sales representative the necessary information when ordering replacement fans or components.

Replacement of individual fan blades may require rebalancing the entire fan. If rebalancing is desired, contact the Marley sales representative in your area.

motor load

The corrected horsepower should be close to but not exceed the contract horsepower specified by SPX Cooling Technologies, Inc. Determine corrected horsepower using the following equation.

Actual volts and amperage must be obtained with the fan running and the specified rate of water flowing over the tower after the motor and drive system have reached operating temperature (approximately 30 minutes of operation).

$$HP_C = \frac{VOLTS_A \times AMPS_A \times DENSITY_D}{VOLTS_N \times AMPS_N \times DENSITY_A} \times HP_N$$

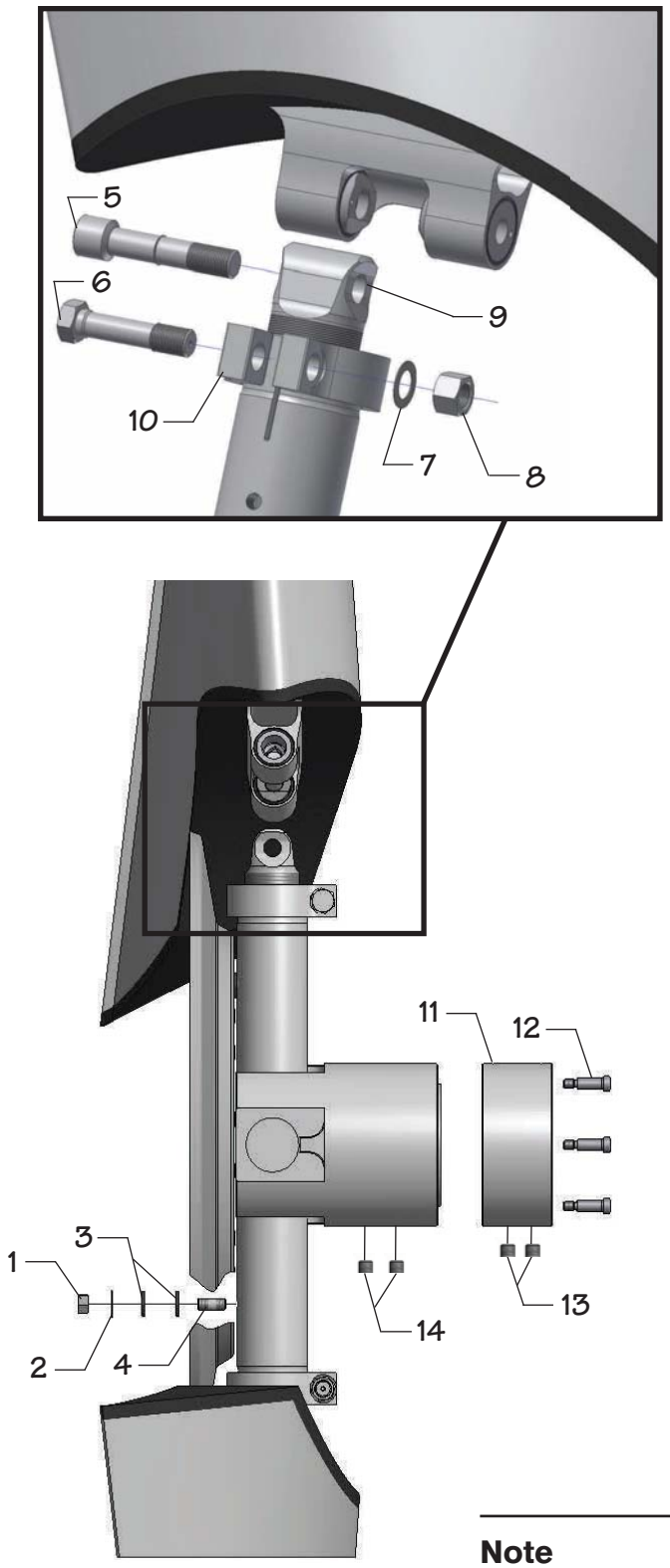
HP_C	=	Corrected Horsepower	$VOLTS_N$	=	Nameplate Volts
$VOLTS_A$	=	Actual Volts	$AMPS_N$	=	Nameplate Amperage
$AMPS_A$	=	Actual Amperage	HP_N	=	Nameplate Horsepower
$DENSITY_A$	=	Actual Air Density	$DENSITY_D$	=	Design Air Density

Note

Measurements taken on motors operating with Variable Frequency Drive controls may read up to 15% high from errors in measuring the approximated sine wave. Instruments capable of measuring a squared off wave form accurately should be used for measuring power in this situation.

Do not start the motor more than four to five times per hour (each low speed start and each high speed start count as one start).

parts list



Dwg. No.	Description
1	16MM ALUMINUM NUT
2	ALUM FLAT WASHER
3	5/8" RESILIENT WASHER
4	16MM AIR SEAL STUD
5	ALUMINUM BLADE BOLT (9'-14' FAN DIA.)
5	ALUMINUM BLADE BOLT (5'-8' FAN DIA.)
6	CLEVIS CLAMP BOLT (9'-14' FAN DIA.)
6	CLEVIS CLAMP BOLT (5'-8' FAN DIA.)
7	SS FLAT WASHER (9'-14' FAN DIA.)
7	SS FLAT WASHER (5'-8' FAN DIA.)
8	CLEVIS CLAMP NUT (9'-14' FAN DIA.)
8	CLEVIS CLAMP NUT (5'-8' FAN DIA.)
9	MAG ROD END (9'-14' FAN DIA.)
9	MAG ROD END (5'-8' FAN DIA.)
10	MAG CLEVIS CLAMP (9'-14' FAN DIA.)
10	MAG CLEVIS CLAMP (5'-8' FAN DIA.)
11	GRDR-2000 SHAFT ADAPTOR
11	GRDR-2200 SHAFT ADAPTOR
11	GRDR-2400 SHAFT ADAPTOR
11	GRDR-3000 SHAFT ADAPTOR
12	1.5" SS SHOULDER BOLT (6)
13	SS SET SCREW (2) (9'-14' FAN DIA.)
14	SS SET SCREW (2) (5'-8' FAN DIA.)

Note

When ordering parts, always provide the cooling tower serial number and when possible, the fan serial number from a decal located on the fan hub.

Marley Ultra Quiet Fan

DESIGNED FOR INDUCED-DRAFT COOLING TOWER APPLICATIONS

SPX®
WHERE IDEAS MEET INDUSTRY

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SERVICE information

SPX COOLING TECHNOLOGIES

White Rust and Water Treatment

About Your Galvanized Cooling Tower

Your new cooling tower is constructed of sheet steel casing and structural components protected with "heavy mill galvanizing" (HMG). This protective zinc coating is fused to the sheet steel at the steel mill in a continuous hot-dip process. The zinc coating in Marley towers conforms to the industry standard coating class G-235, which means the weight of zinc coating averages 2.35 ounces per square foot of steel sheet. All of the HMG steel sheet used in our towers is treated after galvanizing with a chromate rinse to passivate the zinc coating. This important step helps prevent the formation of "white rust" on the surface of galvanized steel sheet during storage, fabrication, and initial tower operation.

What is "White Rust" — Can it Harm My Tower?

HMG steel provides excellent corrosion resistance in cooling towers and many other applications exposed to natural outdoor environments. Zinc protects the base steel sheet by galvanic action. To get the best life from your galvanized tower, it must have proper water treatment. Initially, the zinc coating must be allowed to develop a natural nonporous surface of "basic zinc carbonate". This natural chemical barrier prevents further rapid corrosion of the zinc coating from the environment as well as normal cooling tower operation. The basic zinc carbonate barrier will form on galvanized surfaces within eight weeks of tower operation with water of neutral pH (6.5 - 8.0), calcium hardness of 100 - 300 ppm (as $CaCO_3$), and alkalinity of 100 - 300 ppm (as $CaCO_3$). It is very important for the protective basic zinc carbonate barrier to form on galvanized tower surfaces to resist further corrosion. The initial operation of your cooling tower will ***significantly*** affect its service life.

Based on our experience, a very small percentage of galvanized towers incur a damaging type of corrosion which is commonly called ***"white rust"***. White rust appears as a white, waxy or fluffy adherent deposit on surfaces. If it occurs unchecked, the galvanized steel coating will continue to corrode, eventually leading to an early failure of the galvanization in your cooling tower. White rust is actually another form of zinc carbonate which has a different porous structure from the protective "basic zinc carbonate barrier" that naturally protects galvanized surfaces. White rust can form if your new cooling tower is operated with water of pH greater than 8.0 for an extended time period before the basic zinc carbonate barrier can form. There is also evidence that some types of film-forming inhibitor water treatments can promote the formation of white rust if used excessively. If start-up water treatment of the cooling system does not allow for initial passivation of your cooling tower's galvanized surfaces, you may face expensive corrective repairs and water treatment to cure the resulting white rust.

Why is a Knowledgeable Water Treater Important for My Cooling Tower?

The best cure for white rust is an ounce of prevention when you begin operating your tower. Consult with your water treatment specialist and ask about his program for initial system operation and passivation of your galvanized steel cooling tower. We encourage early operation with near neutral pH water and use of only reasonable levels of film-forming inhibitors. Many water treaters suggest corrosion inhibitor treatments of the Phosphate/Polymer/Phosphonate type, which have not promoted white rust in galvanized steel. ***Ideally—initially operate your cooling tower with water of pH between 6.5 and 8.0, and with hardness and alkalinity values between 100 - 300 ppm for at least 8 weeks,*** which should be enough time for the protective "basic zinc carbonate" layer to form. As an alternative, other acceptable water pretreatment methods such as inorganic phosphate passivation may be considered. Be certain your water treatment company is recommending a program suitable for your galvanized steel cooling tower before you start it up!

