MARLEY SCHOOL OF COOL

FOR SERVICE CONTRACTORS



MARLEY
An SPX Technologies Brand

Workshop Overview

This course includes hands-on workshops focusing on Marley products for the HVAC and Light Industrial markets. Participants will be divided into teams of four and work together through real hands on business scenarios for the Package and Parts products lines. Installation and selling techniques along with competitive advantages information will be incorporated by utilizing our Proof-in-Performance program for Package and Parts products.

Your Workbook

This workbook is designed to help you get the most out of the workshop.
It provides:

- A full set of program materials
- A chance for you to prepare for scenarios
- An opportunity to record what you learn
- Structure to help you apply your learning back in the workplace.

This is your personal copy. As you go through the workshop, you will be

- Guided towards useful materials
- Asked to log ideas, learnings and insights

Name: _____

Please use this space to record your personal objectives for this workshop.

My Personal Objectives

Agenda – Day 1

8:00 – Depart for Development Center

8:30 – Welcome and Introductions

9:00 – Overview of current offerings and Tower Designs - Presentation

9:45 – Break

10:00 – Safety Overview and Development Center Tour

12:00 – Lunch

12:45 – Hands on Product Training

Session 1

– Team 1 – Pinion Shaft Oil Seal Replacement

– Team 2 – Controls Overview and Troubleshooting

– Team 3 – Sheave and Belt Replacement / BAC & Evapco Parts

– Team 4 – MX75 & MBX Fill Installation

– Team 5 – Fan Blade & Hardware Replacement

2:15 – Break

2:30 – Marley® WaterGard™– Presentation & Hands on training on WG018 Model

3:15 – Hands on Product Training

Session 2

– Team 1 – Driveshaft and Close Coupling Replacement

– Team 2 – Pinion Shaft Oil Seal Replacement

– Team 3 – Controls Overview and Troubleshooting

– Team 4 – Fan Blade & Hardware Replacement

– Team 5 – Sheave and Belt Replacement / BAC & Evapco Parts

4:45 – Depart for Hotel

6:15 – Dinner @ Top Golf

Agenda – Day 2

8:00 – Depart for Development Center

8:30 – Hands on Product Training

Session 3

– Team 1 – Controls Overview and Troubleshooting

– Team 2 – Driveshaft and Close Coupling Replacement

– Team 3 – Pinion Shaft Oil Seal Replacement

– Team 4 – Sheave and Belt Replacement / BAC & Evapco Parts

– Team 5 – MX75 & MBX Fill Installation

10:00 – Break

10:15 – Hands on Product Training

Session 4

– Team 1 – Sheave and Belt Replacement / BAC & Evapco Parts

– Team 2 – MX75 & MBX Fill Installation

– Team 3 – Fan Blade & Hardware Replacement

– Team 4 – Driveshaft and Close Coupling Replacement

– Team 5 – Controls Overview and Troubleshooting

11:45 – Lunch

12:30 – Hands on Product Training

Session 5

– Team 1 – Fan Blade & Hardware Replacement

– Team 2 – Sheave and Belt Replacement / BAC & Evapco Parts

– Team 3 – MX75 & MBX Fill Installation8

– Team 4 – Pinion Shaft Oil Seal Replacement

– Team 5 – Driveshaft and Close Coupling Replacement

2:00 – Break

2:15 – Water Monitoring System (LLC) Hands on Training

3:30 – Hands on Product Training

Session 6

– Team 1 – MX75 & MBX Fill Installation

– Team 2 – Fan Blade & Hardware Replacement

– Team 3 – Driveshaft and Close Coupling Replacement

– Team 4 – Controls Overview and Troubleshooting

– Team 5 – Pinion Shaft Oil Seal Replacement

5:15 – Depart for Hotel

6:30 – Dinner @ O'Dowd's Gastrobar

Agenda – Day 3

7:45 – Depart for Plant Tour

8:15 – Plant Tour

10:15 – Break

10:30 – Tower Start-up and Inspection Training - Presentation

11:20 – Depart for Lunch

11:30 – Lunch – KC Joe's BBQ

12:20 – Depart for Development Center (Cave)

12:50 – Hands on Tower Start-up & Inspection Training on NC8411 & NC8422.

2:10 – Break

2:20 – Post Start-up discussion – Group report out

2:45 – Discuss Lessons Learned from the week. Did we meet your Expectations?

3:00 – Depart

Marley Cooling Towers and OEM Parts

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Who is SPX?

SPX Cooling Tech, LLC.

A leading, full-line, full-service cooling tower and air cooled heat exchanger manufacturer.

The companies that formed SPX Cooling Technologies were founded more than 100 years ago and have **more than 250 global patents** in the process cooling, industrial, refrigeration, and HVAC markets.



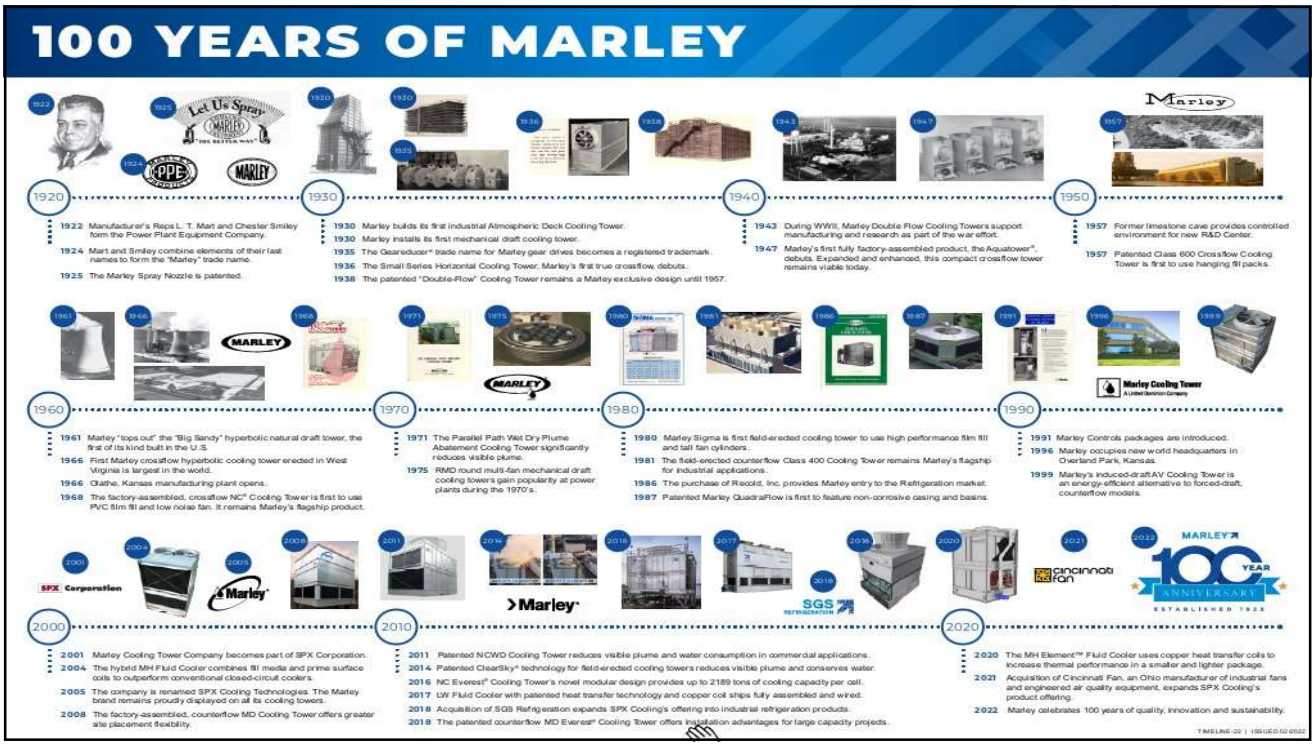
Current Brands:

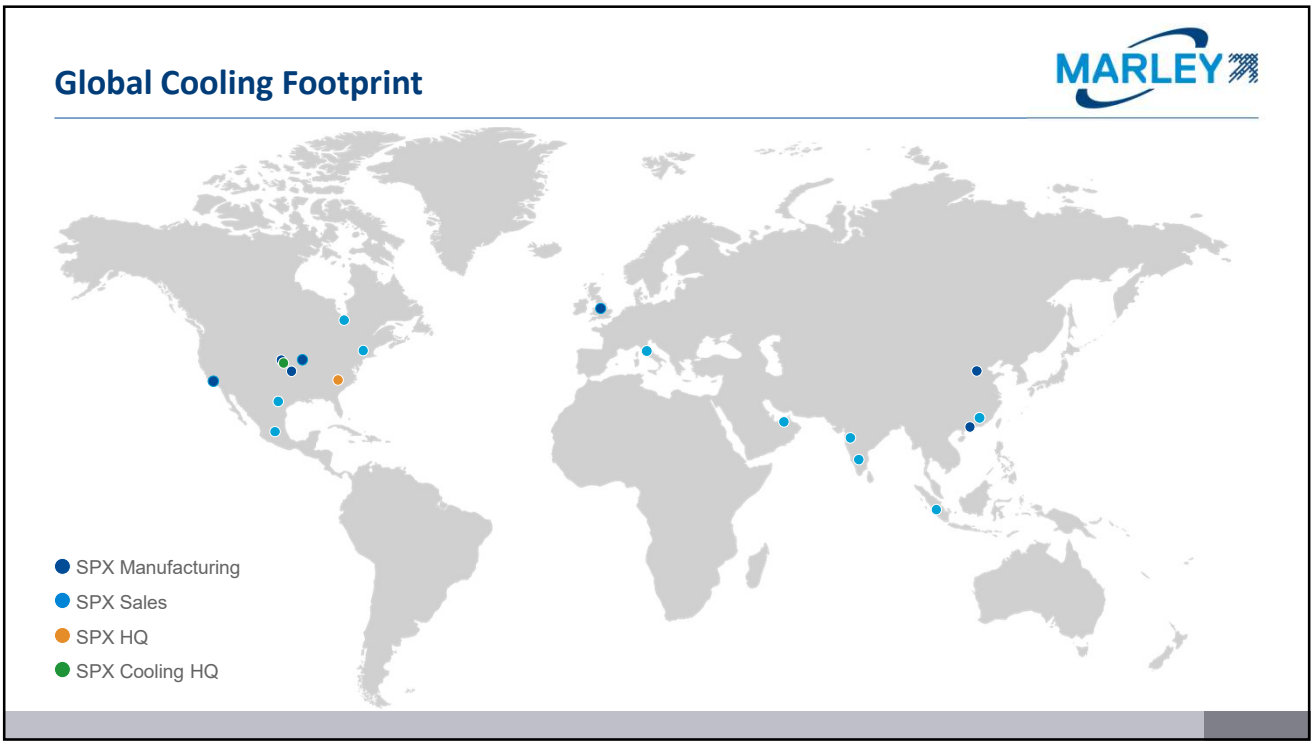
MARLEY RECOLD SGS

Legacy Brands:

Ceramic®	Head Wrightson
Custodis-Ecodyne	Heenan Coolers
Davenport	Pritchard
Hamon	Zurn

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100 YEARS OF MARLEY
1920
1922 Manufacturer's Reps L. T. Mart and Chester Smiley form the Power Plant Equipment Company.
1924 Mart and Smiley combine elements of their last names to form the "Marley" trade name.
1925 The Marley Spray Nozzle is patented.
1930
1930 Marley builds its first industrial Atmospheric Deck Cooling Tower.
1930 Marley installs its first mechanical draft cooling tower.
1935 The Geareducer® trade name for Marley gear drives becomes a registered trademark.
1936 The Small Series Horizontal Cooling Tower, Marley's first true crossflow, debuts.
1938 The patented "Double-Flow" Cooling Tower remains a Marley exclusive design until 1957.
1940
1943 During WWII, Marley Double Flow Cooling Towers support manufacturing and research as part of the war effort.
1947 Marley's first fully factory-assembled product, the Aquatower™, debuts. Expanded and enhanced, this compact crossflow tower remains viable today.
1950
1957 Former limestone cave provides controlled environment for new R&D Center.
1957 Patented Class 600 Crossflow Cooling Tower is first to use hanging fill packs.
1960
1961 Marley "tops out" the "Big Sandy" hyperbolic natural draft tower, the first of its kind built in the U.S.
1966 First Marley crossflow hyperbolic cooling tower erected in West Virginia is largest in the world.
1966 Olathe, Kansas manufacturing plant opens.
1968 The factory-assembled, crossflow NC® Cooling Tower is first to use PVC film fill and low noise fan. It remains Marley's flagship product.
1970
1971 The Parallel Path Wet Dry Plume Abatement Cooling Tower significantly reduces visible plume.
1975 RMD round multi-fan mechanical draft cooling towers gain popularity at power plants during the 1970's.
1980
1980 Marley Sigma is first field-erected cooling tower to use high performance film fill and tall fan cylinders.
1981 The field-erected counterflow Class 400 Cooling Tower remains Marley's flagship for industrial applications.
1986 The purchase of Recold, Inc. provides Marley entry to the Refrigeration market.
1987 Patented Marley QuadraFlow is first to feature non-corrosive casing and basins.
1990
1991 Marley Controls packages are introduced.
1996 Marley occupies new world headquarters in Overland Park, Kansas.
1999 Marley's induced-draft AV Cooling Tower is an energy-efficient alternative to forced-draft, counterflow models.
2000
2001 Marley Cooling Tower Company becomes part of SPX Corporation.
2004 The hybrid MH Fluid Cooler combines fill media and prime surface coils to outperform conventional closed-circuit coolers.
2005 The company is renamed SPX Cooling Technologies. The Marley brand remains proudly displayed on all its cooling towers.
2008 The factory-assembled, counterflow MD Cooling Tower offers greater site placement flexibility.
2010
2011 Patented NCWD Cooling Tower reduces visible plume and water consumption in commercial applications.
2014 Patented ClearSky® technology for field-erected cooling towers reduces visible plume and conserves water.
2016 NC Everest® Cooling Tower's novel modular design provides up to 2189 tons of cooling capacity per cell.
2017 LW Fluid Cooler with patented heat transfer technology and copper coil ships fully assembled and wired.
2018 Acquisition of SGS Refrigeration expands SPX Cooling's offering into industrial refrigeration products.
2018 The patented counterflow MD Everest® Cooling Tower offers installation advantages for large capacity projects.
2020
2020 The MH Element™ Fluid Cooler uses copper heat transfer coils to increase thermal performance in a smaller and lighter package.
2021 Acquisition of Cincinnati Fan, an Ohio manufacturer of industrial fans and engineered air quality equipment, expands SPX Cooling's product offering.
2022 Marley celebrates 100 years of quality, innovation and sustainability.


Global Cooling Footprint
MARLEY
SPX Manufacturing
SPX Sales
SPX HQ
SPX Cooling HQ

How Does a Cooling Tower Work?

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How Does a Cooling Tower Work?



- Hot condenser water flows over the fill
- Fan draws ambient air across water on the fill
- Heat from the water is transferred to the air by latent and sensible cooling
- Cooled water is collected and recycled through the system being serviced

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Selection Parameters

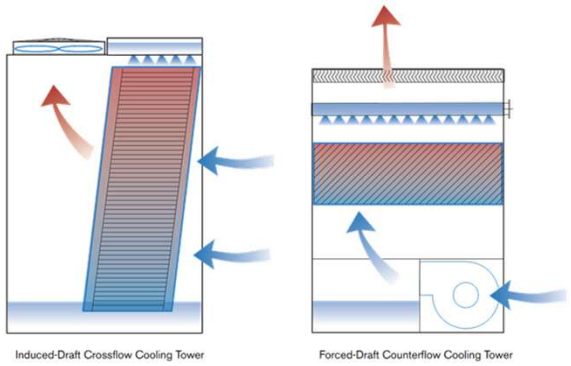
Common Terms:	Examples:
• Flow rate	= 3,000 gpm
• HW temperature (condenser LWT)	= 95°F
• CW temperature (condenser EWT)	= 85 °F
• WB temperature (entering wet bulb)	= 78 °F
• Range = HW – CW	= 10 °F
• Approach = CW - WB	= 7 °F

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Common Terms

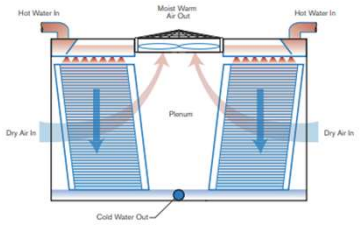
Induced Draft vs. Forced Draft

- Induced draft cooling towers have fans that are typically mounted on top of the unit and pull air through the fill media.
- Forced draft towers have blowers located at the base that push air through the tower.

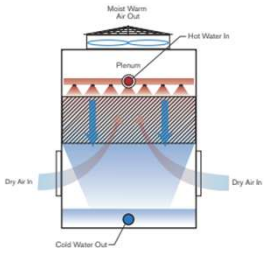


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Common Terms



Crossflow cooling tower schematic



Counterflow cooling tower schematic

Crossflow vs. Counterflow

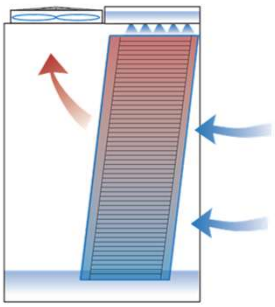
- Crossflow cooling towers are designed so that the water flows vertically through the fill while the air flows horizontally, across the flow of the falling water.
- Counterflow cooling towers are designed so that air flows vertically upward, counter to the flow of falling water in the fill.

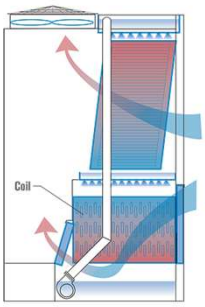
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Common Terms

Open Circuit vs. Closed Circuit Cooling Towers

- In open circuit cooling towers, the process fluid is directly exposed to the atmosphere as it flows over the heat transfer media and is evaporated during the cooling process.
- In closed circuit cooling towers, process fluid is pumped internally through a coil and heat is transferred from the process fluid to the recirculating water as us flows over the outside of the coil tubes.

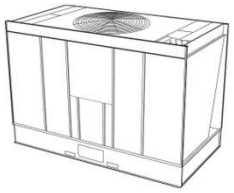

Open Circuit Cooling Tower



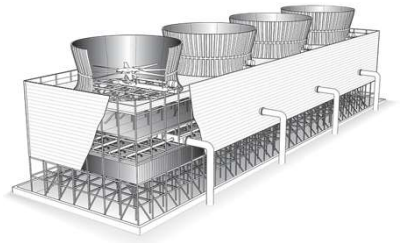
Closed Circuit Cooling Tower

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Common Terms



FAP Cooling Tower



FEP Cooling Tower

Factory Assembled (FAP) vs. Field Erected (FEP)

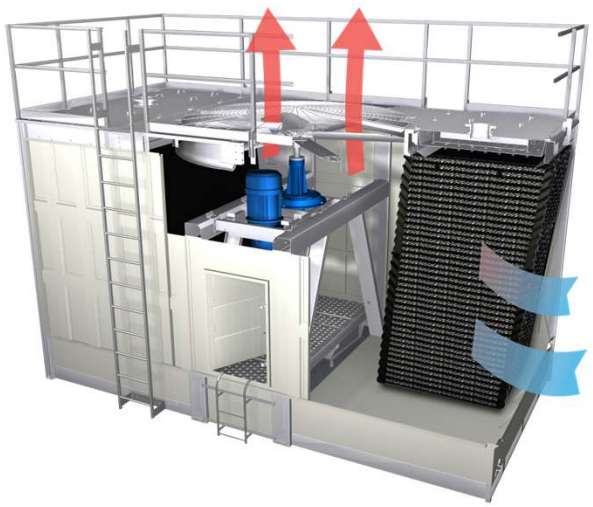
- FAP towers are built and shipped in as few sections as the mode of transportation will permit. A relatively small tower will ship essentially intact. A larger, multi-cell cooling tower is manufactured as modules at the factory and shipped ready for final assembly.
- FEP towers are primarily constructed at the site of ultimate use. All large cooling towers, and many of the smaller towers, are prefabricated, piece-marked, and shipped to the site for final assembly.

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Induced Draft Crossflow

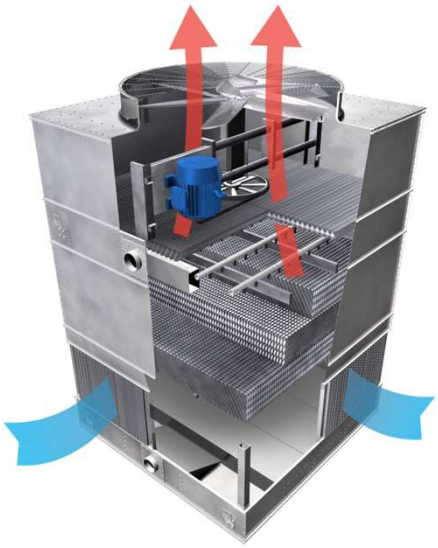
- Air flows *across* the falling water
- Uses a gravity-fed water distribution system

+	−
• Lower pump head • Accessible plenum for easy mechanical access • Variable flow capabilities	• Larger footprint at lower tonnages



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Induced Draft Counterflow



- Air flows *counter* to the falling water
- Pressurized water distribution system

+
- Smaller footprint at low tonnages

−
- Increased sound
- Maintenance
- Capacity per cell

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Forced Draft

- Uses centrifugal blowers instead of axial fans
- Pressurized water distribution



+
- External static applications
- Low noise
- Low profile

−
- High horsepower (up to 2x)

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Closed-Loop: Evaporative Fluid Cooler/Condenser



- Process fluid in closed loop
- Recirculation pump circulates cooling water over fill & coils
- Available in crossflow or counterflow configurations and induced or forced draft fan types
- Used for preventing process fluid contamination from airborne matter

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Closed-Loop: Adiabatic Fluid Cooler

- Process fluid in closed loop
- Recirculation pump circulates cooling water over pads – used to pre-cooling the air before it passes over the coils.
- Able to operate wet or dry.
- Used to minimize water consumption and/or save energy compared to air-cooled solutions.



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What Does SPX Offer?

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SPX Offering



NC EVEREST®
1,311 to 2,189 tons per cell



NC®
101 to 1,455 tons per cell



NCWD WET-DRY HYBRID
reduce visible plume



NC ALPHA
Splash-fill design



AV
125 to 772 tons per cell



MD®
165 to 500 tons per cell



MD EVEREST®
1,227 to 3,790 tons per cell



AQUATOWER®
8 to 126 tons per cell



JT
30 to 415 tons per cell

Full line of cooling towers to replace any brand

SPX Offering



Marley MH
34 - 812 Tons per Cell



Recold JW
GPM Range: 10 - 1700



Recold MW



Marley DT
58 - 321 nominal tons per cell



Marley LW
18-107 nominal tons per cell



Marley OlympusV Adiabatic

Full line of Fluid Coolers to replace any brand

SPX Offering



Recold JC



Recold MW



SGS IEC
187 to 1358 ammonia R717 tons



SGS DTC
136 to 1272 ammonia R717 Tons



Recold OlympusV Condenser or CO2 Cooler



Recold LC
80-371 nominal tons per cell

Full line of Evaporative Condensers to replace any brand

SPX Offering



Marley Geareducer®



Marley X7 Fan



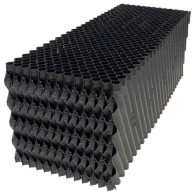
Marley MC Close Coupling
Marley 6-Q Driveshaft



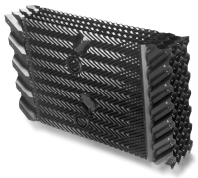
Motors
Marley Specified



Marley Spiral-Target Nozzle
Crossflow towers



Marley MC120S Counterflow Fill
High Performance fill pack



Marley MX Crossflow fill
Hanging type



Marley MBX Crossflow fill
Bottom Supported type

Marley OEM Parts – Precision-Engineered

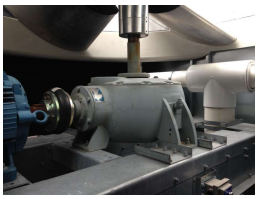
SPX Offering



Fill Replacement
Hanging fill & Bottom Supported



Hot Water Basin Replacement
Galvanized or Stainless Steel



Increased Performance
Mechanical Upgrades



Sound Reductions
Marley Low Sound Packages



Variable Flow – Nozzle cups
Up to 30% turndown



Tower Access – Safety Equipment



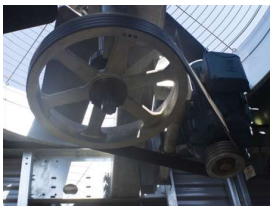
Mechanical Equipment
Removal



Marley Liquid Level Control

Marley Repair and upgrade kits - Engineered to fit Marley Towers

SPX Offering



Belts, Aluminum Sheave, Bushings, Fan shafts



Bearing with Rain Shield



Fill Replacement Kits
Hot Water Basin Kits



FRP Louver Replacement



Plastic Float Valve
Replaced with Marley Brass Valve

BAC and Evapco Towers – Utilize Marley Parts – Engineered to fit

SPX Offering



(Source: MMCO)

Before



(Source: MMCO)

After

Marley MBX Fill Kits – Engineered to fit

SPX Offering



(Source: MMCO)

Before



(Source: MMCO)

After

Hot Water Basin Kits – Engineered to fit

SPX Offering

- Hot Water Basins are designed for direct replacement of existing unit. *(some field drilling may be required for the retrofit replacement)*
- Available in stainless and galvanized steel
- Steel HW basin covers
- Nozzle cups and basin dams are available for low flow profiles

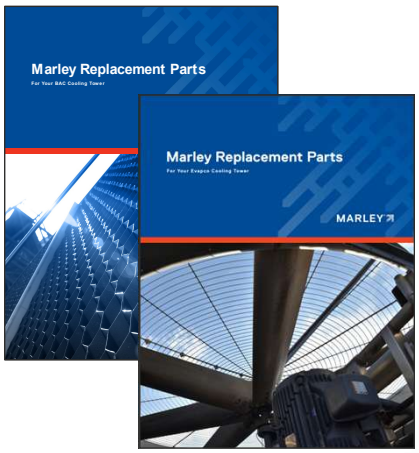




(Source: SPX)

Engineered Marley Hot Water Basins - Goal: Keep Inlet At Same Location

SPX in Other OEM Towers





Marley Parts for BAC & Evapco towers - Available on spxcooling.com

SPX Offering



Marley Industrial crossflow tower



Marley Industrial counterflow tower



Marley Mechanical Components



Marley M-Series Geareducer
Drop-in replacement for double reduction Amarillo Gearbox



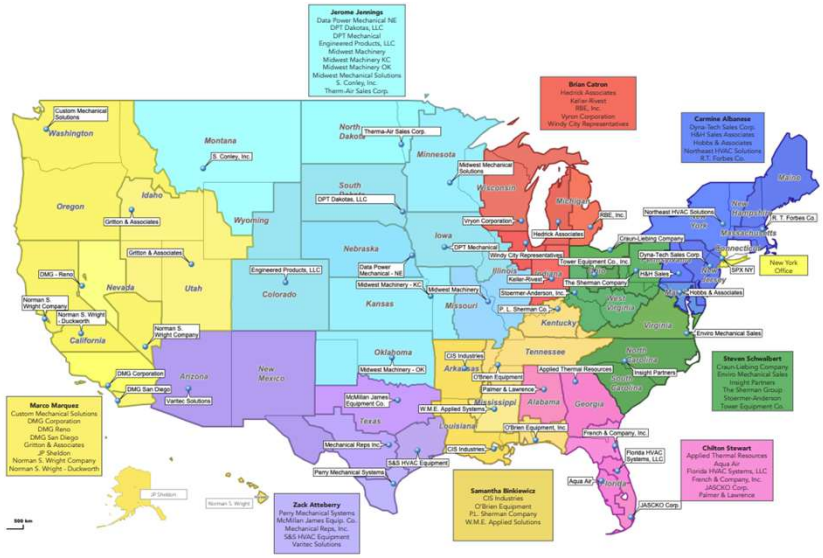
Marley Geareducer
Repair and Rebuilt Program

Field Erected Cooling Towers (FEP) – Components for Marley and Non-Marley towers

Marley Representative Network & Resources

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Marley HVAC/LI Representatives



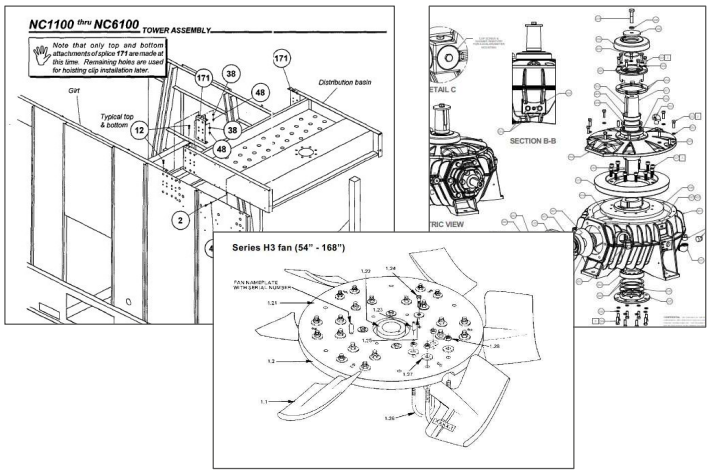
Local representatives available for sales and technical support.

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Representative Resources

Marley representatives have access to additional technical resources to support your needs.

- Tower service/parts histories
- Exploded drawings
- BOMs
- Etc.



Tower Manuals found on www.spxcooling.com : Library - Manuals

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Parts Stocking

Inventory:

- 2,271 SKUs stocked
- $6.6 Million value
- Marley, BAC, and Evapco Towers

Packing/shipment:

- Pick slip Audits
- Photo Documentation









Pick Slip Audited
Ensures order accuracy



Photo Documentation
Parcel - Inside box contents



Photo Documentation
LTL - Stapled to skid

Marley Warehouse Inventory – 50% of shipments ship out within two days.

Company Confidential

Additional Resources

Videos

- How-to videos available on spxcooling.com and the SPX Cooling Youtube channel



How To Install A Marley® NC® Cooling Tower Episode 1: Site Prep, Tower Arrival...



Marley Ultra Quiet Fan Blade Pitch Adjustment

Training Workshop

- Location: Kansas City
- ½ day classroom
- 1 ½ days Hands on Product Training
- ½ day Plant & R&D Tour

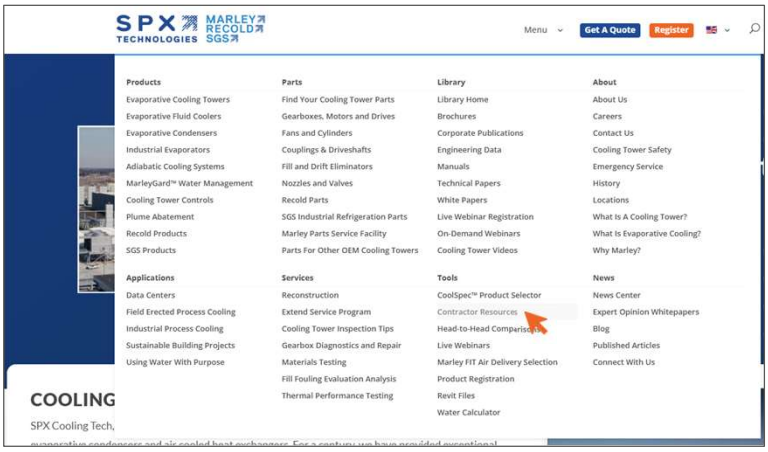


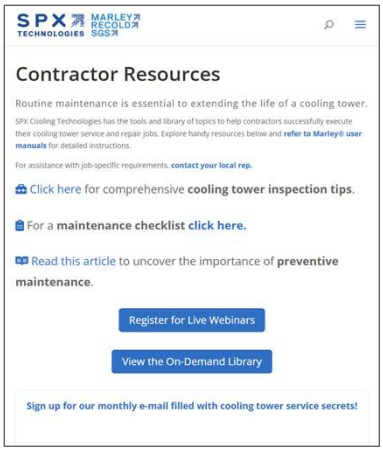
Marley LLC Water Level Control Part 6 - Troubleshooting the Panel