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Manual 92-1184B

/ Marley Cooling Tower Downtime Instructions /

Manual 92-1308A

SPX
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Instructions for Downtime

Mechanical Draft Cooling Towers

Preface

Proper preventive maintenance of equipment during downtime will assure trouble-free start-up. This manual gives suggested procedures for protection of tower mechanical equipment for downtime ranging from seasonal to extended downtime in two different periods. The periods increase in length and in extent of protection.

SPX Cooling Technologies offers these suggestions as being representative of good practice. Warranty of condition after downtime and or amendment to specific contract warranties is not intended.

⚠ Warning

Never start motor on fan drive without first making sure that there will be no interference with free rotation of the fan, drive shaft, or V-belt.

Seasonal Downtime

Fans, Drive Shafts, and V-belts

Maintain freedom for fan rotation. Do not operate if snow, ice or other obstruction will interfere with rotation.

Geareducers

Note

With the introduction of the 10.1, 20.1, and 22.3 Geareducer® models, oil changes in these models have been reduced to 5-year intervals. To maintain five-year change intervals, use only oil designed specifically for these Geareducer models. Proceed to step 2 below. If, after five years, turbine-type mineral oil is used, then proceed starting with step 1. Refer to Geareducer Service Manual for oil recommendations and further instructions.

1. At start of down-time period, operate Geareducer until oil is warm (120° F) and change the oil. See Lubrication section of the Geareducer Service Manual for instructions on changing oil. Allow freedom for fan to windmill.
2. Each month, drain any water condensate from the lowest point of the Geareducer and its oil system. Check the oil level and add oil if necessary. Operate the Geareducer a minimum of 20 minutes to recoat the interior surfaces with oil.
3. To return to operation, drain off any condensate, check oil level and add oil as necessary to establish required oil level. Change oil at normal recommended interval, accounting for downtime as operating time.

Bearing Housing, Oil Lubricated Type

1. At start of downtime period, operate bearing housing until oil is warm (95° F) and change the oil. See the Lubrication section of the Bearing Housing Service Manual for instructions on changing oil. Allow fan freedom to windmill.
2. Each month drain any water condensate from the lowest point of the bearing housing. Add oil if necessary to maintain oil level.
3. To return to operation, drain any water condensate, check oil level and add oil as necessary to establish required level. Change oil at normal recommended interval, accounting for downtime as operating time.

Electric Motors

1. At start of shutdown, clean all air passages and lubricate bearings. See the motor manufacturer's instructions.
2. Each month, run motor until it has reached operating temperature. Space heaters are recommended. If heaters are used, motors need be run only 20 minutes minimum.

Note

Higher density of cold air at fan increases motor horsepower. If motor overloads will not allow fan motor operation at high speed in forward direction, one of the following might be done:

- If overloads are adjustable, set at a higher value (+ 15%) for cold weather operation.
- Operate motor (fan) in reverse (reverse any 2 leads).
- Operate two speed motor at low speed.

3. Enclose motors or cover them to protect from wet-down of a fire protection system or rainfall.
4. To return into operation, clean all air passages, remove temporary vented cover and lubricate bearings.

Drive Train Backstop

Fill to normal level with oil recommended in Drive Train Backstop Service Manual.

Extended Downtime (beyond 3 months)

Fans and Drive Shafts

Maintain freedom of rotation. Do not operate if snow, ice or other obstructions will interfere with rotation.

V-Belt Drives

1. At start of down time, remove and store belts in a cool, dry, dark room. Clean and coat sheave grooves with rust preventative, lacquer or paint.
2. Remove rust preventative from sheaves before reinstalling belts.

Geareducers with External Gauge and Drain Lines

At Start of Downtime Period:

1. Operate Geareducer until oil is warm (120° F) and drain the oil. Completely replacing the oil may only be required for Geareducers using mineral oil. See Geareducer note on Page 2 for further information.

2. Fabricate and install an expansion chamber on the sight glass riser; see Figure 1. The figure shows the proportions of the expansion chamber and its relationship in elevation to the oil level. The purpose is to allow for expansion of the oil due to temperature change from that at the time of filling without causing it to overflow at the fan shaft closure. Smaller chambers may satisfy smaller Geareducer applications, but the 4″ depth and elevation relationships should be maintained.

   Expansion volumes required by Geareducers most likely to require this type of storage are listed by basic Series number:

   Models 34, 36 and 38 _____ 1.5 gallons (5.68 liters)
   Models 3600 and 4000 _____ 1.5 gallons (5.68 liters)
   Models 27 and 32 _____ 1.0 gallons (3.79 liters)
   Models 22, 2200 and 2400 ___ .75 gallons (2.84 liters)

   The vent may be removed from the top of the oil level gauge to be used as a vent for the expansion chamber. The chamber must be vented.
3. Remove the vent or vent line from the Geareducer.
4. Fill the Geareducer with oil until it rises just to the bottom of the vent hole in the top (cover) of the Geareducer. Use one of the oils listed in the appropriate Geareducer Manual.
5. Smaller Geareducers than listed may be stored this way, provided the basic requirement of submerging the top-most bearing in oil and the requirements above are satisfied.
6. Plug the vent on the Geareducer with a 1/2" pipe plug. The Series 22 requires a 1/4" plug.

7. Open the disconnect switch to the fan motor, and tag it to prevent running the Geareducer while it is full of oil. Allow Geareducer freedom to windmill. (See note on page 6.)
8. Quarterly, drain water condensate at lowest point of oil system, at drain in expansion chamber, check and make up oil level and rotate input shaft at least 15 revolutions. Allow to windmill.

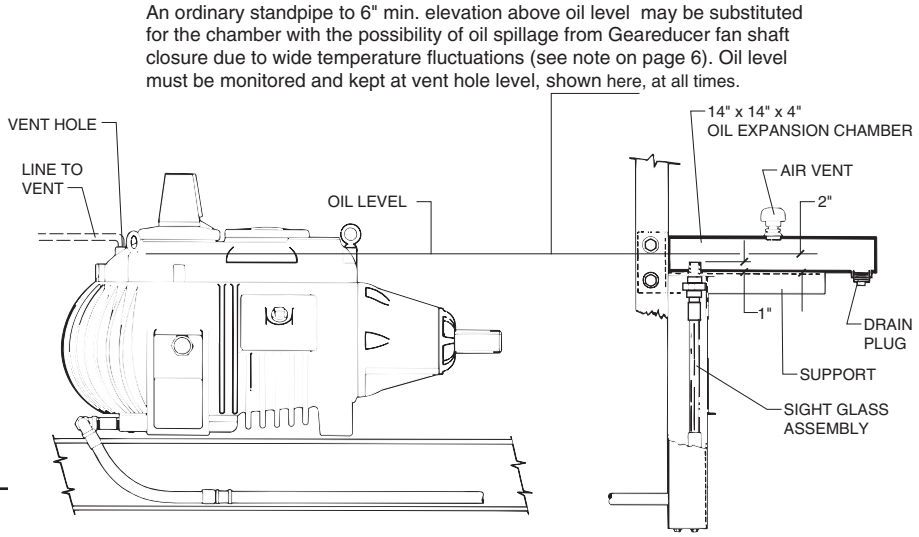

Figure 1

At End of Downtime Period

1. Drain oil to operating level.
2. Remove the pipe plug from the Geareducer vent hole and reinstall the vent fitting or line.
3. Remove the tag and close the disconnect switch to the fan motor. The expansion chamber may be removed .
4. If downtime was 6 months or longer, check to be sure there is no obstruction to rotation and run Geareducer until oil is warm (120° F). Stop the Geareducer and change the oil. Changing oil may only be required for Geareducers using mineral oil. See Geareducer note on page 2 for further information.

Geareducers without External Gauge and Drain Lines

Use the same procedure as outlined for Geareducer with external gauge and drain lines. It will be necessary to install an external gauge and drain line or pipe and a riser which would permit mounting the expansion chamber outside the fan cylinder, see Figure 1.

Bearing Housings, Oil Lubricated

1. At the start of the downtime period, operate bearing housing until oil is warm (95° F), then change the oil. See the Lubrication section of the Bearing Housing Service Manual for instructions.
2. Each quarter, drain any water condensate from the lowest point of the bearing housing. Add oil as necessary to maintain level. Allow to windmill. (See note below.) Rotate 15 revolutions.
3. To return to operation, bring up to operating temperature and change the oil.

Electric Motors

1. At start of downtime period, lubricate bearings. See motor manufacturer's instructions on lubrication.
2. Keep the motor temperature 5° F to 10° F above ambient temperature with the aid of space heaters or reduced voltage winding heating. Allow freedom to windmill.
3. Once each quarter, rotate motor shaft 15 revolutions.
4. Once each year, remove grease fill and relief plugs and lubricate motor bearings. ***Do not*** operate motor. Replace plugs.
5. Enclose motors or cover them to protect from wet-down of a fire protection system or rainfall.
6. To return to operation, remove temporary covers and clean air passages. Remove grease fill and relief plugs and lubricate bearings. Operate the motor to purge excess grease and replace the plugs. See motor manufacturer's instructions on lubrication.

Note

The frequency of maintenance operations required by these instructions assumes sufficient wind velocity to cause some fan rotary motion (not necessarily fan spinning) at least once per month. This motion is required to reposition bearing, shaft and gear elements with respect to each other to allow the lubricant the greatest opportunity to protect these vital parts from corrosion. Any time a period of one month passes without wind-caused fan rotary motion, maintenance personnel should be alert to this fact and provide manual rotation of the drive line. At least 15 revolutions of the motor shaft is recommended.