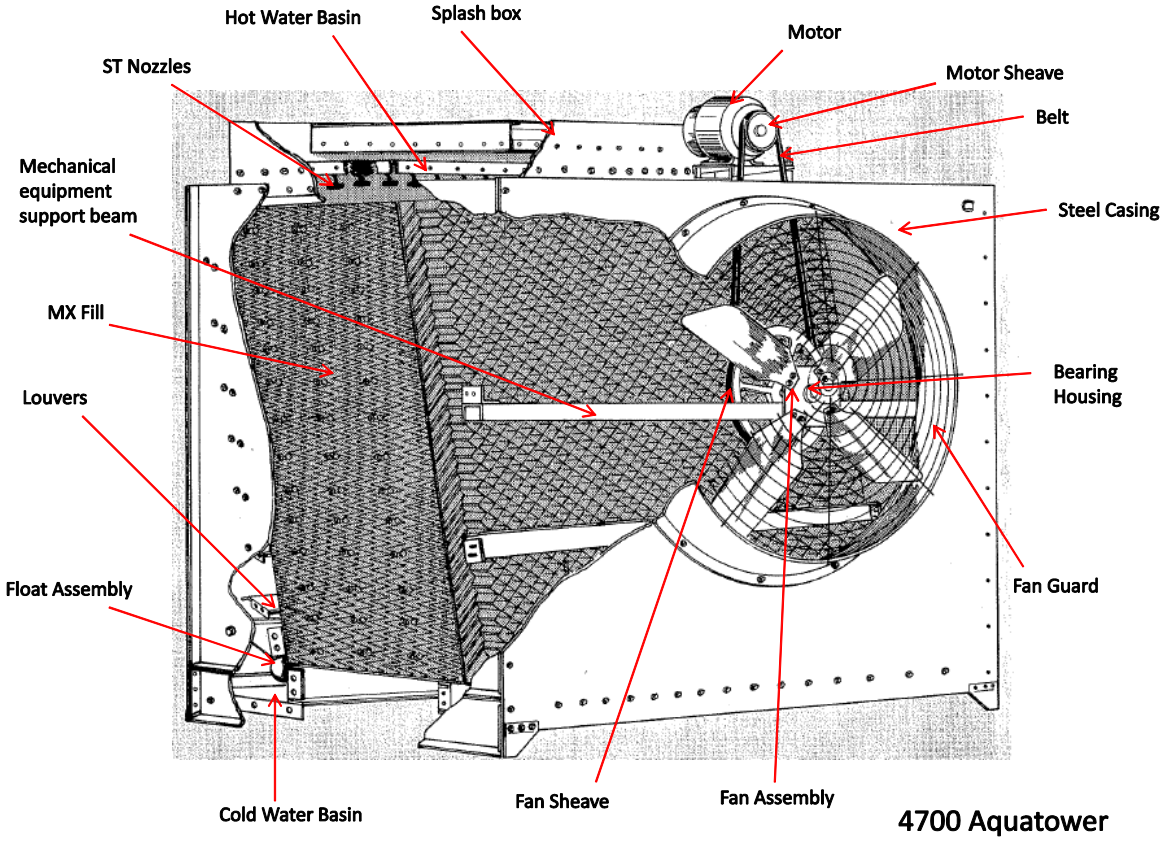
Marley® BasinGard™ Cooling Tower Filter Installation and Replacement

Additional Resources

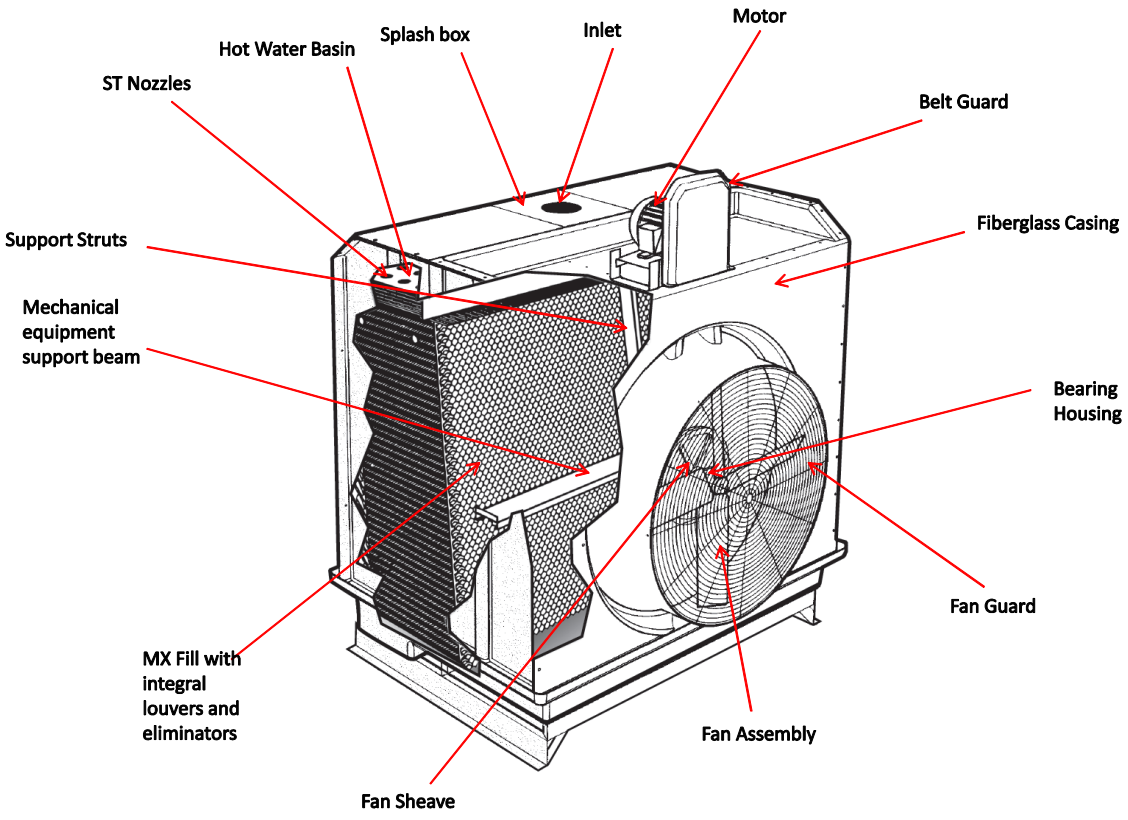




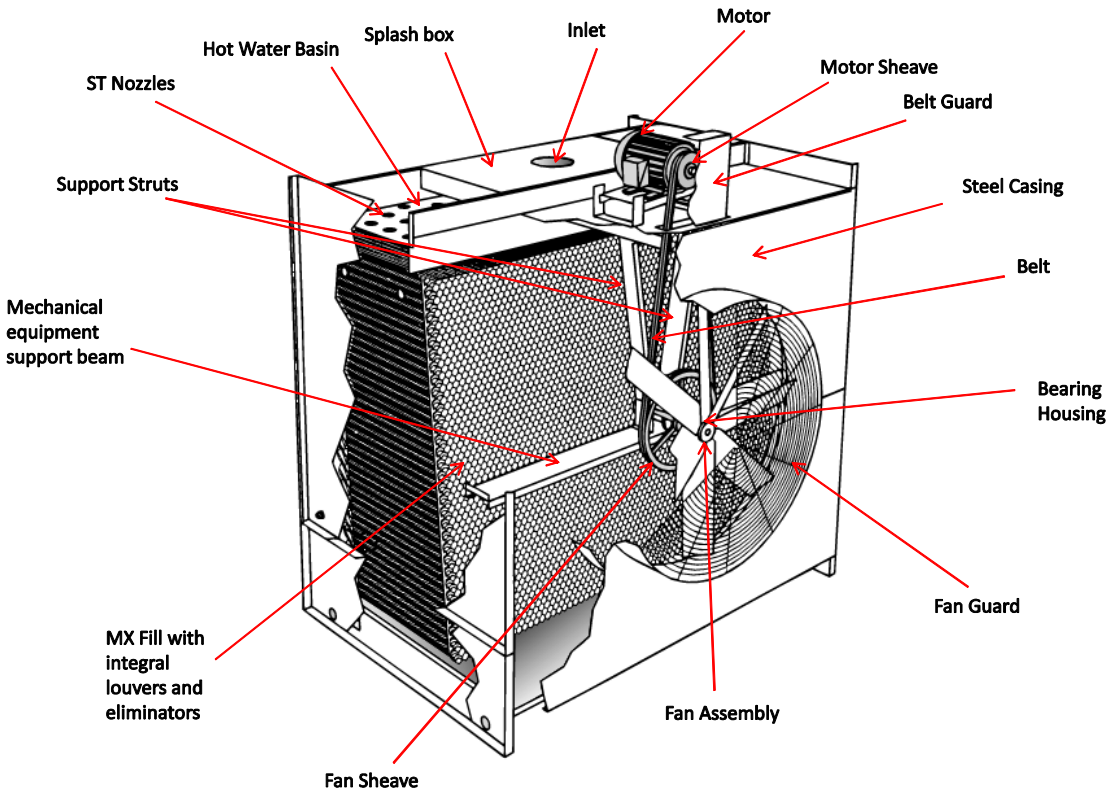
https://spxcooling.com/contractor-resources



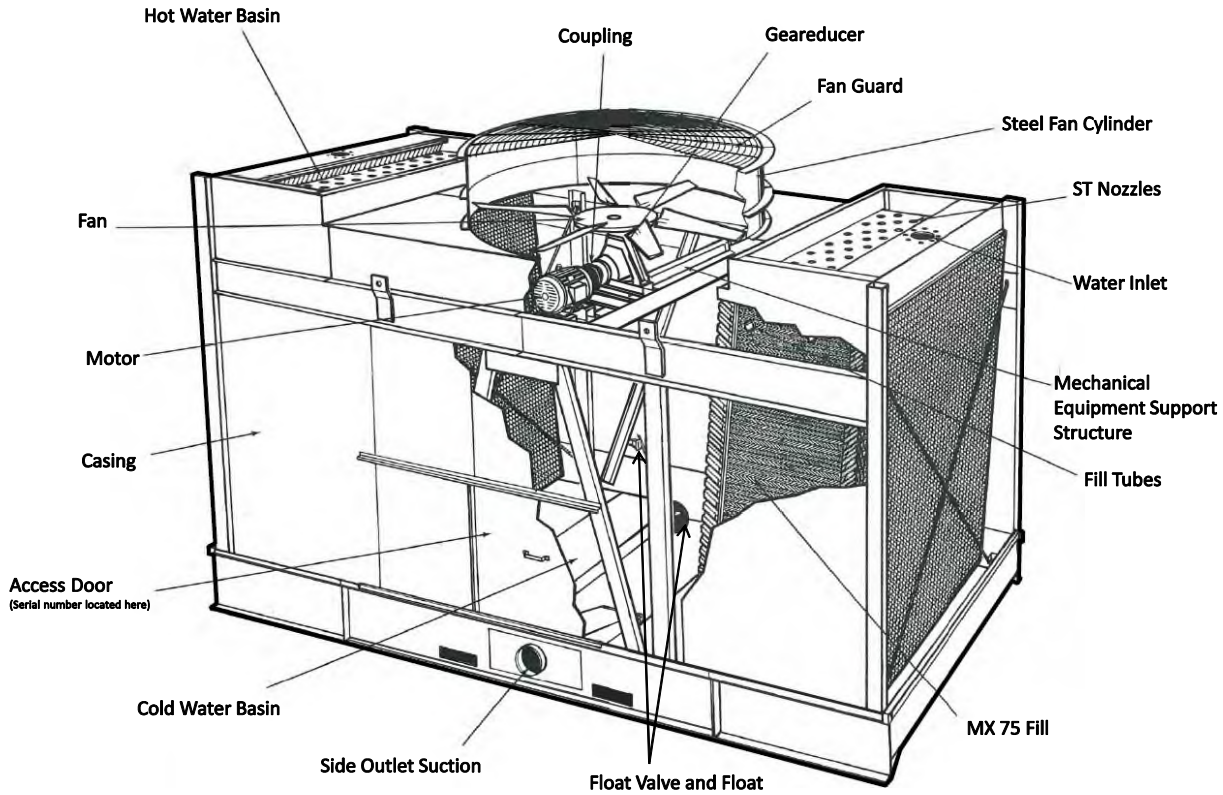
4700 Aquatower



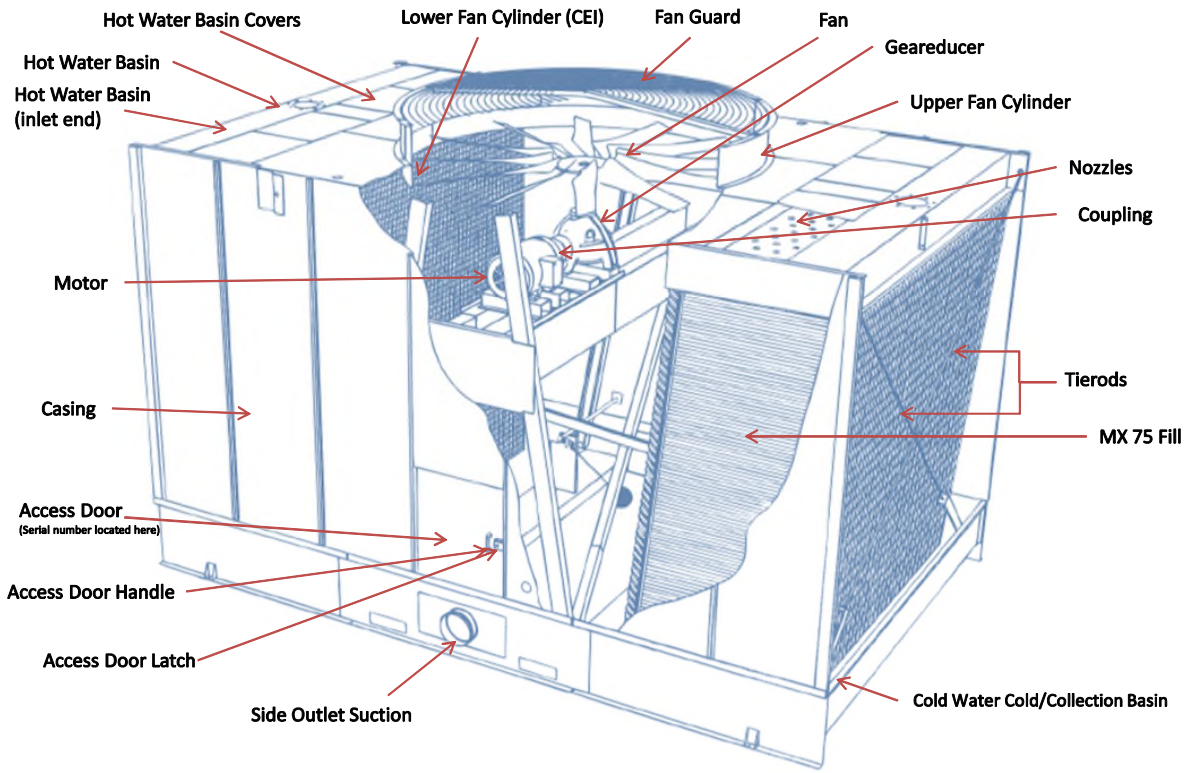
3800 Aquatower (Fiberglass)