Drive Train Backstop

Fill to top with oil recommended in the Drive Train Backstop Service Manual. Drain and refill to top each two-year period. To start up, drain oil to operating level.

General

Fire Protection—Protect dry wood towers against fire. Any flammable debris should be removed weekly. Wood towers may be wetted for fire protection. This may be done by providing some form of sprinkler system to wet the entire top of the tower. This should include the top structure inside the fan cylinder. Sprinkling should be avoided in freezing weather.

The sprinkler system must be designed in order not to cause direct water impingement on Geareducer shaft closures, the Geareducer vent, the Geareducer external oil system vent, and the electric motor shaft closures, air openings, vents and drains.

The electric motor(s) must be covered with a vented enclosure to avoid moisture entrapment. This is necessary to avoid excessively high humidity around the motors, and to avoid wide fluctuation in motor temperature that sprinkling would cause. The enclosure should cover any back stop or brake assembly mounted on, or connected to any part of the motor.

During Freezing Weather—Drain tower basins and all exposed piping including risers. Leave the drain and overflow valves open to prevent accumulation of rain water, snow or melted snow and ice.

During Non-Freezing Weather—It may be more convenient to keep normal water level in wood basins for short downtime periods to keep basins tight. Wood basins (over longer periods) and concrete and steel basins should be drained.

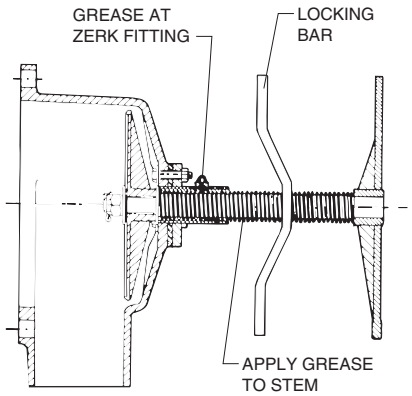

Figure 2

Flow Control Valves are to be left full open with locking bar locked. Apply grease through the zerk fitting to the stem-guide interface and coat the entire exposed stem with grease. NLGI #2 Lithium base grease is suggested. See Figure 2.

Start-Up Preparation of a wood tower after a long dry shut-down should include thorough wetting before full operation.

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Manual 92-1308A

/ Cooling Tower Motor /

User Manual 92-1475A

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Installation, Operation and Maintenance
of
Electric Motors
on Cooling Towers

RECEIVING AND STORING MOTORS

A motor should be inspected on receipt to make sure it was not damaged during shipment. Turn the shaft by hand to see that it turns freely. Check motor nameplate for correct horsepower, voltage, phase and speed.

If a motor is stored before installation, place it in a building in which air is kept reasonably dry and with a minimum of temperature fluctuation to prevent moisture condensing in the motor. Do not store directly on the floor, always block up.

Windings should be meggered at the time the motors are put in storage.

If motors have space heaters, the heaters should be energized when the motors are placed in storage.

NOTE: Remove units from containers when heaters are energized. Reprotect if necessary.

If outdoor storage is necessary, protection should include a vapor barrier beneath the motor. The motor should be blocked up to prevent flooding. All external parts such as shafts, machined surfaces, and threaded holes should be protected with a rust inhibitor coating.

Rotate motor shaft monthly to insure that the bearing surfaces are protected with lubricant.

When a motor is removed from storage, the insulation and rotor movement should be checked. The insulation should be checked by applying the potential from a 500 volt megohmmeter between the windings and grounded frame for 10 minutes. Resistance readings should be taken at 1 and 10 minutes. Correct the readings to 40°C as discussed on page 6 of this manual. Calculate the winding polarization index by dividing the 10 minute reading by the one minute reading. The recommended minimum value of polarization index for alternating current machine is:

Class A insulation 1.5
Class B insulation 2.0
Class F insulation 2.0

A low polarization index indicates the insulation should be cleaned and dried before the motor is placed in operation. It is possible to operate a motor with a polarization value less than the minimum listed above but this is not considered good practice.

The rotor movement is checked by rotating the shaft by hand. If shaft is not free, contact the motor manufacturer's authorized repair shop. Grease in the motor bearings should be purged at the time of removal from storage. Refer to LUBRICATION on pages 5 and 6.

INSTALLATION

Check to see that the motor nameplate data agrees with the voltage and frequency of the power supply provided for the motor. All induction motors will operate successfully when the frequency is not more than five percent above or below the nameplate rating, the voltage is not more than ten percent above or below the nameplate rating, and the combined variation in voltage and frequency is not more than ten percent above or below the nameplate rating.

The power supply line for the motor should be of sufficient capacity to carry 125 percent of the motor's full load current with a maximum voltage drop of three percent on the line.

The power supply MUST conform with motor nameplate voltage. Motors rated 200 volts are for a 208 volt system. Motors rated 230/460 volts are for a 240 or 480 volt system. Do not use a 230 or 230/460 volt motor on a 208 volt system.

Unbalanced voltages in the power supply will greatly increase the internal losses of the motor, reducing the safe load the motor can carry. Have the power company correct any unbalanced voltage.

When motor power is supplied by overhead conductors, it is advisable to provide a lightning arrestor on each ungrounded line.

Wire the motor to the power supply through a disconnect switch, short-circuit protection, and suitable magnetic starter with overload protection. All wiring and fusing should be in accordance with the National Electrical Code and local requirements. All motors should be connected as shown on the nameplate diagram.

The National Electrical Code requires a motor to be in sight of the controller unless the disconnecting means can be locked open or unless there is a manually operated switch in sight of the motor which will disconnect the motor from its electrical supply.

Overload protection should be installed in all three lines. Size overload heaters in starters for nameplate service factor and amps. Overloads for 1.15 service factor motors must kick out at no more than 125% of nameplate current. Overloads for 1.0 service factor motors must kick out at no more than 115% of nameplate current.

Overloads should be at the same ambient temperature as motor. Do not use ambient compensated overloads.

If a two-speed motor is used, be sure control characteristics are compatible with the motor. A two-speed single-winding motor requires a different starter than a two-speed two-winding motor. Starters for two-speed motors must include a minimum time delay of 20 seconds when switching from high to low speed.

When a disconnect switch is installed between motor and starter for two speed or part winding start single- speed motor, a 6-pole disconnect must be used.

SAFETY NOTE: Use of two 3-pole disconnects can result in one disconnect not being off and unexpected starts or motor damage.

If reverse operation of mechanical equipment is required, provide minimum time delay of two minutes before energizing motor when changing direction of rotation.

Check the wiring system for grounds and check the resistance between all leads for open, bad or incorrect connections before operating the motor.

The conduit system should be arranged so that trapped water will collect in a sump equipped with suitable drain and will not go into the motor terminal box.

When the motor must be moved for coupling removal or belt adjustment, a short section of flexible, watertight metallic conduit should be used in place of rigid conduit to protect the leads to the motor.

Remove all water drain plugs from totally-enclosed motors. These plugs will be located in the lowest part of the installed motor. Because of inaccessability of drain plugs with motor installed on supports, it is sometimes necessary to remove plugs before the motor is bolted in place.

The drain plugs on explosion-proof motors are automatic and must not be removed.

NOTE: After motor is installed, it should be run for three hours at least once a month, even if the tower is not in operation. This serves to dry out windings and relubricate bearing surfaces. If motors are purchased with space heaters, they should be energized as soon as possible. Use an auxiliary contact on the starter to turn heater off when motor is running.

OPERATION

Sleeve bearing motors are usually shipped without oil and must be oiled before operation. Ball bearing motors are lubricated for the initial operation by the motor manufacturer; however, it is recommended that the grease and relief plugs be removed and the motor bearing housing be examined for presence of adequate grease before motor is placed in operation. Add grease if necessary. See instructions on pages 5 and 6 for lubricating ball bearing or sleeve bearing motors.

Turn the rotor by hand to see that it rotates freely. Motor shaft should be parallel to driven shaft so that there are no stresses in motor frame.

INITIAL STARTING: The motor should bring the fan up to speed in less than 15 seconds. If it does not, check connections, fuses, overloads and voltage at motor terminals during start-up period. Run the motor to check the connections and direction of rotation. If the rotation is incorrect, change any two of the three motor leads for a three phase motor or interchange the connections of either the main or start windings for single phase capacitor start motor.

CAUTION: Excessive fan cycling may shorten the motor's expected service life. On fans 20 feet (6 meter) diameter and smaller allow for 4 to 5 starts per hour. On larger fans, 2 or 3 starts per hour may be the limit. On two speed motors each low speed start and each high speed start count as one start.

If a two-speed motor is used, 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 of rotation, allow a minimum of two minutes time delay before energizing the fan motor.

DETERMINE LOAD AT MOTOR: With design water rate and design heat load on the tower, test motor hp as follows:

1. Run motor for 30 minutes. Record motor name plate data.
2. Measure voltage between all lines at motor terminals.
3. Measure amps in all three lines.
4. Average the measured volts and amps and calculate test horsepower using the following equation:
5. For a given fan pitch setting and RPM, horsepower will

$$\text{hp (test)} = \frac{\text{Volts x Amps (average)}}{\text{Volts x Amps (nameplate)}} \text{ x hp (nameplate)}$$

vary directly with the air density which is a function of temperature and barometric pressure. Because fans are generally pitched for summer weather horsepower, it is expected that the motor nameplate horsepower will be exceeded during winter operation. Assuming 100% heat load, the temperature rise in the motor will be greater at the higher horsepower, but the operating temperature of the motor will actually be lower due to the drop in ambient temperature. Under these conditions, the higher horsepower should not be detrimental to the motor.

If the horsepower measurement is taken during cold weather conditions, the predicted horsepower which will result during summer operation may be determined by applying the Factor from Figure 1. For a given location, the barometric pressure will not normally vary enough to cause significant error and for this reason, has not been included in the Factors.

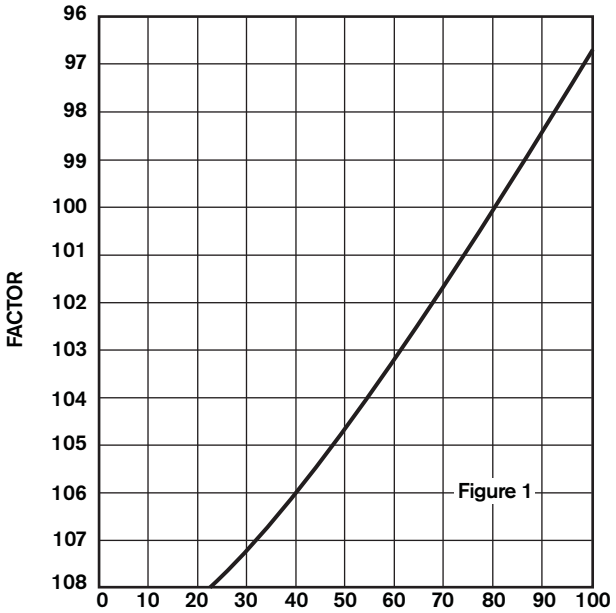


Figure 1

Example: The horsepower on an induced draft cooling tower is 7.8 hp on a 40°F ambient wet-bulb day. What is the predicted hp on a 75°F ambient wet-bulb day?*

$$\text{hp}_{(75°F)} = \text{hp}_{(40°F)} \text{ X } \frac{\text{Factor (75°F)}}{\text{Factor (40°F)}} = 7.8 \text{ x } \frac{100.8}{105.9} = 7.43$$

If it is desired to correct for high or low test barometric pressure, multiply the predicted horsepower by standard station barometric pressure and divide by test station barometric pressure.

*Use ambient dry-bulb temperatures if checking a forced draft cooling tower.

Fan motor overloads sized for summer weather will handle the higher winter horsepower without adjustment providing they are at the same ambient temperature as the motor and there is ample heat load on tower.

NORMAL OPERATION: Class B insulated motors are rated at a maximum total operating temperature of 130°C (266°F). A thermometer in contact with the winding may indicate a temperature up to 100°C (212°F). on a protected motor or up to 115°C (239°F) on a totally enclosed motor without the motor being too hot. Therefore, a motor that appears to be hot is not necessarily overloaded. Check with thermometers.

CAUTION: Normal operating temperatures of electric motors can be hot enough to cause burns. Avoid any unprotected contact with the surface of an operating motor.

MAINTENANCE

SAFETY NOTE: When working on the fan or fan drive, make sure the electric motor cannot be started. See "Installation" section.

To obtain maximum motor life, establish a schedule of maintenance based on the particular application of the motor and observe the following procedures and precautions:

CLEANING: Remove any oil, dust or scale deposits from the motor. They can cause excessive insulation temperatures.

LUBRICATION:

Ball Bearing Motors: The following table may be used as a guide in determining greasing periods for motors:

Duty	1 – 30 hp	40 – 250 hp
Intermittent	12 months	12 months
8 to 16 hours per day	12 months	6 months
Continuous	8 months	4 months

All greases will deteriorate in time depending upon bearing size, speed and temperature. The grease used should be recommended by the motor manufacturer. See instructions attached to motor for recommended lubricant. If these instructions have been lost or misplaced, obtain information on lubricant to use and local supply source from motor manufacturer's nearest authorized service facility or from the motor manufacturer. Give complete motor nameplate data and state clearly that the motor is used on a water cooling tower. Chevron SRI-2 is recognized by many motor manufacturers as a suitable grease for ball bearing motors for cooling tower service. In general, a polyurethane or lithium base grease with rust and oxidation inhibitors is recommended. Use a grease of NLGI No. 2 consistency. Do not mix greases which are of different types or specifications. If a change is desired, the motor bearing housing grease reservoir should be completely cleaned of old grease before repacking with new grease.

The relief method of greasing motors tends to purge the bearing housing reservoir of used grease by forcing out old grease with new grease. Use a plunger type grease gun which will not fit the bearing grease fill hole too tightly.

Either an excess or insufficient amount of lubricant in the bearings can cause overheating. To prevent this occurrence, use the following greasing procedure:

1. Stop motor.
2. Wipe grease plugs, outside of bearing housing, and relief plug, clean.
3. Remove grease and relief plugs and free relief hole of any hardened grease. Use a thin piece of wire in opening.
4. Add grease with a hand operated pressure gun until new grease appears at the relief hole. Take special care when greasing the fan end bearing of TEFC motors. The long relief might be too small for the bearing to relieve properly.
5. Run the motor for approximately one hour after greasing to permit rotating parts of the bearing to expel excess grease. Take out some of the excess grease with a thin piece of wire.
6. Replace plugs and wipe the outside of the bearing housing clean.

Every few years the motor end brackets should be removed and the grease reservoirs cleaned and repacked full with approved ball bearing grease. Open bearings should be cleaned and repacked.

Bearings should be checked for "roughness" by turning the outer race slowly with the fingers while holding the inner race. If the bearing feels rough or binds in spots, it should be replaced.

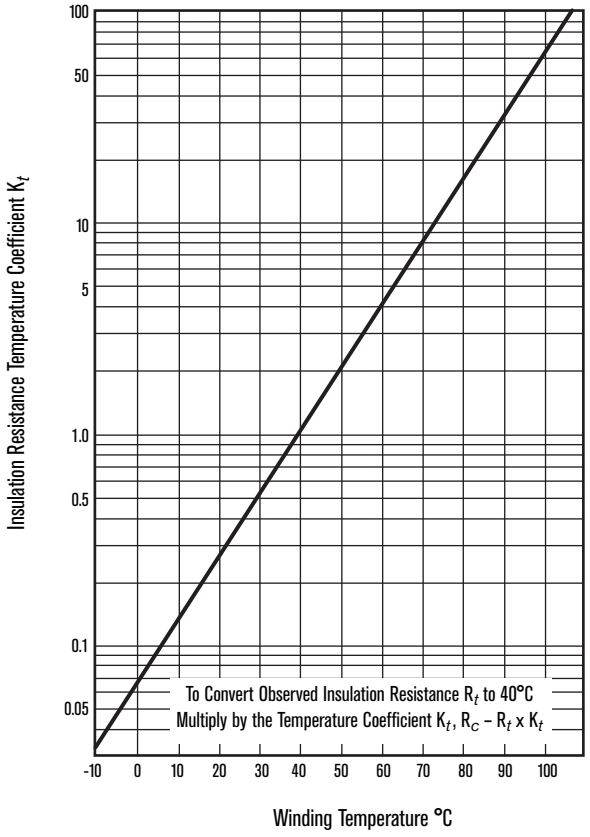
Sleeve Bearing Motors: Check oil in sleeve bearings at least every three months. When journal size is less than two inches, stop the motor to check the oil level. Old oil should be drained and replaced at least every year. Clean out oil well if there is evidence of dirt and sludge.

Motor shaft must be stopped when motor is oiled. The oil used should be a good grade of mineral oil of light or medium viscosity (such as SAE No. 10). Turbine oil rather than automotive crankcase oil is recommended.

Check bearing wear yearly by measuring the air gap with a feeler gauge. Measure gap in at least four equally spaced positions at each end of the motor with two of the places being the lowest point and the point subject to the load pull.

INSULATION: Check insulation resistance with a megohmmeter at the end of each shutdown period. Apply the megohmmeter potential to the winding for one minute before taking a reading. Correct the reading to 40°C by using the equation:

$R_{40°C} = K_t \times R_t$ and the curve below



Approximate Insulation Resistance Variation with Temperature for Rotating machines.

A record of these corrected readings will show a trend in the insulation condition. It is considered good practice to recondition a winding if the resistance, having been high on previous readings, drops to near the recommended minimum value as calculated by:

$$\text{Megaohms} = \frac{1000 + \text{Rated Voltage of Machine}}{1000}$$

Motors in continuous operation will stay at a temperature sufficiently above ambient temperature to prevent condensation of moisture on and about the windings, even if the location is very humid. Idle motors, however, accumulate moisture readily which causes gradual deterioration of insulation. Where motors are idle for a long time, single-phase heating or space heaters may be required to prevent water condensation.

Check insulation resistance at least once a year with the motor at normal operating temperature. Comparison with several previous readings will give an indication of improvement or deterioration of insulating value. Readings, to have comparison value, should be taken under the same conditions (temperature, operating time since last shutdown, etc.).

Low or falling resistance readings indicate the need for maintenance. Contact the nearest repair facility authorized by the motor manufacturer for repair service.

VIBRATION: If vibration occurs, it should be corrected without delay. Use the following procedure to determine source of trouble:

1. Check motor mounting to see that fasteners are tight.
2. Disconnect motor from load and run motor separately. If motor still vibrates, rebalance rotor.
3. If vibration is in mechanical equipment*, check:
   a. Alignment of motor with mechanical equipment.
   b. Tightness of Geareducer, or belt driven components, mounting bolts.
   c. Unbalance in drive shaft or fan.

*Refer to service manuals for operating and maintenance recommendations.

SEASONAL SHUTDOWN

If a motor is used only seasonally, it should be cleaned and lubricated at the close of each season. Refer to motor manufacturer's recommendations for lubrication and maintenance instructions. At start of new season, make sure bearings are adequately lubricated before returning motor to operation. *When tower is not in operation, the motor should be run for three hours at least once a month. This serves to dry out windings and relubricate bearing surfaces.*

Do not start motor without determining that there will be no interference with free rotation of the fan drive.