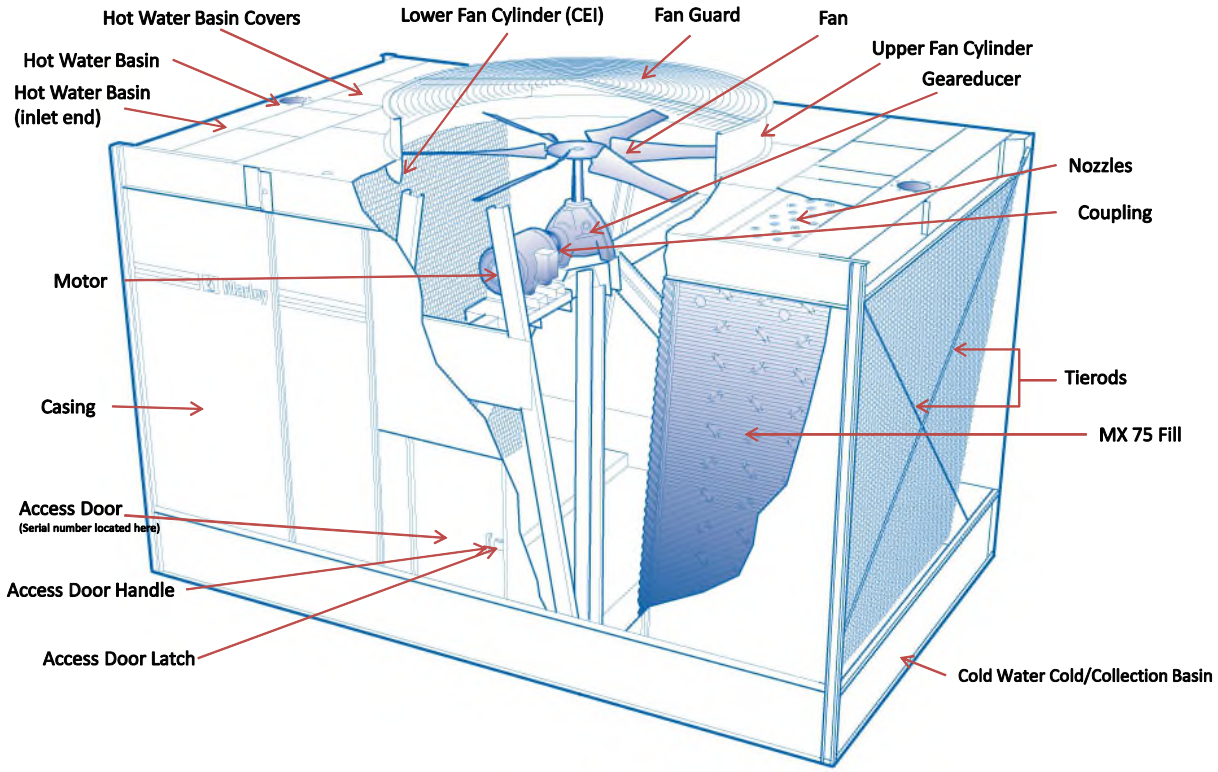
4800 & 4900 Aquatower



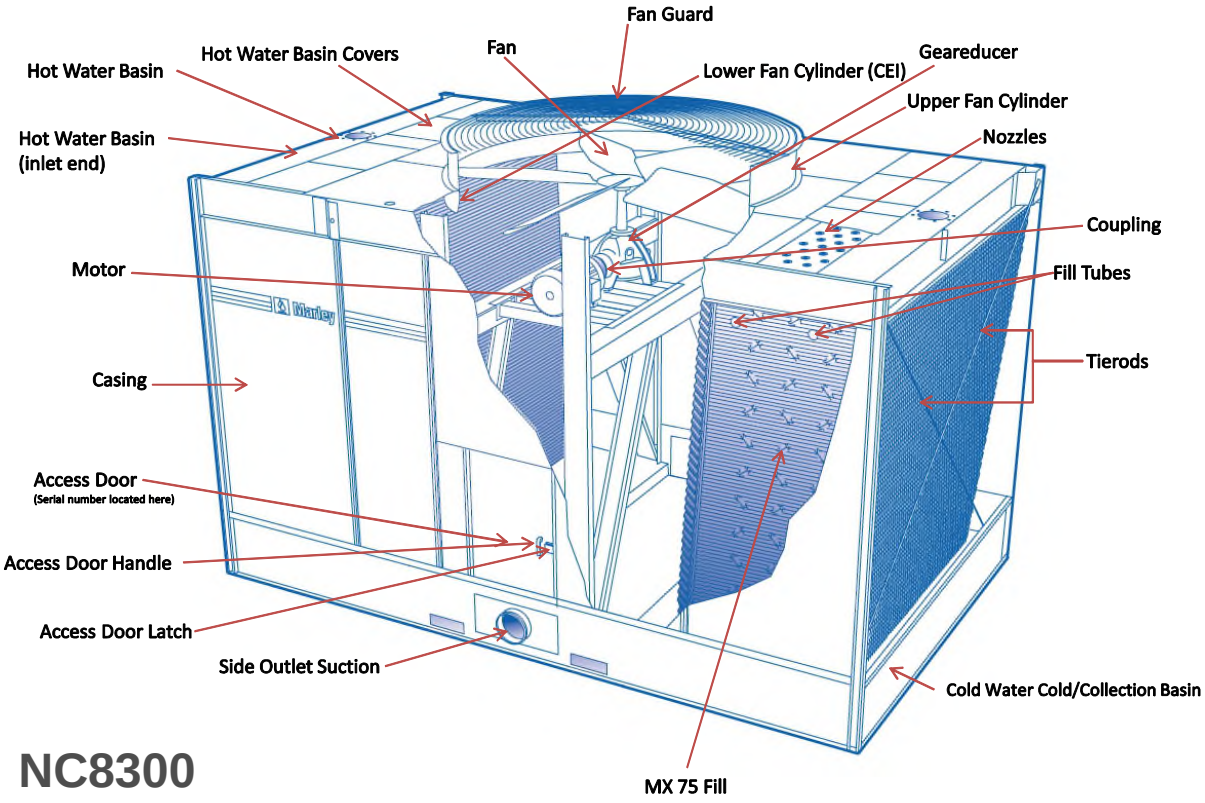
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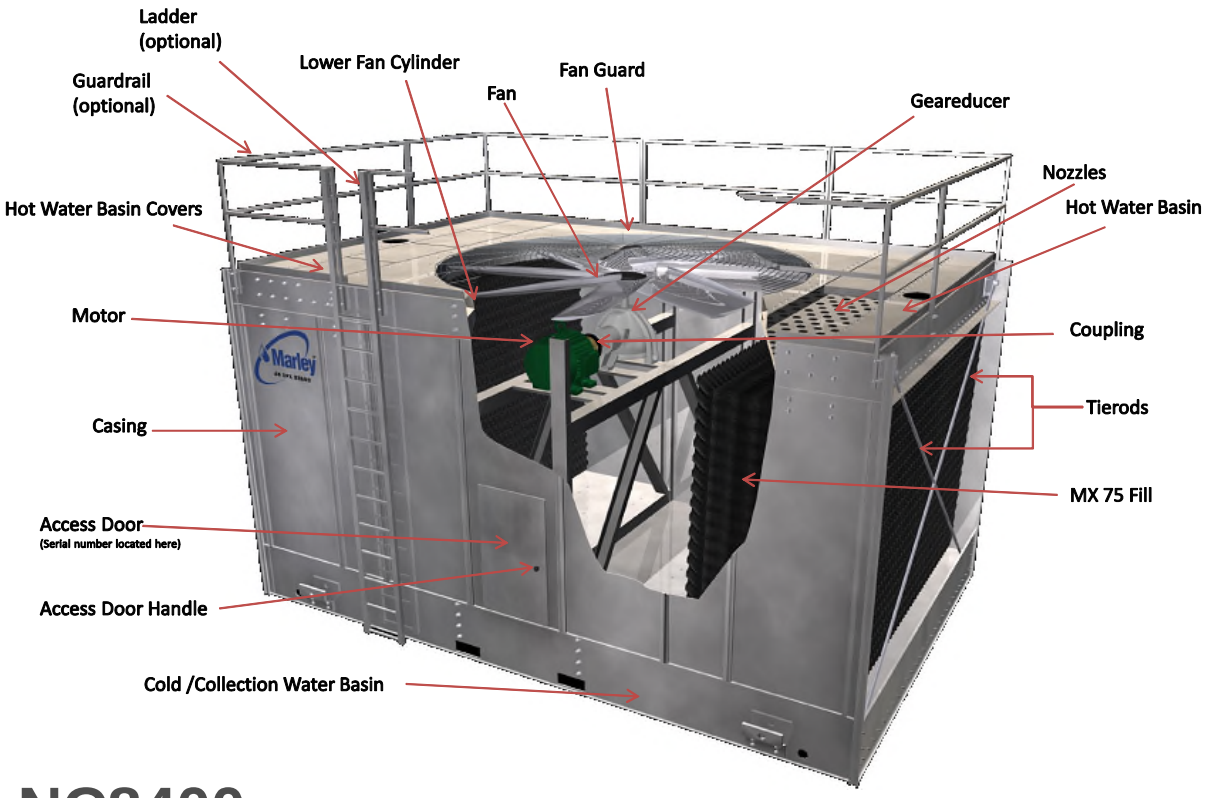
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NC1200

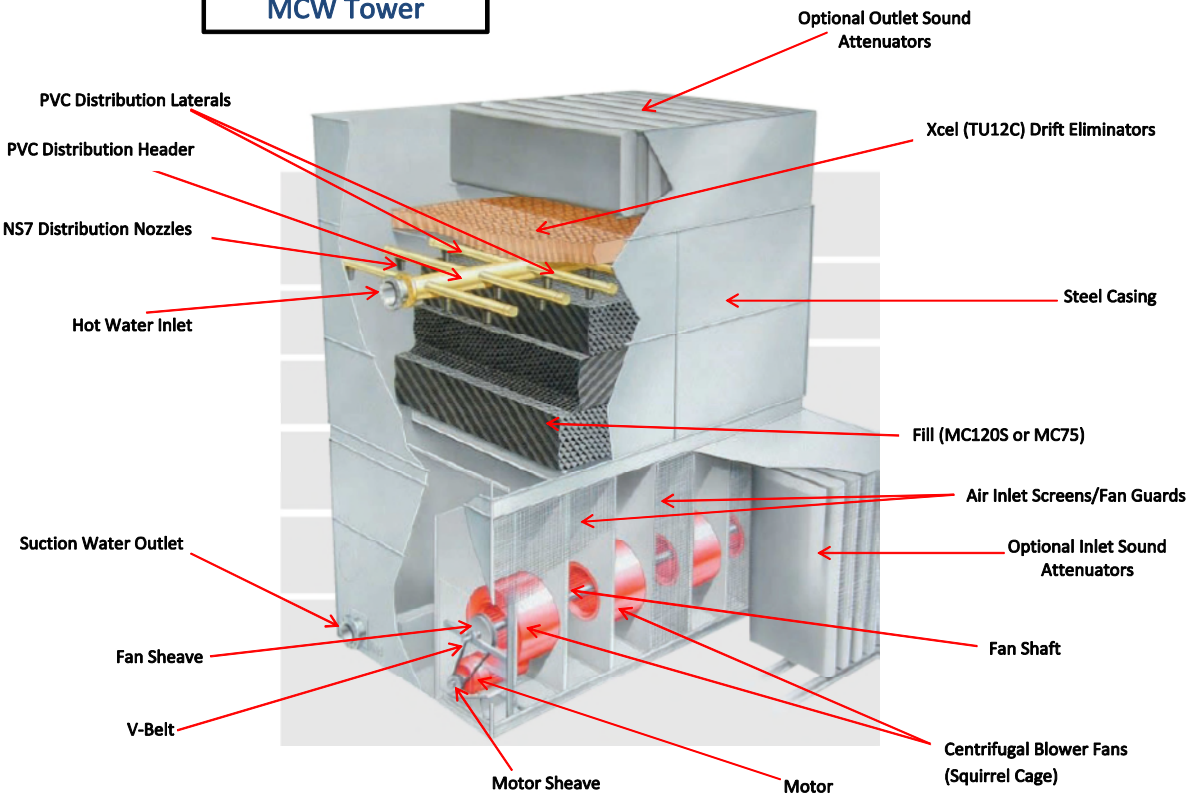


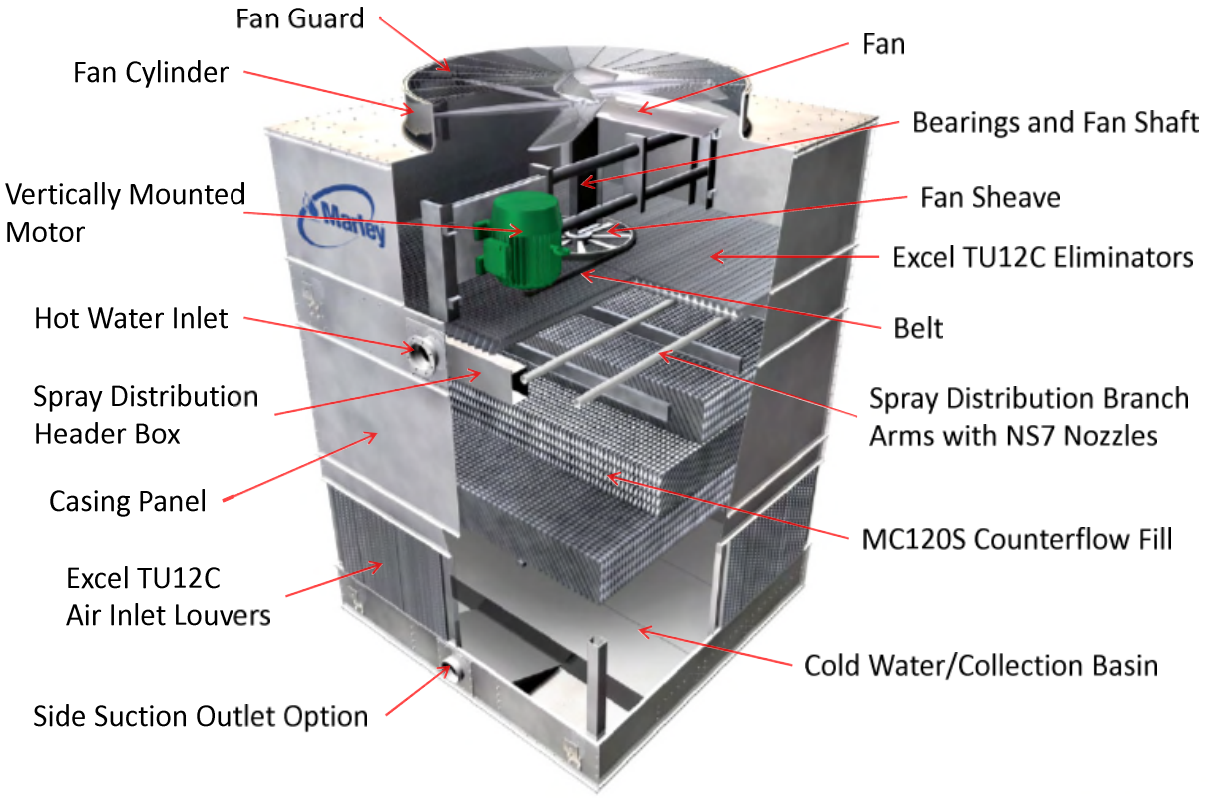
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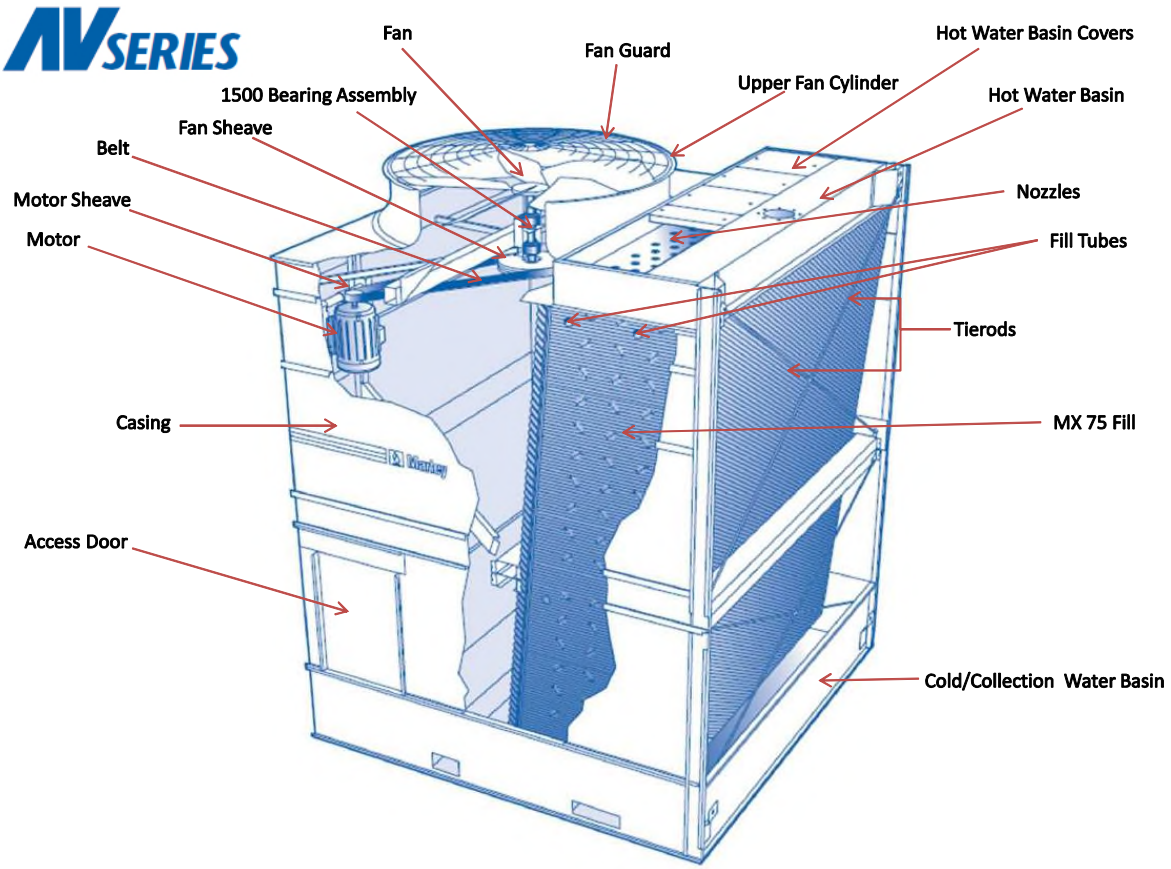
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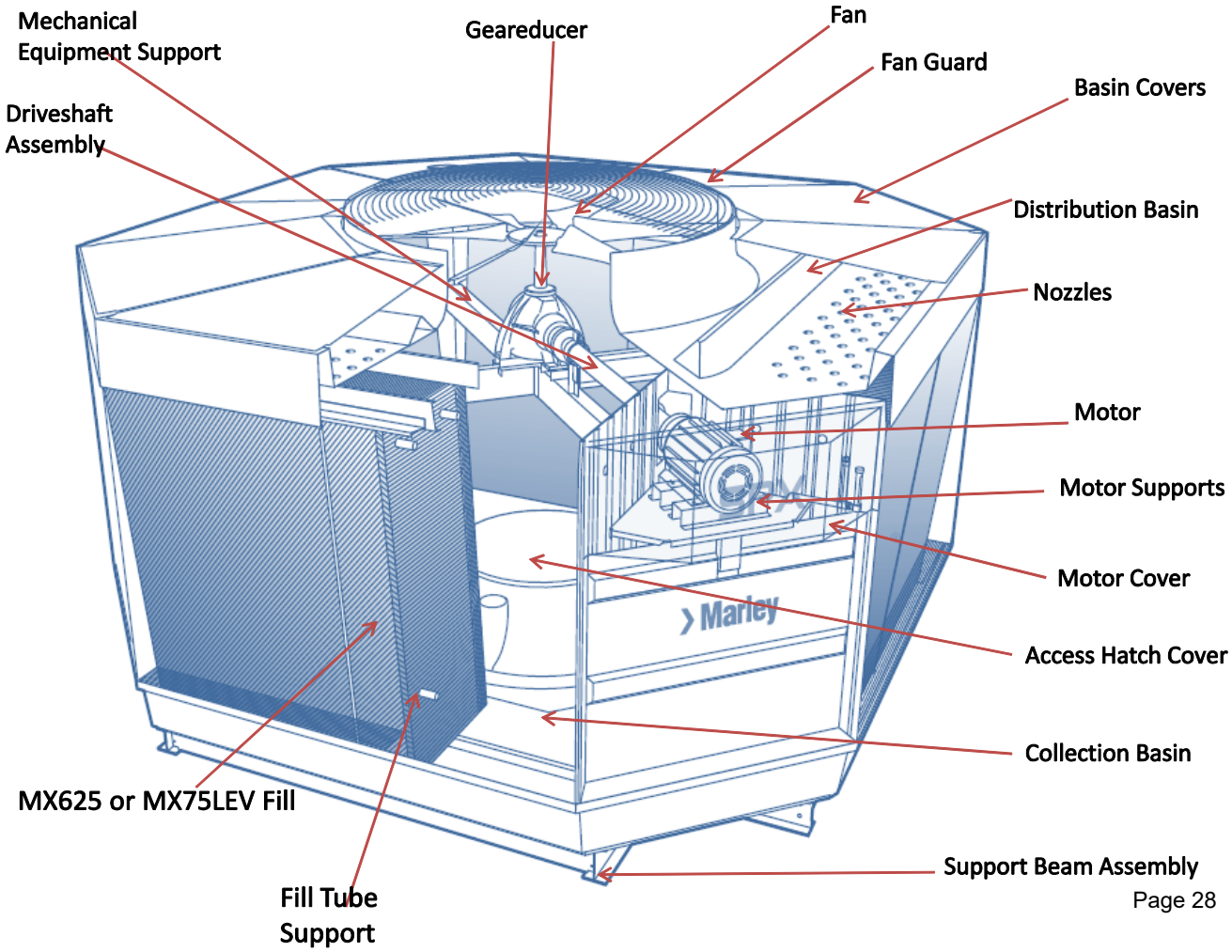
MCW Tower