MOTOR WARRANTY

Motor manufacturers' warranties run for 12 months in service but not to exceed 18 months from date of manufacture. Motor manufacturers warrant their products to be of the type and quality described, suitable for the service for which they are supplied, and free of defects in materials and workmanship. Failures from causes external to the motor (e.g., single phasing, operation under prolonged or extensive overload, damage from handling, improper maintenance, use on other than the service for which supplied, defect in wiring to power supply, or deficiency or defect in controls) are not covered by the motor manufacturers' warranties.

If a motor failure occurs within the warranty period because of defect in material or workmanship, the motor manufacturer is liable and has the right to remedy the failure by adjustment, repair, or supplying a replacement motor F.O.B. his factory or authorized repair facility. In such event, the motor must be delivered to the nearest repair facility authorized by the motor manufacturer with notification that the motor is from a Marley product and that warranty consideration is requested. Prompt notification of such failure should be directed to a Marley sales representative.

Motor manufacturers will not accept warranty obligation for repair of motors by other than their authorized repair facility nor warranty obligation for materials or workmanship employed in making repairs. Repair shops, including authorized repair facilities, generally warrant their material and workmanship for a period of 12 months.

Motor manufacturers' warranties do not cover cost of dismounting, transportation to and from repair facilities, or remounting motors.

MOTOR OPERATION NOTE:

Higher density of cold air at fan increases motor horsepower. If motor overloads will not allow fan motor operation at high speed in forward direction, one of the following might be done:

1. If overloads are adjustable, set at a higher value (+15%) for cold weather operation. Readjust for summer operation.
2. Operate motor (fan) in reverse (reverse 2 loads).
3. Operate 2-speed motor at low speed.

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Manual 92-1475A

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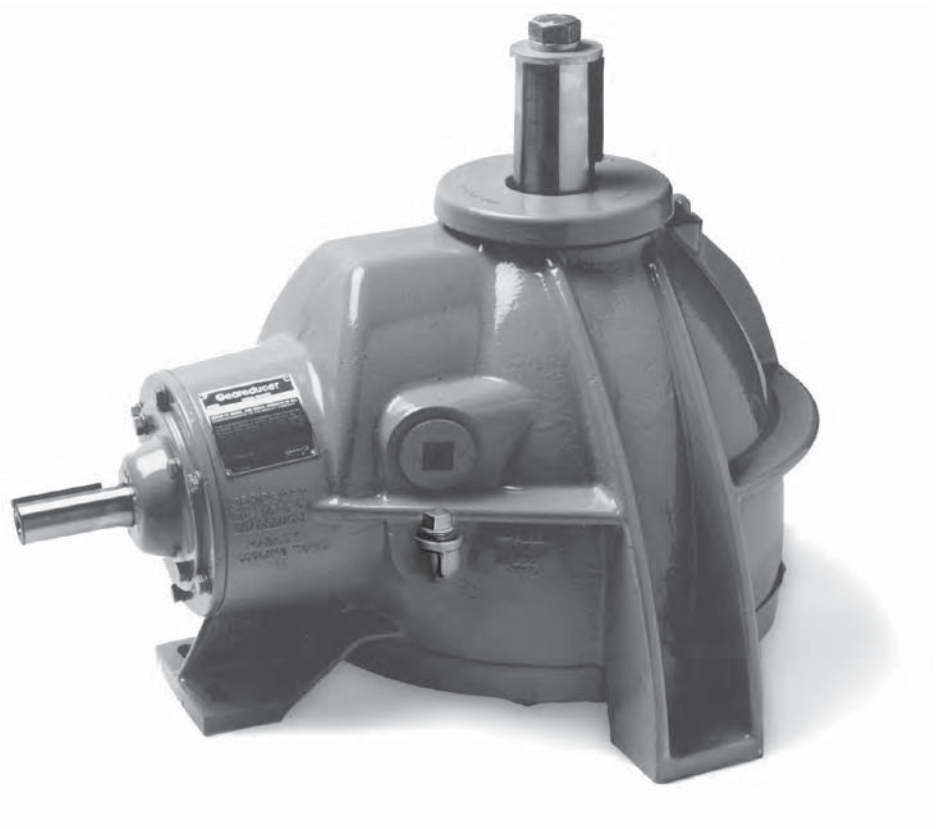
USER MANUAL

Geareducer® models 2200-2250-2400

OPERATION - MAINTENANCE - REPAIR

M99-1260E ISSUED 6/2012

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.



Marley®

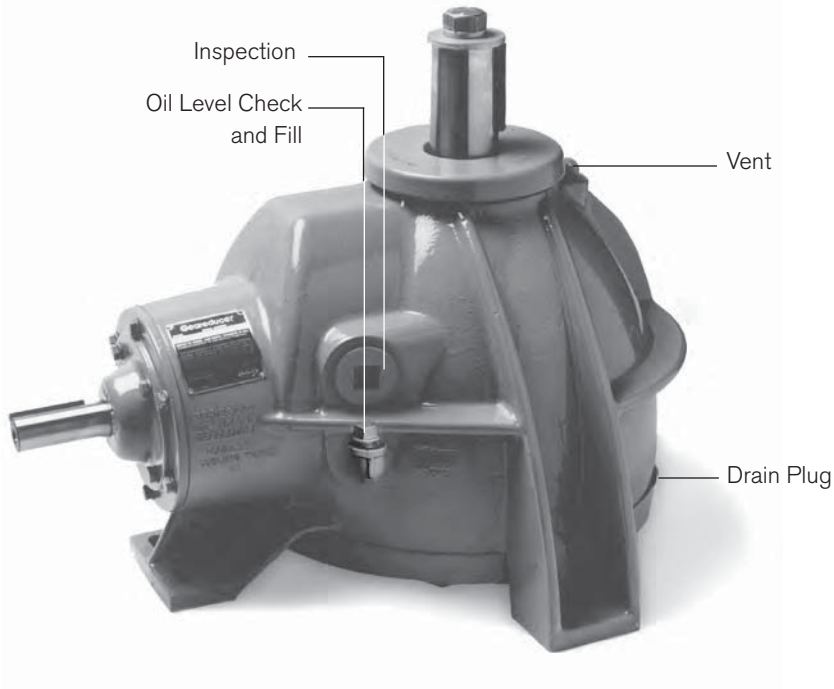


Figure 1 Service Fittings

Protection Against Corrosion

All Marley Geareducer units ship from the factory with a protective coating of epoxy enamel paint on all unmachined parts and with rust-proofing oil and grease on machined surfaces. Machined surface coatings normally protect the Geareducer against atmospheric corrosion during storage periods for up to six months. However, if oil is added to the Geareducer, the new oil will dissolve the rust-proofing grease and require that the Geareducer be run once a week to keep a protective coating of oil on all interior machined surfaces.

Check Geareducer exterior yearly and touch up with epoxy paint if required. If your Geareducer is equipped with an oil gauge and drain line, coat any exposed threads at pipe joints to prevent corrosion.

Alignment

In order to assure long service life, the Geareducer and motor must be level, and the drive shaft or coupling must be properly aligned. Refer to the alignment instructions in the Driveshaft or Coupling Manual shipped with the cooling tower. Copies are also available from your local Marley sales representative.

Initial Operation

Check to be sure that the Geareducer is filled with oil and that there are no visible oil leaks. If equipped with an external dipstick/oil level gauge, be sure the oil full mark corresponds with the full level at the Geareducer.

Note—If this tower is equipped with a two-speed motor, allow a time delay of at least 20 seconds when switching from high speed to low speed. Allow a time delay of at least two minutes when changing direction of fan rotation. Failure to provide these delays may significantly reduce equipment service life.

Lubricants

To insure maximum performance and service life, it is recommended Marley factory lubricants be used in all Marley Geareducers. Marley lubricants can be purchased through your local Marley sales representative.

If lubricants other than Marley factory lubricants are used, they must not contain any additives (such as detergents or EP additives) which are adversely affected by moisture and could reduce the service life of the Geareducer. The responsibility for use of lubricants other than Marley factory lubricants rests with the customer/owner and the lubricant supplier.

Note—Geareducer is designed for 5-year oil change intervals. To maintain five-year change intervals, use only Marley Gearlube. Marley Gearlube must be inspected every six months to ensure the oil has not been contaminated. If turbine-type mineral oil is used the oil must be changed every six months.

Seasonal temperature changes may require one viscosity of oil for summer operation and another for winter operation. Refer to the tables below for the seasonal selection information.

Winter or Summer	Severe Duty/High Temperature
Air Temperature at Geareducer	
Below 110°F (43°C)	Above 110°F (43°C)
ISO 150	ISO 220

Table 1 Synthetic oil—5-year oil change interval

Maintenance Service	Monthly	Semi-annually	Seasonal Startup or Annually
Geareducer Drive			
Inspect and tighten all fasteners including oil plug		x	x
Check for and repair oil leaks	x	x	x
Check oil level	x	R	x
Change oil		R	R
Make sure vent is open		x	x
Check driveshaft or coupling alignment			x
Inspect and tighten driveshaft or coupling fasteners			x
Check driveshaft or coupling bushing / flex elements for unusual wear			x
Lube Lines (if equipped)			
Check for oil leaks in hoses and fittings	x	R	x

R – Refer to instructions within this manual

Note: It is recommended at least weekly, that the general operation and condition be observed. Pay particular attention to any changes in sound or vibration that may signify a need for closer inspection.

Scheduled Maintenance

⚠ **Warning**—Make certain that mechanical equipment is inoperable during periods o**f** 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.

Monthly—Check Geareducer oil level. Shut down the unit and allow 5 minutes for the oil level to stabilize. Add oil if required, noting the addition in your maintenance log. If equipped with an external dipstick/oil level gauge, small quantities of oil can be added at that location.

Semi-annually—Check that all the assembly bolts and cap screws are tight, that oil plugs and pipe connections are in place and free from leaks, and that the vent on the Geareducer (and external dipstick/oil level gauge, if present) is clear—a clogged vent can lead to oil leaks. If using turbine-type mineral oil, change oil—see Changing Geareducer Oil for instructions. Intermittent operation and extended periods of downtime can cause condensation of water in the oil.

Annually—Check mechanical equipment anchor bolts, drive shaft coupling bolts, and coupling set screws. Tighten as required.

Every 5 Years—Change oil. Geareducer was designed for 5-year oil change intervals. Perform Monthly and Annual maintenance checks prescribed above. To maintain five-year change intervals, use only Marley Gearlube.

Changing Geareducer Oil

Drain the Geareducer oil by removing the drain plug. See **Figure 1** for location. If equipped with an external dipstick/oil level gauge, remove the drain plug at that location, and drain the entire system.

To maximize service life of the Geareducer, remove a sample from the drained oil and look for evidence of foreign material, such as water, metal shavings or sludge, or send the oil sample to an oil analysis lab for inspection. If you find unacceptable condensation or sludge, flush the Geareducer with mineral oil before refilling.

After inspection is complete, fill the Geareducer with **10 quarts** (9.5 liters) of oil. See **Figure 1** for location. If the Geareducer is equipped with an external dipstick/oil level gauge an additional 2 to 3 quarts (1.9 to 2.8 liters) of oil will be required. Be certain that the vent on the Geareducer (and external dipstick/oil level gauge, if present) is not plugged. Verify that the gauge/drain line is full and that there aren't any leaks at the connections.

Protection Against Corrosion

Check Geareducer exterior yearly and touch up with epoxy paint if required. If your Geareducer is equipped with an oil gauge and drain line, coat any exposed threads at pipe joints to prevent corrosion.

Repair and Overhaul

If your Geareducer ever needs replacement or repair, we recommend returning the unit to a Marley factory service center. Contact your Marley sales representative to discuss course of action. A factory reconditioned Geareducer carries a one year warranty. The Order Number on your cooling tower will be required if the Geareducer is shipped back to the factory for repair. Obtain a ***"Customer Return Material"*** tag from the Marley sales representative in you area. To find your Marley sales representative call **913 664 7400** or check the internet at **spxcooling.com.**

Major repairs require the use of a fully equipped machine shop. If you decide to repair or overhaul your Geareducer, refer to the **Field Repair Section** and **Geareducer Parts List**.

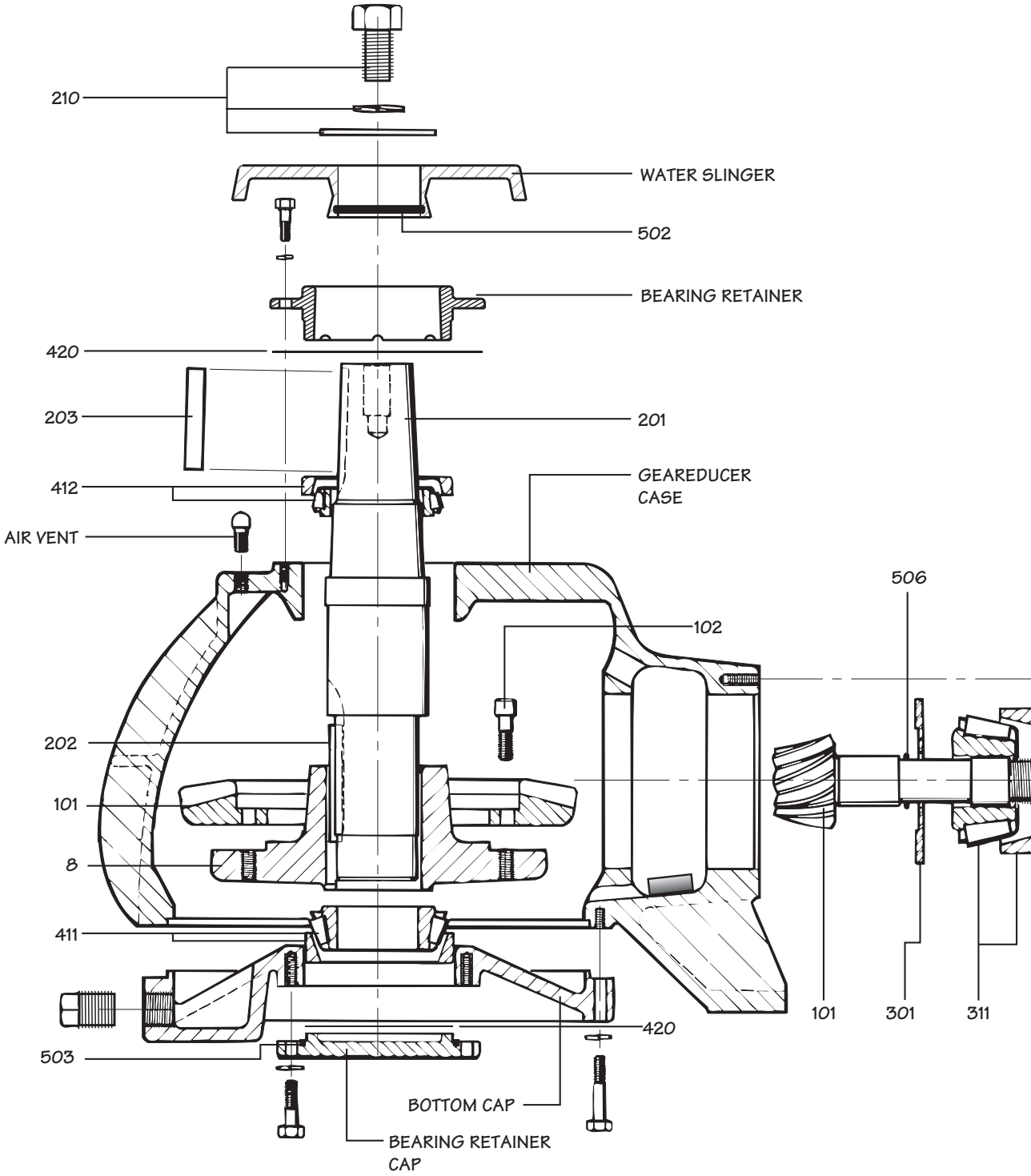
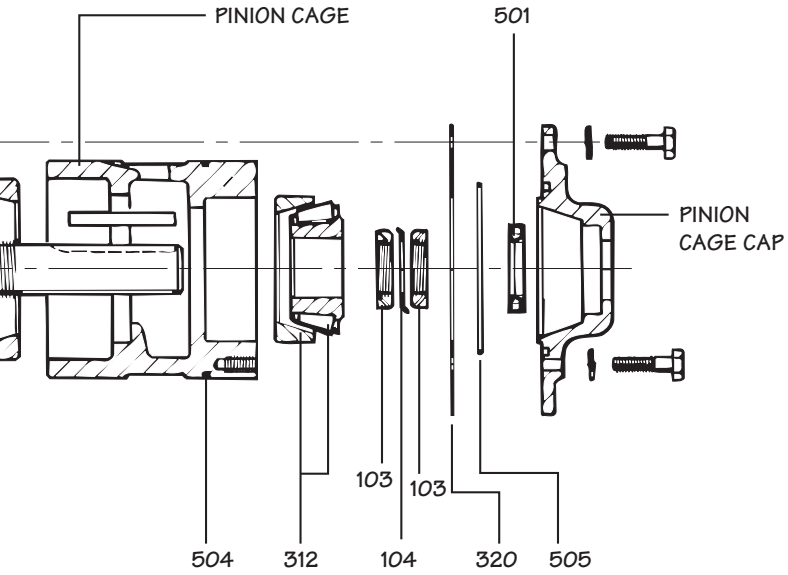


Figure 2 Exploded Cross Section



Parts List

1 Complete Geareducer Assembly.
8 Ring Gear Hub.
100 Spiral Bevel Gear Set.
- 101 Set of matched spiral bevel gears including integral pinion shaft with key.
  Gear ratios as follows:
  3.45 to 1 3.79 to 1 4.10 to 1
  4.56 to 1 5.11 to 1 5.50 to 1
  6.12 to 1 6.50 to 1 7.33 to 1
- 102 Ring gear attaching hardware.
- 103 Locknuts.
- 104 Lockwasher.

200 Fan Shaft Set.
- 201 Fan shaft.
- 202 Ring gear hub key. This is a special high strength key. It must be obtained from Marley.
- 203 Fan key.
- 210 Fan attaching hardware.
  Cap screws and washers.

301 Oil Slinger.
310 Set of Two Pinion Shaft Bearings.
- 311 Head, tapered roller bearing.
- 312 Tail, tapered roller bearing.

320 Pinion Cage Shims.

410 Fan Shaft Bearing Set.
- 411 Lower tapered roller bearing.
- 412 Upper tapered roller bearing.

420 Fan Shaft Shims.

500 O-Rings Set.
- 502 Water slinger O-ring, 3" ID × 3¼" OD × ⅛".
- 503 Bearing retainer O-ring, 5" ID × 5¼" OD ×⅛".
- 504 Pinion cage O-ring, 5¾" ID × 6" OD × ⅛".
- 505 Pinion cage cap O-ring, 4" ID × 4⅜" OD × 3/16".
- 506 Oil slinger O-ring, 1 15/16" ID × 2⅛" OD × 5/32".