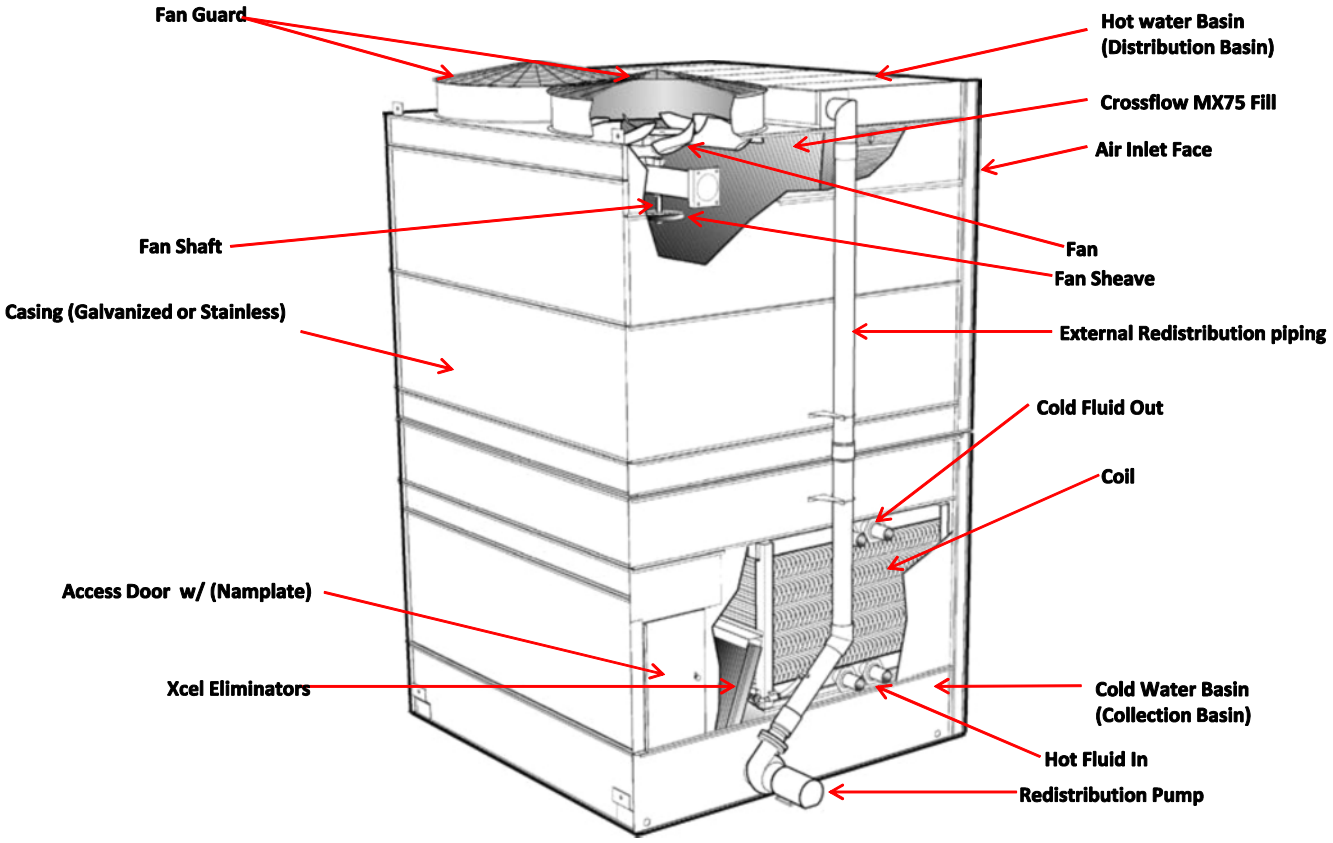


MD Tower Model


AV SERIES
Fan
Fan Guard
Hot Water Basin Covers
Upper Fan Cylinder
1500 Bearing Assembly
Hot Water Basin
Fan Sheave
Belt
Nozzles
Motor Sheave
Fill Tubes
Motor
Tierods
Casing
MX 75 Fill
Access Door
Cold/Collection Water Basin

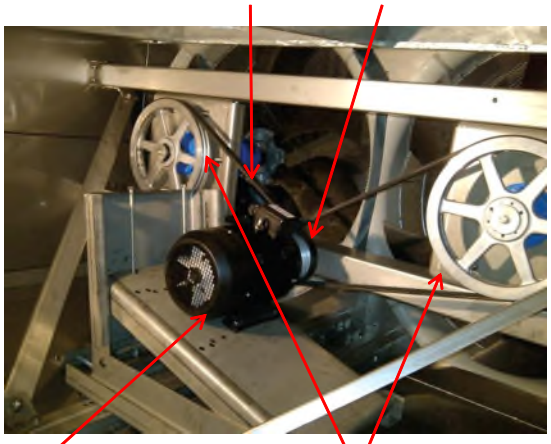

Mechanical Equipment Support
Geareducer
Fan
Fan Guard
Basin Covers
Driveshaft Assembly
Distribution Basin
Nozzles
Motor
Motor Supports
Motor Cover
Access Hatch Cover
Collection Basin
MX625 or MX75LEV Fill
Support Beam Assembly
Fill Tube Support

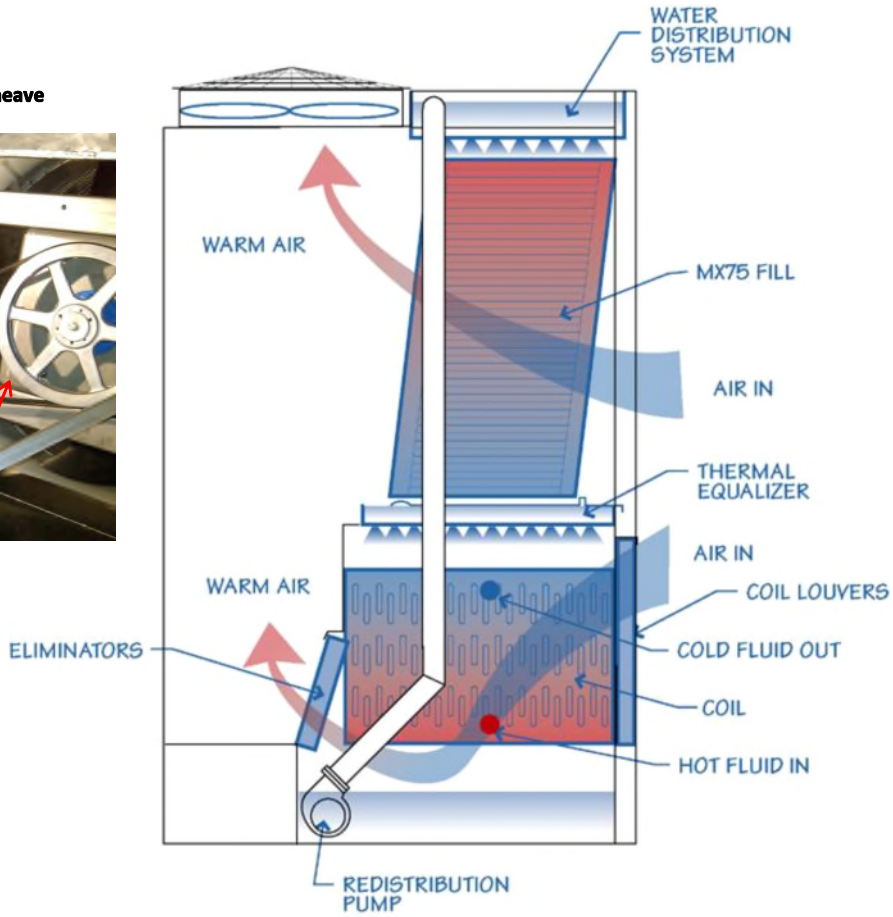
Marley MH Fluid Cooler



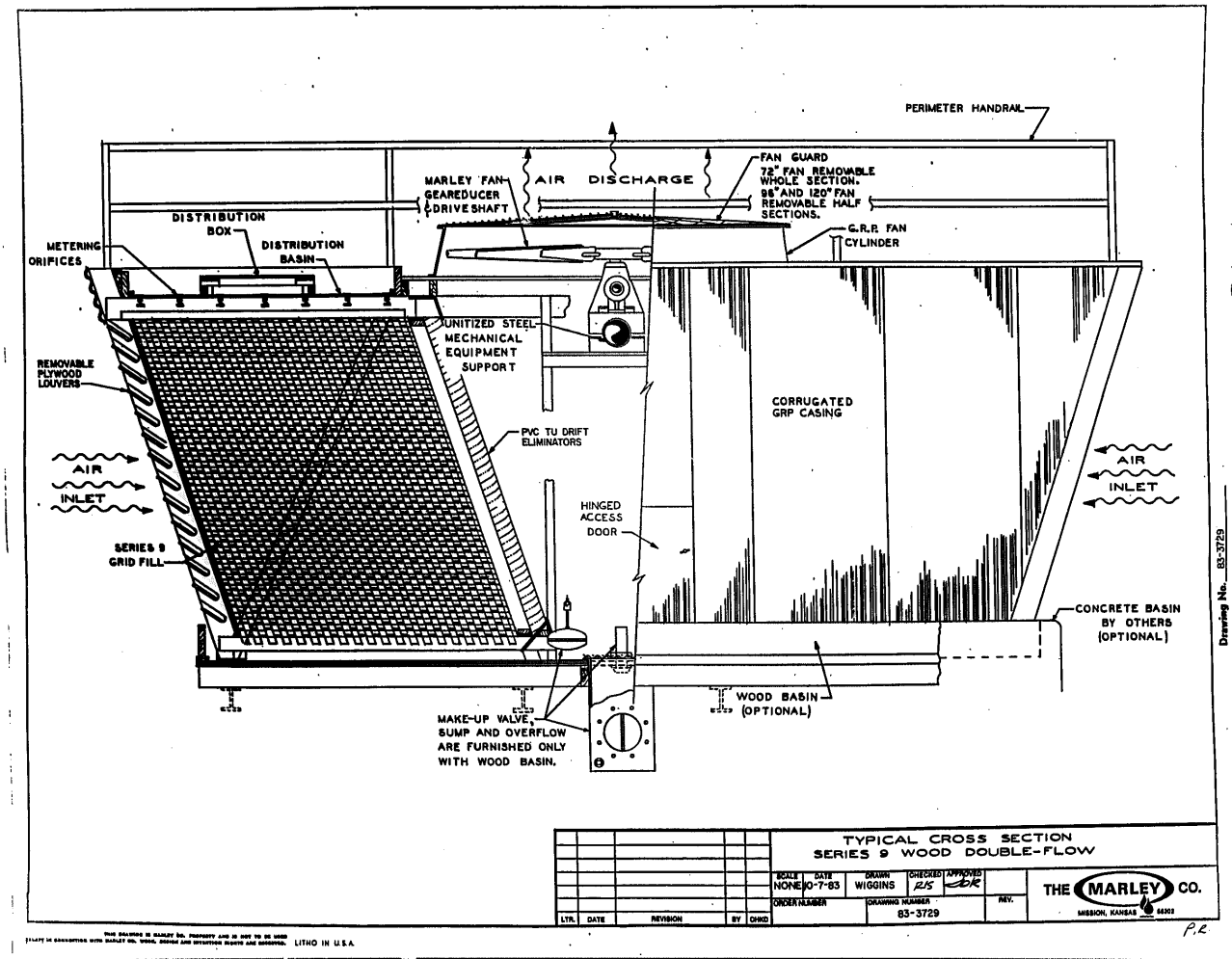
SPX Cooling Technologies
Balcke | Hamon Dry Cooling | Marley