501 Pinion Shaft Oil Seal.

field repair

General

Geareducers can be repaired in the field—however, major repairs require the use of a fully equipped machine shop. When field repair or replacement of parts is necessary, the following procedure is recommended for the disassembly and assembly of the unit. If any O-ring, oil seal or gasket is to be reused, care should be taken not to damage it during disassembly. Parts which contain O-rings or seals should not be jerked or twisted past a shoulder or edge. These parts are marked with an asterisk (*) in the description below. O-rings, oil seal and gaskets should be carefully inspected for damage before being reinstalled. Always use new O-rings and oil seal during a major overhaul.

Disassembly

Part numbers and references—refer to Figure 2 and 3.

1. Remove drain plug and drain oil.
2. Remove outer ring of bolts in pinion cage cap and remove pinion subassembly*.

Note—The thickness of the shim pack (320) is important in resetting the gears. The shim pack should either be saved or carefully measured with a micrometer. If the gears are to be replaced, record the pinion setting distance that is etched on the pinion gear.

3. Remove water slinger*.
4. Turn case upside down and remove bearing retainer cap* and shim pack (**420**).

Note—The thickness of this shim pack is important in the backlash setting of the gears. The shim pack should either be saved or carefully measured with a micrometer.

5. Remove bottom cap and fan shaft assembly.
6. Turn Geareducer case right side up and remove bearing retainer and shim pack (**420**).

Note—The thickness of this shim pack is important in setting the fan shaft bearing endplay. This pack should be saved or carefully measured with a micrometer.

7. Remove bearing cups (**411** and **412**) from the bottom cap and Geareducer case using a soft metal punch or mallet.

Pinion Cage Disassembly

1. Remove pinion cage cap* from pinion cage.
2. Remove O-rings* (**504** and **505**).
3. Remove locknuts and lockwasher (**103** and **104**) then press pinion shaft (**101**) out of pinion cage. This will free tail bearing cone (**312**). A hydraulic press or jack is recommended for removing or assembling press fit parts.
4. Press oil slinger*, O-rings* (**301** and **506**), and head bearing cone (**311**) from the pinion shaft. Bearings must not be exposed to dirt, dust or moisture.
5. Press bearing cups (**311** and **312**) out of pinion cage.

Fan Shaft Disassembly

1. Remove ring gear (**101**) from the ring gear hub (**8**).
2. Press ring gear hub and lower bearing cone (**411**) off of the fan shaft (**201**).
3. Remove lower fan shaft key (**202**).
4. Press the top bearing cone (**412**) off of the shaft.

Assembly

Before assembling a new pinion gear in the pinion cage, check match numbers on pinion gear and spiral bevel ring gear to be certain that they are a matched set. Gears are lapped in matched sets at the factory and should not be separated. Numbers are etched on both the pinion and ring gear as illustrated in **Figure 4**.

All parts that are to be reused should be thoroughly cleaned before being reinstalled. Do not remove new bearings from packaging until ready to use. Clean all bearings (new or used). Do not spin dry bearings. Take each bearing set and roll the cup on the cone to note any roughness. Replace bearing if necessary. If bearings cannot be installed immediately after cleaning, lubricate and cover to protect against dust, moisture, etc.

If a press is not available to install bearing cones, they can be heated as long as the temperature does not exceed 275°-300°F (135°-149°C). If the bearings get hotter than this, they will begin to draw and soften. Bearings can be heated with infrared lamps or with oil baths. If an oil bath is used, the bearing should be supported an inch or so above the pan to prevent local overheating.

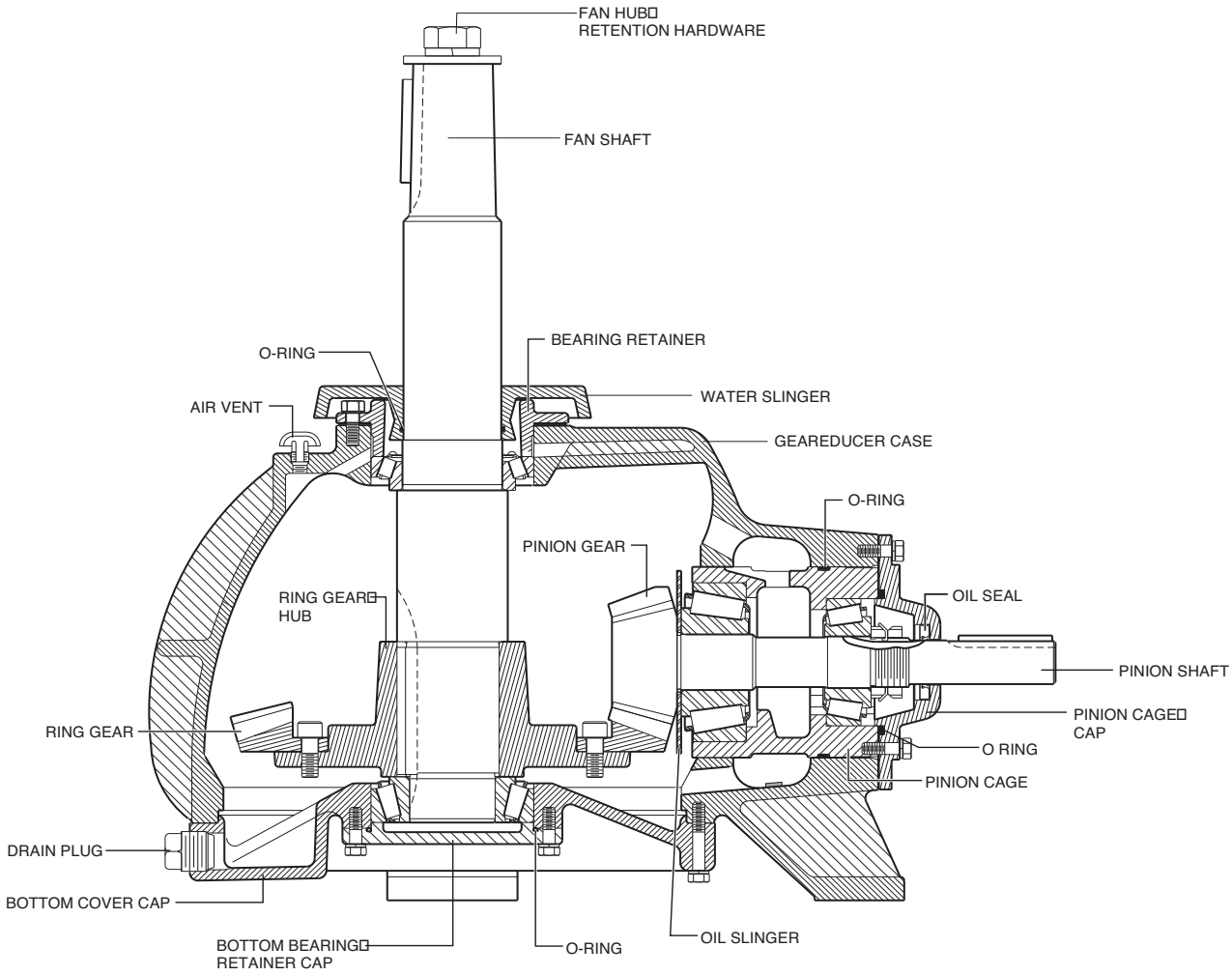


Figure 3 Cross Section

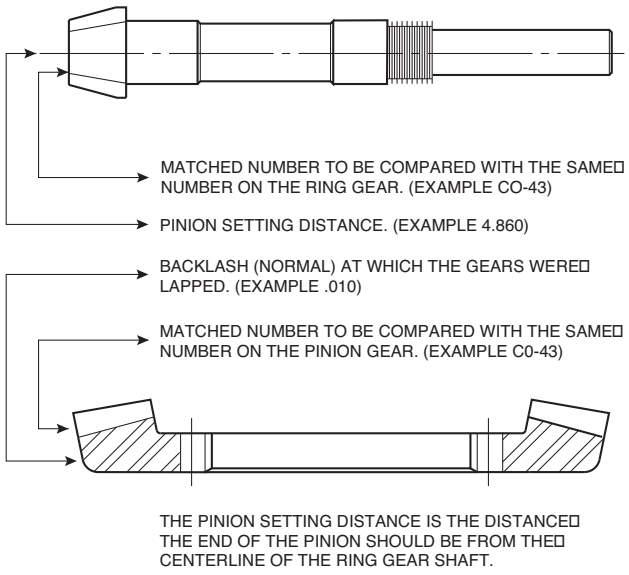


Figure 4 Gear Match Numbers and Setting Data

Pinion Cage Subassembly

1. Place O-ring (**506**) on pinion shaft (**101**).
2. Place oil slinger (301) on pinion shaft.
3. Press head bearing cone (**311**) on pinion shaft making sure oil slinger and bearing are against gear.
4. Press bearing cups (**311** and **312**) into pinion cage.
5. Lower pinion cage on pinion shaft, until head bearing cone and cup mate.
6. Press tail bearing cone (**312**) on pinion shaft until it mates with its bearing cup.
7. Install locknuts and lockwasher (103 and **104**). Tighten nuts on bearing cone until 5 to 15 in·lb$_f$ (565-1695 mN·m) of bearing preload is obtained. Bearing preload is the resistance in the bearings to shaft rotation measured in in·lb*f* required to rotate the shaft at uniform velocity. Preload is necessary to insure the stability of the gear engagement. Crimp the lockwasher to hold the two nuts in place.
8. Install O-ring (**504**) in groove.
9. Press oil seal (**501**) onto pinion shaft.
10. Position O-ring (**505**) and push cap—with seal and sleeve—in place on shaft. Attach cap to pinion cage and slide sleeve from cap.
11. Record the pinion setting distance that is etched on the pinion gear.

Installation of Fan Shaft

1. Press ring gear hub (**8**) and the upper and lower bearing cones (**411** and **412**) on the fan shaft (**201**). Install ring gear (**101**) on ring gear hub and tighten cap screws to 90 ft·lb$_f$ (123 N·m) .
2. Install upper fan shaft bearing cup (**412**) and bearing retainer without shims.
3. Turn the Geareducer case upside down and install the fan shaft assembly seating the upper fan shaft bearing cone into its cup. Install the lower bearing cup (**411**).
4. Install the bottom cover cap using sealer as indicated in **Figure 5** and tighten cap screws to 25 ft·lb$_f$ (34 N·m). Use old shim pack or make up equivalent thickness shim pack (**420**) and install the bottom bearing retainer cap. Do not install the O-ring for the bottom bearing retainer at this time. Tighten the cap screws to 25 ft·lb$_f$ (34 N·m).
5. Turn the Geareducer right side up and rotate the fan shaft several turns in each direction to seat the bearing rollers. With a dial indicator and using the Geareducer case as a reference, measure and adjust the fan shaft bearings to .003-.005" (.076-.127mm) endplay. The endplay is adjusted by adding shims (part **420**) under the bearing retainer.

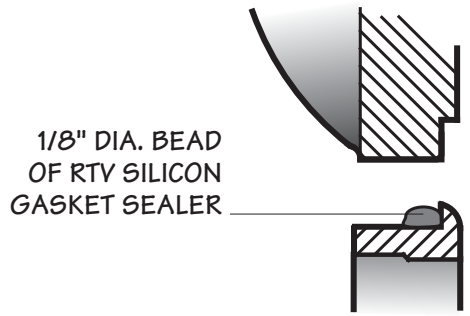


Figure 5 Flange Seal of Bottom Bearing Cap

Installation of Pinion Cage

1. The "X" marked pinion and gear teeth should be clearly identified with chalk or other markings which can be seen from the inspection opening or the bottom of the case.
2. Find the difference between the pinion setting distance of the old gear and the new pinion gear and adjust the old shim pack (**320**) or make a new shim pack to compensate for the different setting distances.

   Example:

Pinion setting distance of old gear	4.883
Pinion setting distance of new gear	4.878
Difference	.005

   Remove .005 from shim gap.
3. Install shims (**320**) and pinion cage subassembly.

Note—Care must be taken not to damage the pinion gear teeth by forcing them into the ring gear teeth.

Gear Setting Procedure

The proper mounting of the gear set is essential to obtain long life and smooth operation of the gears. The pinion and ring gears were positioned approximately in the preceding steps. The correct gear position is determined by the gear tooth contact pattern and by the backlash.

With the "X" marked tooth on the pinion gear engaged between the two "X" marked teeth on the ring gear, check the backlash with a dial indicator as shown in **Figure 6**. Lock the pinion shaft against rotation. The amount of movement of the fan shaft, measured at a distance equal to the outside radius of the ring gear is the backlash. The backlash on the 6.50/1 gear set should be between .013 and .018" (.33 and .46mm). The backlash on all other ratios should be between .010 and .015" (.25 and .38mm). With the "X" teeth engaged, the backlash should be approximately in the middle of the allowable range. Check the backlash at three other points around the ring gear to be sure the backlash is within the specified limits. Adjust ring gear axially by removing or adding shims (**420**) at bottom bearing retainer.

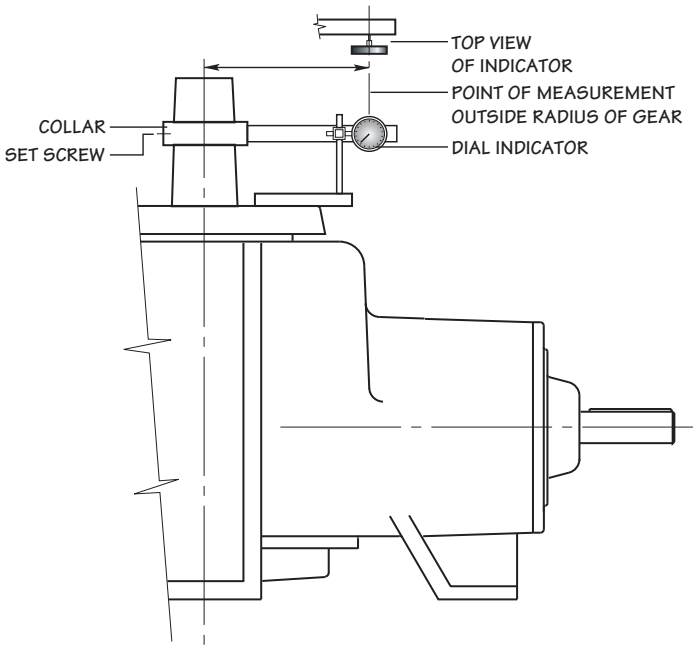


Figure 6 Gear Backlash Measurement

Note—To maintain bearing adjustment corresponding shim (**420**) adjustment must be made at the bearing retainer.

Example: *Removing .003" shims at the bottom bearing retainer requires the addition of .003" shims at the top bearing retainer to maintain correct bearing adjustment.*

Recheck the backlash to make sure it is within the proper limits.

With gears adjusted to the proper backlash, blue (Prussian blue in oil) the pinion teeth. By using a long handled brush or swab, the pinion teeth can be reached through the inspection opening. Drive the pinion by turning the fan shaft in both directions for several revolutions. Observe the markings on both gears on both sides of the teeth. Compare the markings with the contact pattern shown in **Figure 7**.

If contact pattern is incorrect, adjust the pinion position with shims between the pinion cage cap and Geareducer case.

When tooth contact is correct, recheck backlash. If necessary, adjust ring gear to obtain proper backlash and recheck contact pattern. Proper contact is more important of the two. On a used set of gears, it may be necessary to set the gears with slightly greater backlash in order to obtain proper tooth contact. Should a condition be encountered where correct contact cannot be obtained, contact your local Marley sales representative for information on factory repair service.

Final Assembly

1. Remove bottom bearing retainer cap and install the O-ring (**503**). Reinstall the bottom bearing retainer cap and tighten the cap screws to 25 ft·lb$_f$ (34 N·m).
2. Install O-ring (**502**) in water slinger.
3. Install water slinger on fan shaft (**8**).
4. Replace air vent and all pipe plugs.
5. Fill with lubricant selected from **Table I**.

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Geareducer user manul

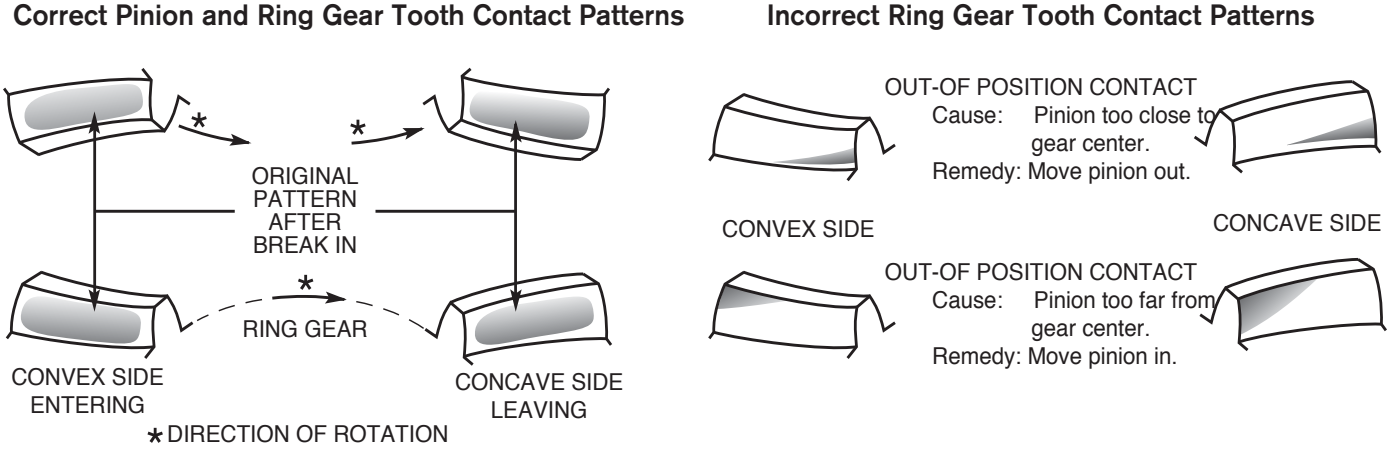

Figure 7 Tooth Contact Pattern—Correct and Incorrect

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/ *Marley LLC™* Water Level Control Panel /

Product Specifications

LLC Control Panel Features:

- NEMA 4X Fiberglass Enclosure
- Mounting flanges located top and bottom
- Outdoor rated
- Stainless steel continuous hinge
- Swing out lid with stainless steel clamps
- Lock-off capabilities
- 14" high x 12" wide enclosure for configurations up to 4 cards
- 18" high x 16" wide enclosure for configurations up to 6 cards

Electrical Components:

- Main breaker disconnect
- HAND-OFF-AUTO selector switch for manual fill control when makeup card is used
- Output contact for makeup card is internally powered with 120 VAC for use by customer
- User terminal points for connecting field devices e.g. solenoid, water level probes and alarm devices
- Terminal strip raised for easy access
- Wiring diagram and User Manual secured in literature pocket inside the panel door
- Built to UL and CUL standards
- Single enclosure for all control cards
- Level cards as required for following conditions:
  - Make up
  - Hi alarm
  - Lo alarm
  - Hi level cutout
  - Lo level cut out

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