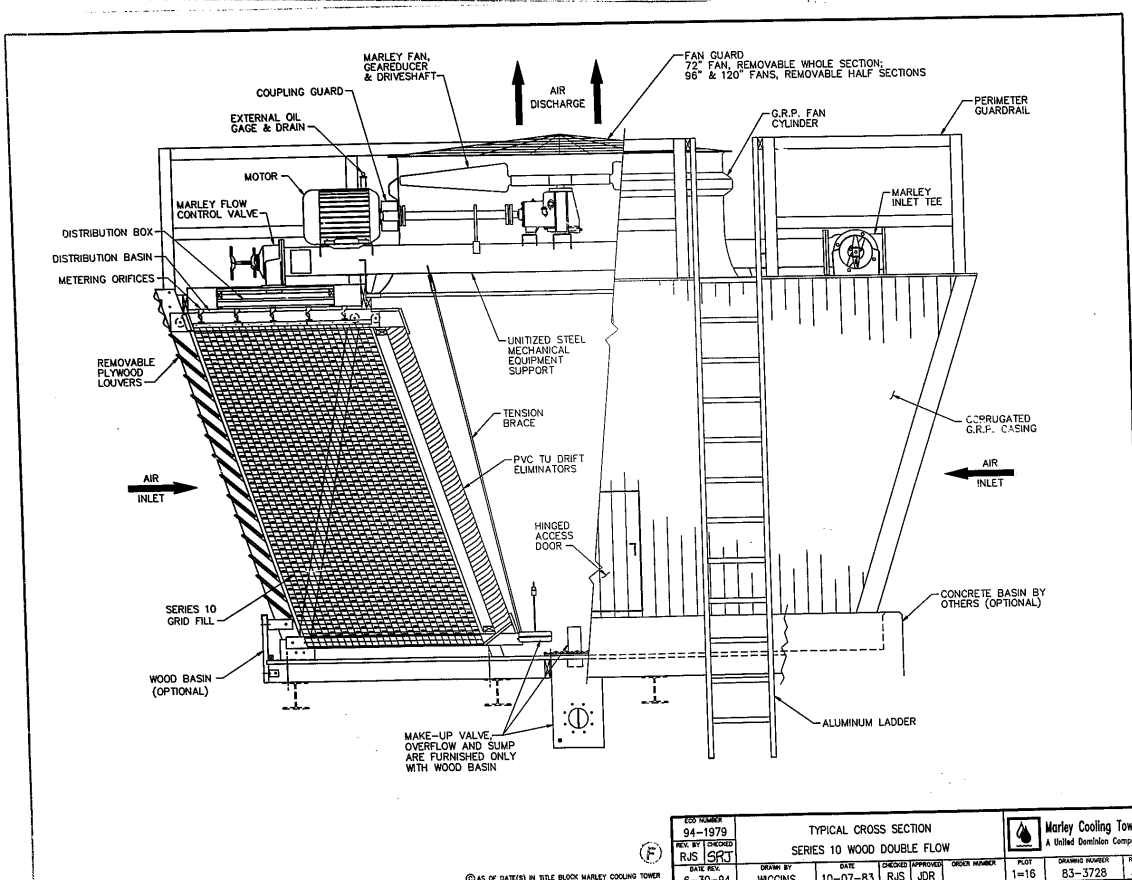
Marley MH Fluid Cooler



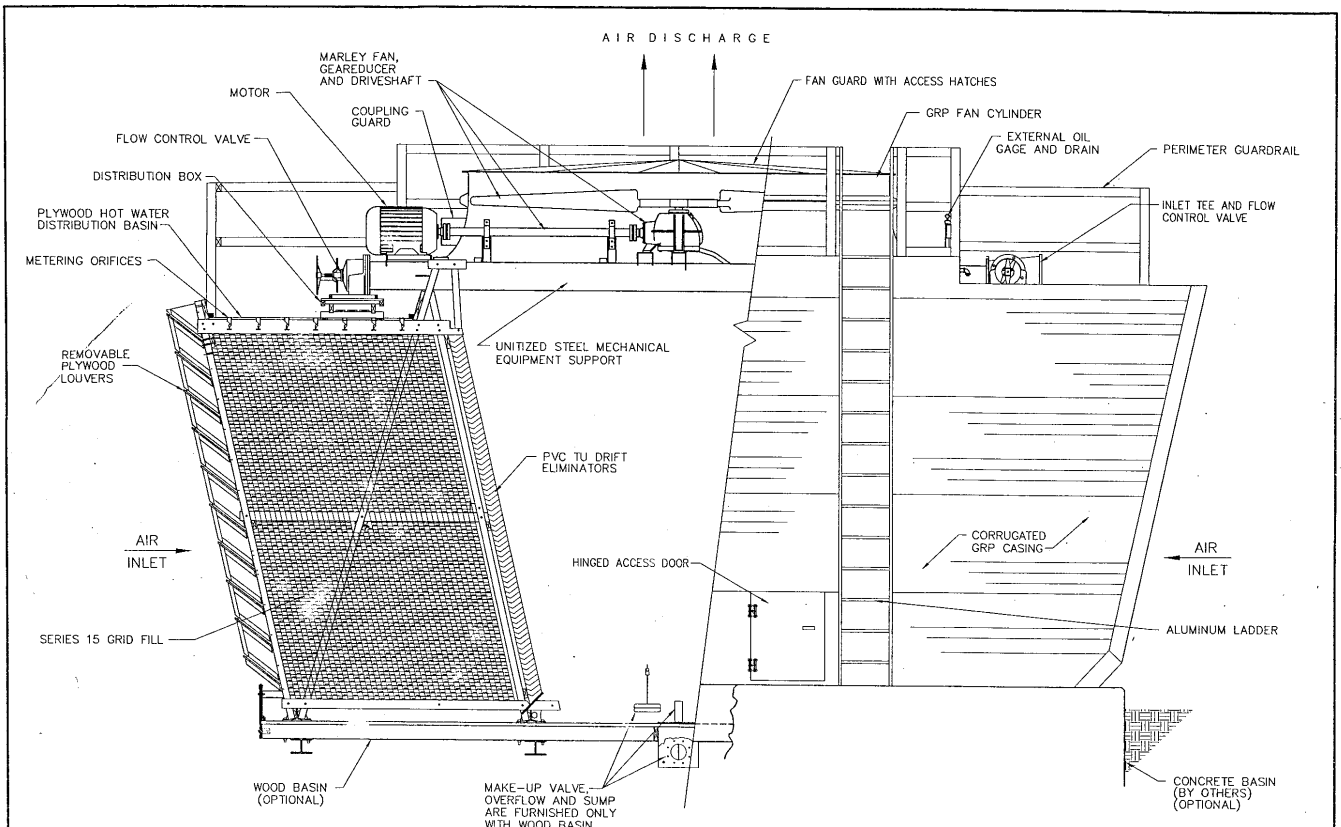


SPX Cooling Technologies
Balcke | Hamon Dry Cooling | Marley



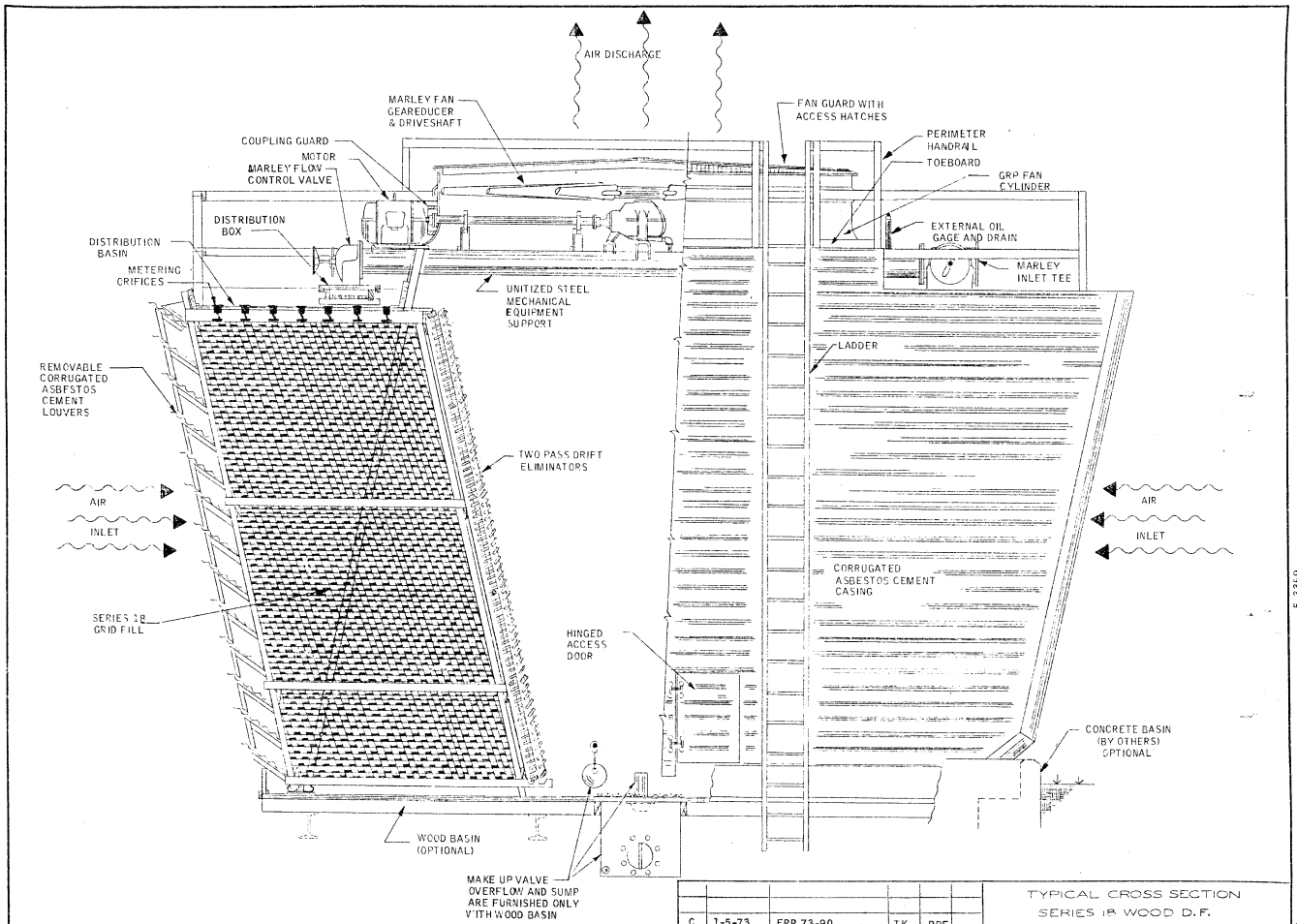


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ECO NUMBER		TYPICAL CROSS SECTION SERIES 15 WOOD DOUBLE FLOW						Marley Cooling Tower A United Dominion Company	
98-775									
REV. BY	CHECKED								
CDK									
DATE REV.	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.	
03-27-98	LOBDELL	1-16-87	DT	JBN		1/2"=1'	87-337	A	

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LTR.	DATE	REVISIONS	BY	CHECKED	B.M.
C	1-5-73	ERR 73-90	TK	RBE	
B	8-4-69	ERR 69-502	HWN	PAG	
A	5-6-68	ERR 68-360	PAG	MJR	

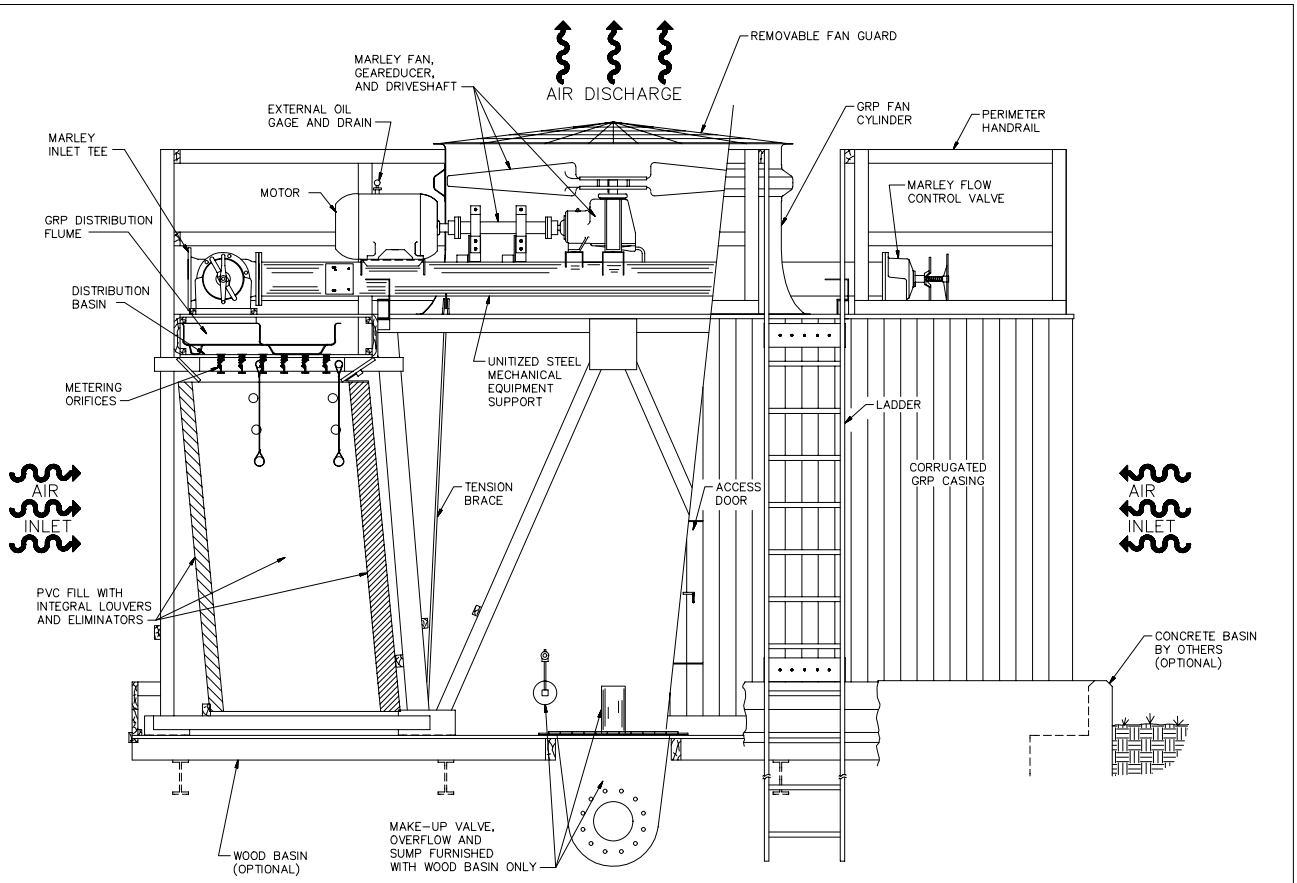
TYPICAL CROSS SECTION
SERIES 18 WOOD D.F.
THE MARLEY COMPANY
MASTER FILE KANSAS CITY, MISSOURI SECTION FILE

SCALE	DATE	DRAWN	CHECKED	APPROVED
NONE	2-2-65	STOTTS	MJR	RGR

Drawing No. 5-3359

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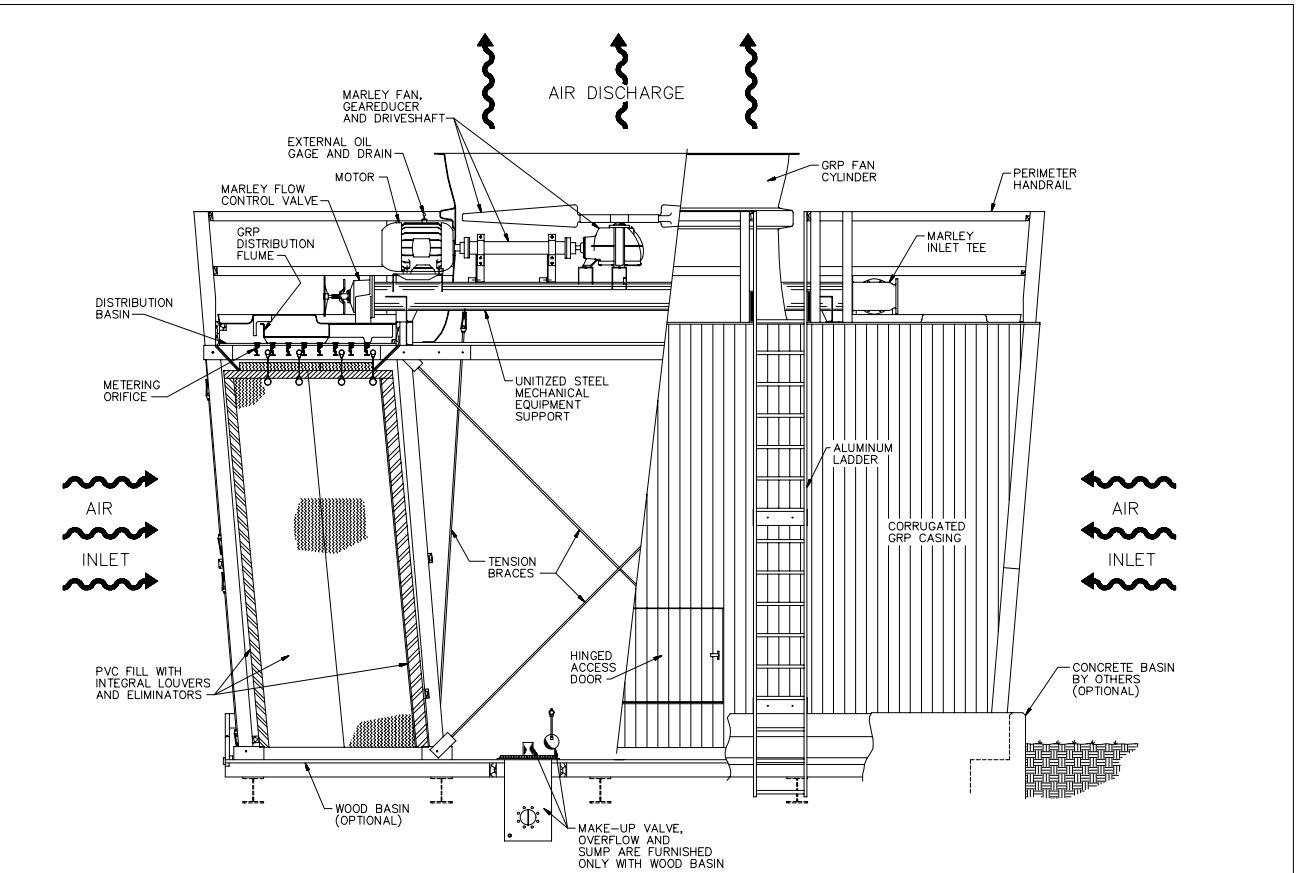
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TYPICAL CROSS SECTION
SIGMA 100 WOOD DOUBLE-FLOW

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ORDER NUMBER		DRAWING NUMBER			REV
		87-3348			

THE MARLEY COOLING TOWER CO.
MISSION, KANSAS 66202

Drawing No. 87-3348



LTR	DATE	REVISION	BY	CHKD

TYPICAL CROSS-SECTION
SIGMA SERIES 120 WOOD DOUBLE-FLOW

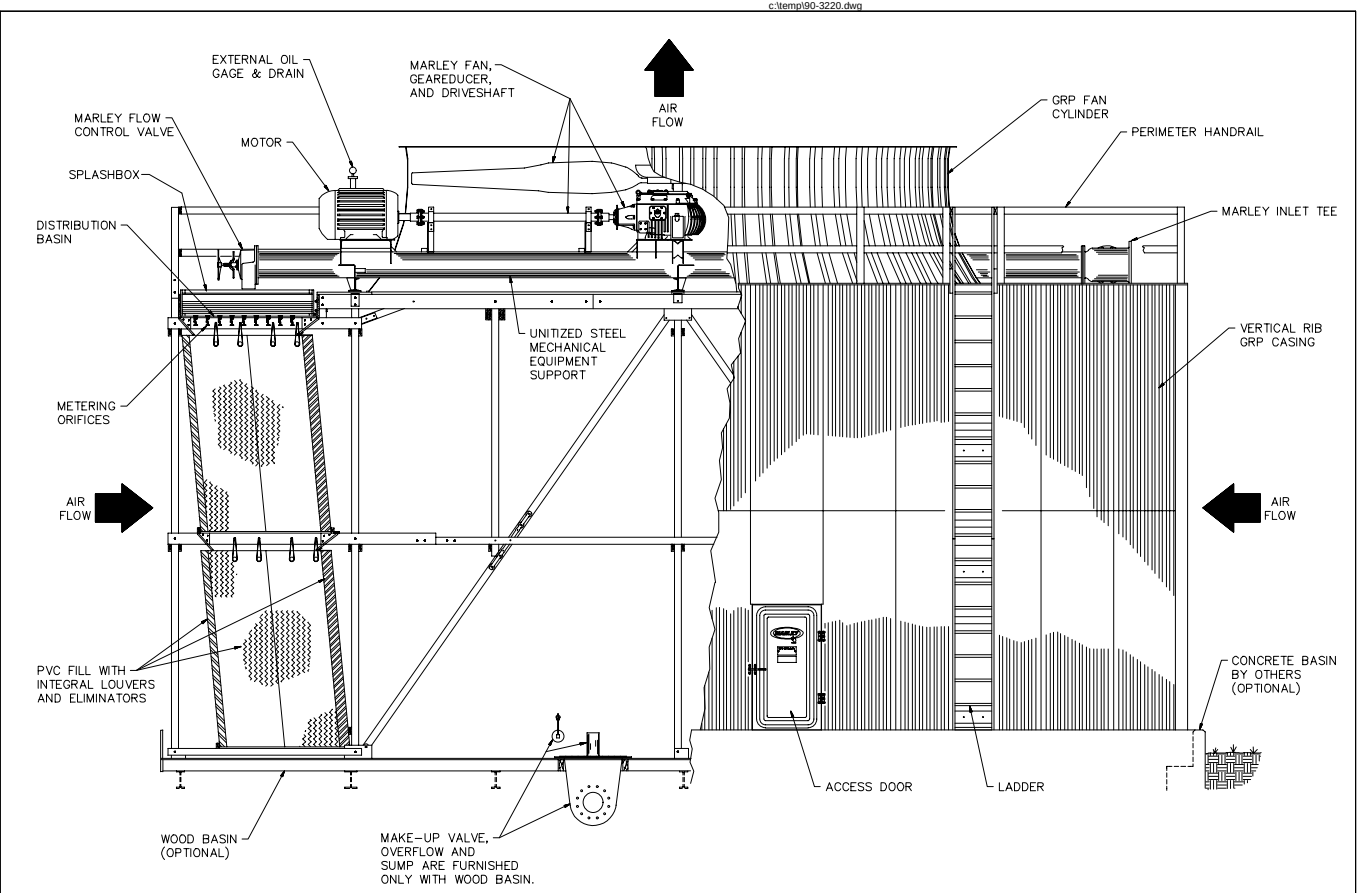
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ORDER NUMBER		DRAWING NUMBER			REV
		88-3784			

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Drawing No. 88-3784

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Drawing No. 90-3220

LTR	DATE	REVISION	BY	CHKD
A	5-22-91	PER E.C.O. #91-1660	MWC	

TYPICAL CROSS SECTION
SIGMA SERIES 160 WOOD DOUBLE-FLOW

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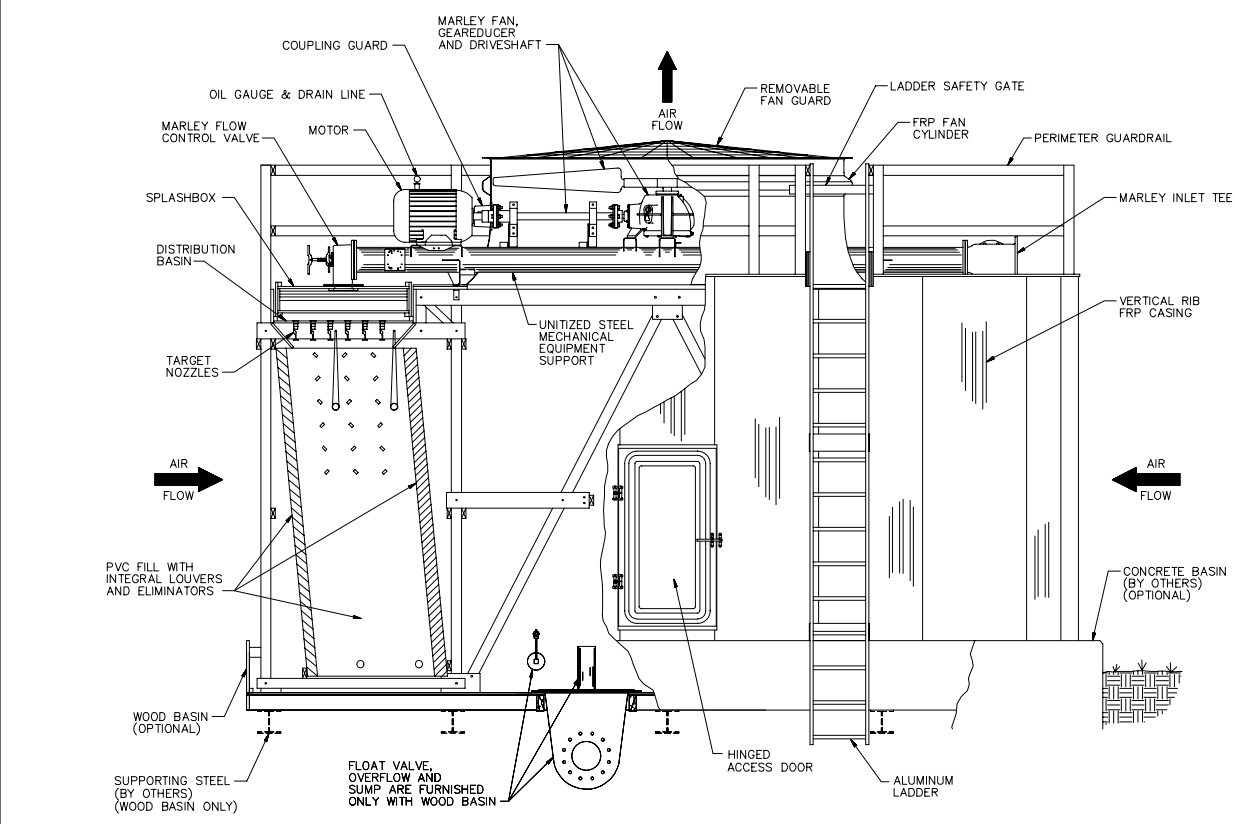
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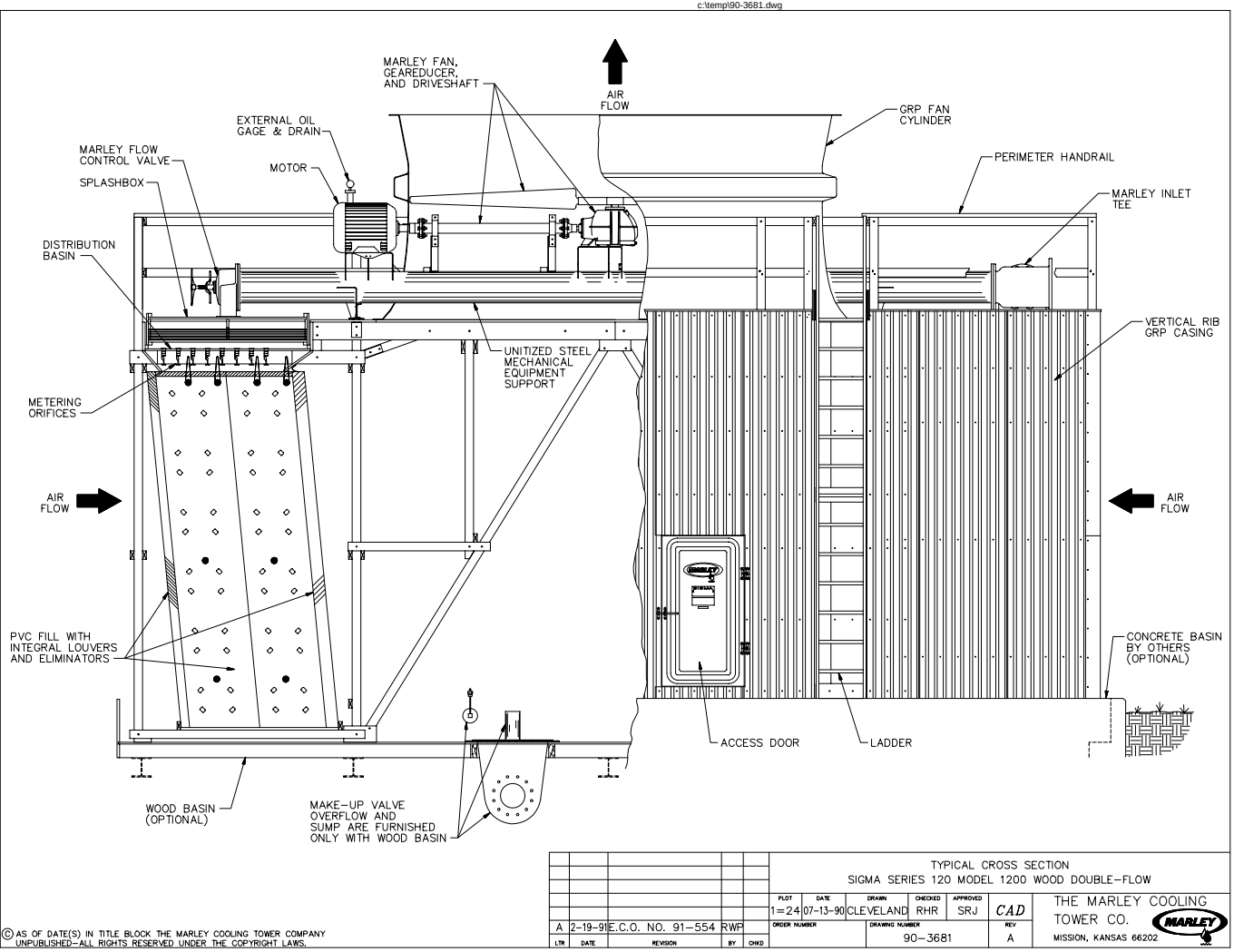
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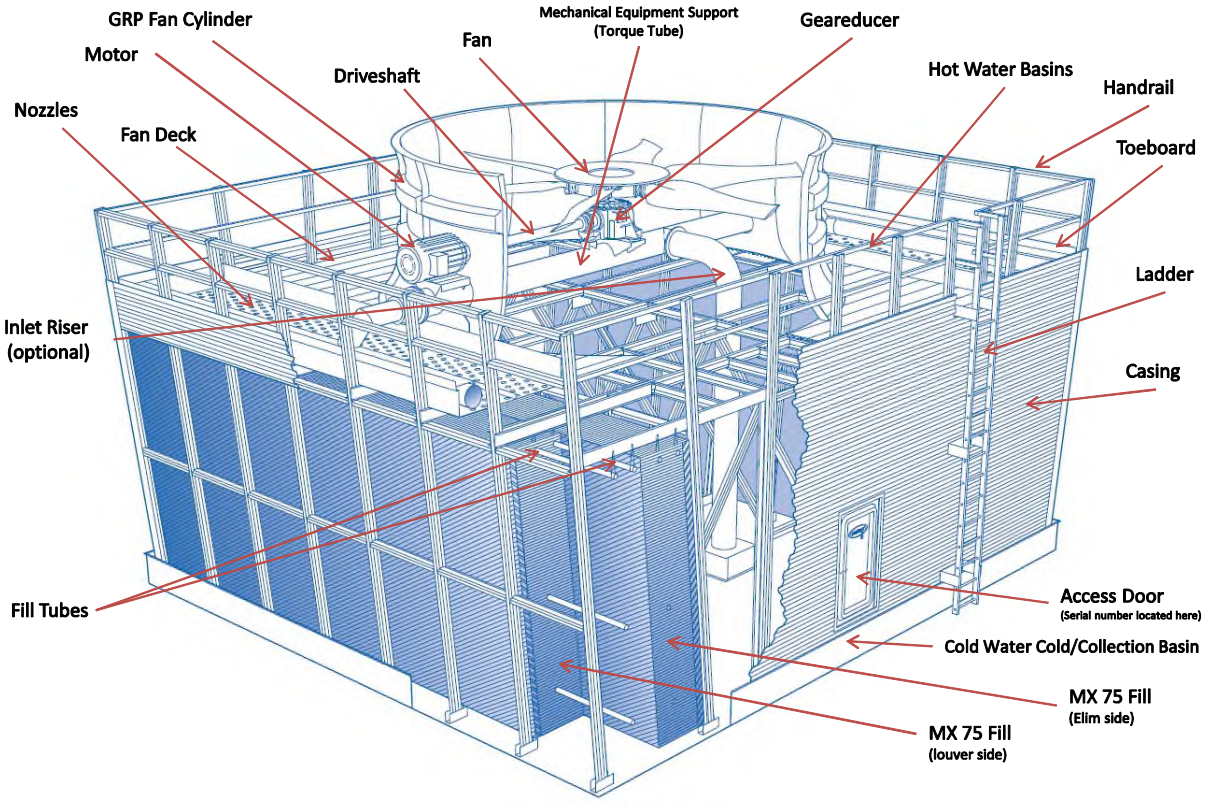
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REV. BY	CHECKED									
AU										
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER		PLOT	DRAWING NUMBER	REV.
07/09/1999		CLEVELAND	07/19/90	RHR	SRJ			1=22	90-3669	A

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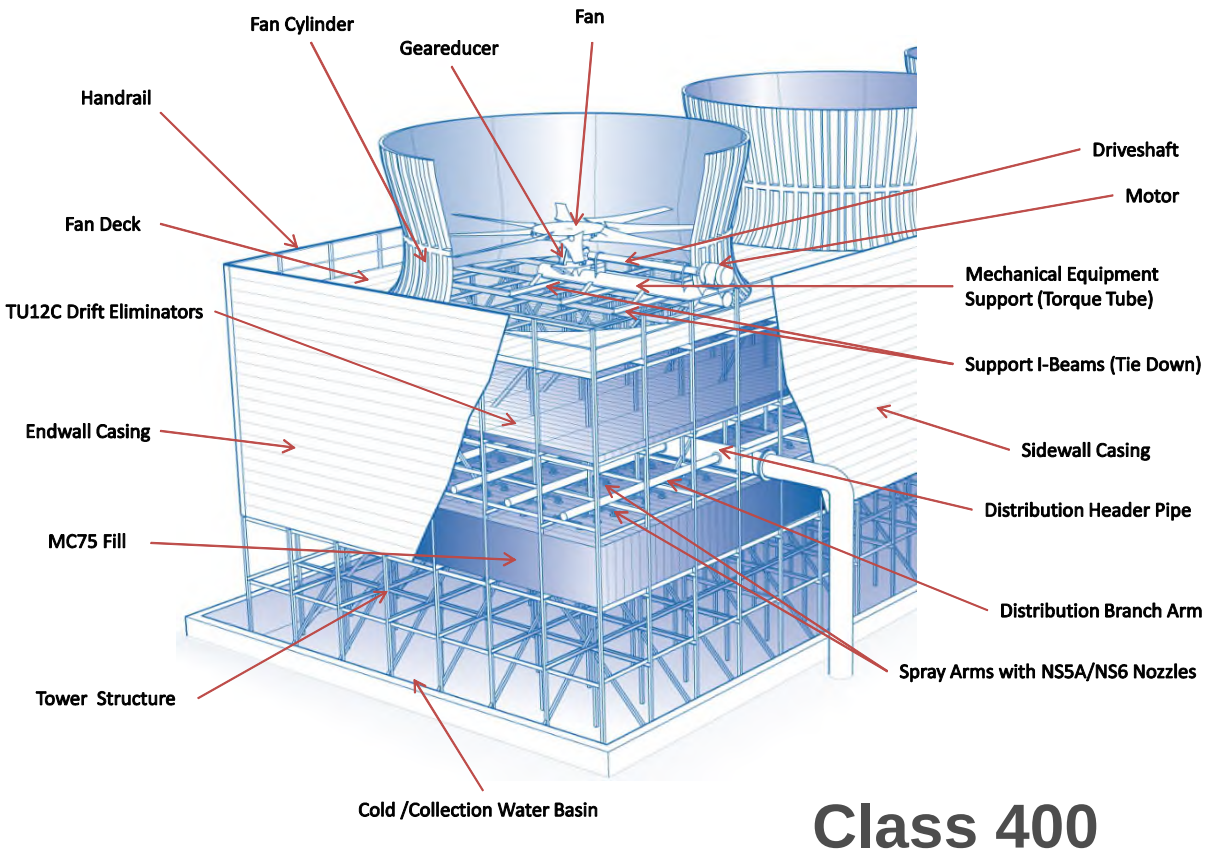
1 of 1


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MARLEY FAN, GEAREDUCER, AND DRIVESHAFT
AIR FLOW
EXTERNAL OIL GAGE & DRAIN
GRP FAN CYLINDER
MARLEY FLOW CONTROL VALVE
MOTOR
PERIMETER HANDRAIL
SPLASHBOX
MARLEY INLET TEE
DISTRIBUTION BASIN
VERTICAL RIB GRP CASING
UNITIZED STEEL MECHANICAL EQUIPMENT SUPPORT
METERING ORIFICES
AIR FLOW
AIR FLOW
PVC FILL WITH INTEGRAL LOUVERS AND ELIMINATORS
CONCRETE BASIN BY OTHERS (OPTIONAL)
ACCESS DOOR
LADDER
WOOD BASIN (OPTIONAL)
MAKE-UP VALVE OVERFLOW AND SUMP ARE FURNISHED ONLY WITH WOOD BASIN
TYPICAL CROSS SECTION
SIGMA SERIES 120 MODEL 1200 WOOD DOUBLE-FLOW
A 2-19-91 E.C.O. NO. 91-554 RWP
1=24 07-13-90 CLEVELAND RHR SRJ CAD
90-3681
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THE MARLEY COOLING TOWER CO.
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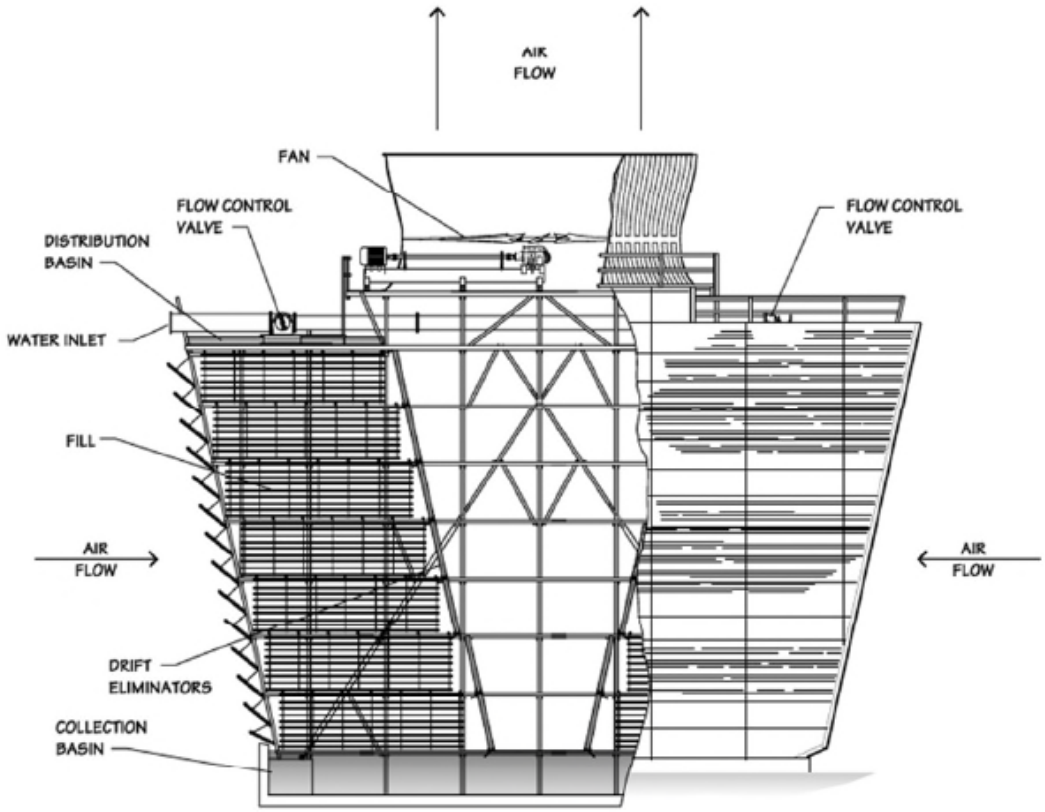
1 of 1


GRP Fan Cylinder
Motor
Nozzles
Fan Deck
Driveshaft
Fan
Mechanical Equipment Support (Torque Tube)
Geareducer
Hot Water Basins
Handrail
Toeboard
Ladder
Casing
Inlet Riser (optional)
Fill Tubes
Access Door (Serial number located here)
Cold Water Cold/Collection Basin
MX 75 Fill (Elim side)
MX 75 Fill (louver side)

FSigma



Class 400



Class 600

MARLEY®

user manual

Downtime Instructions

MECHANICAL DRAFT COOLING TOWERS

Z0238848_C ISSUED 8/2017

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



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, driveshaft, or V-belt.

Seasonal Downtime

Fans, Driveshafts, and V-belts

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

Geareducers

Note

The 2000, 2250 and 2800 Geareducer models have 5-year synthetic oil change 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 the Geareducer User 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 User 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 coat 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

1. At start of downtime period, operate the bearing housing until oil is warm (95°F) and change the oil. See the Lubrication section of the Bearing Housing User 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.

Fan Motors

1. At start of downtime, clean all air passages and lubricate bearings. See the motor manufacturer's instructions. Motors with sealed bearings do not require lubrication maintenance.
2. Each month, run motor until it has reached operating temperature. Space heaters are recommended. If space heaters are used, motors need be run only 20 minutes minimum. Refer to the **"Fan Motor"** User Manual for additional information.

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 to protect from wet-down of a fire protection system or rainfall.
4. To return motors into operation, clean all air passages, remove temporary vented cover and lubricate bearings. Motors with sealed bearing do not require lubrication maintenance.

Extended Downtime – Beyond 3 Months

Fans and Driveshafts

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 model number:

   Models 3400, 36, 38, 3600 and 4000 ____ 1.5 gallon (5.7 liter)

   Models 2700, 3000 and 32.2_____ 1.0 gallon (3.8 liter)

   Models 2200, 2250, 2400 and 2800 _____ .75 gallon (2.9 liter)

   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 User 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. Model 2200, 2250 and 2400 requires a 1/4" plug.

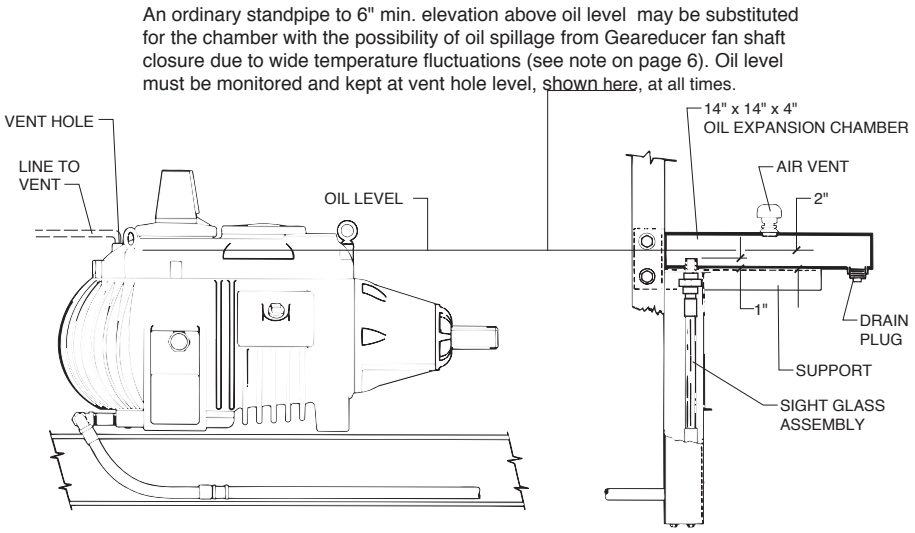


Figure 1

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.

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 the fan motor until 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 User 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 on page 6. Rotate 15 revolutions.
3. To return to operation, bring up to operating temperature and change the oil.

Fan Motors

1. At start of downtime period, lubricate bearings. See motor manufacturer's instructions on lubrication. Does not apply to motors with sealed bearings.
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. Does not apply to motors with sealed bearings.
5. Enclose motors or cover 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. Does not apply to motors with sealed bearings. Refer to the **"Fan Motor"** User Manual Z0239042 for additional information.

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.

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 fan 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.

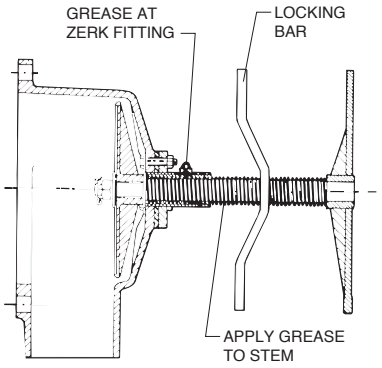


Figure 2

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.

Note

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

Downtime Instructions

SPX COOLING TECHNOLOGIES, INC.
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OVERLAND PARK, KS 66213 USA
913 664 7400 | spxcooling@spx.com
spxcooling.com

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SPX®

Marley WaterGard – Water-saving membrane Filtration

Objective: Learn:

1. how the Marley WaterGard saves water by pre-conditioning the cooling tower makeup water to enable equipment operation at increased cycles of Concentration, reducing wastewater and overall water usage.
2. how to startup and service these units.
3. the filter change intervals and how to change out the membrane, carbon and sediment filters.

Scenario: Customer has multiple cooling towers at their facility. Their local Government agencies have water usage incentive programs locally to conserve water. Customer is looking to take advantage of these cost saving programs and their local operating water conditions are 3 cycles of concentration (COC) or less. So customer is purchasing this Marley WaterGard Model WG018 and the service contractor has a contract to install, start-up, service and replace the filters.

Notes / Take away Points:

NOW AVAILABLE!

Marley WaterGard™ Water Usage Optimizer

MARLEY



Patent pending

Marley® WaterGard™ pre-conditions cooling tower makeup water to enable equipment operation at increased Cycles of Concentration, **reducing wastewater and overall water usage**

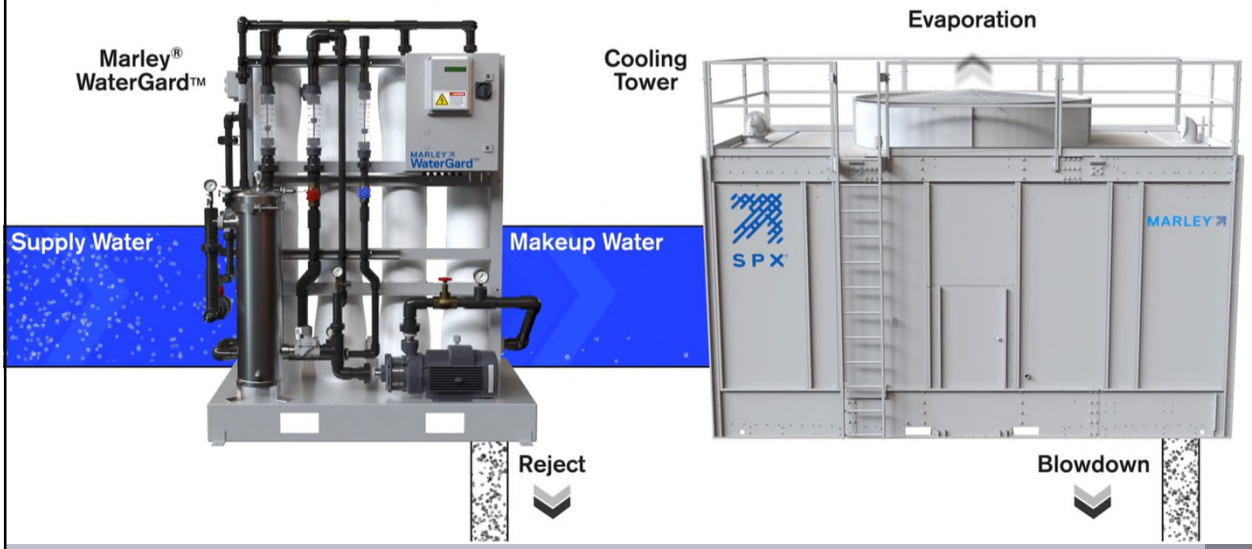
- Reduces water usage (withdrawal) up to 59%*
- Reduces wastewater (discharge) up to 88%*
- Reduces discharge losses of water treatment chemicals
- LEED points available
- Augments existing water treatment

*potential benefits vary with source water mineral content

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Marley® WaterGard™ - How It Works

Fewer minerals in makeup = Higher safe CoC = Less blowdown = Less water usage



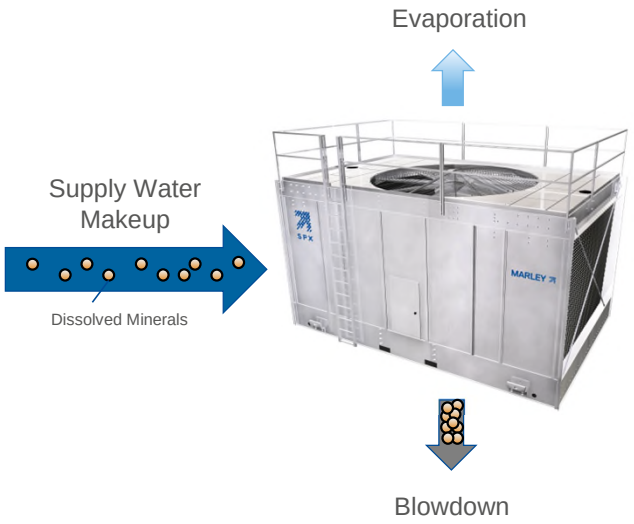
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Water Usage – Typical System

MARLEY

Site Water Usage

Typical Cooling Tower System



M = E + B

Makeup = **E**vaporation + **B**lowdown

Note: equations simplified to exclude drift (assumed negligible)

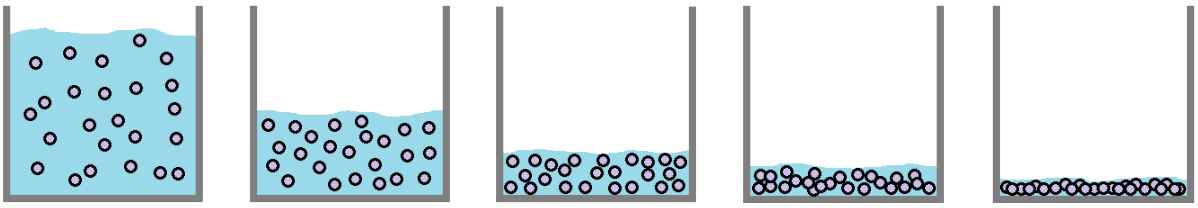
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Water Usage – Cycles of Concentration (COC)

MARLEY

As Water Evaporates, Minerals Concentrate

Cycles of Concentration (COC) is the ratio of dissolved solids in the blowdown to the dissolved solids in the makeup



M = E + B **M**akeup = **E**vaporation + **B**lowdown

B = E / (COC-1) **B**lowdown = **E**vaporation / (**C**ycles **O**f **C**oncentration – 1)

COC = M / B **C**ycles **O**f **C**oncentration = **M**akeup / **B**lowdown

Mineral content limits determine appropriate operating COC to minimize corrosion and scale tendencies

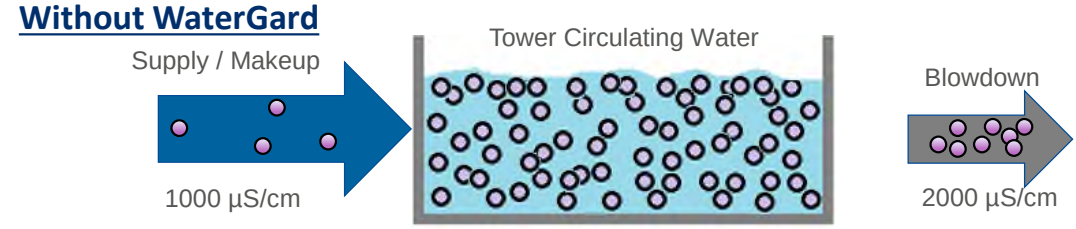
Note: equations simplified to exclude drift (assumed negligible)

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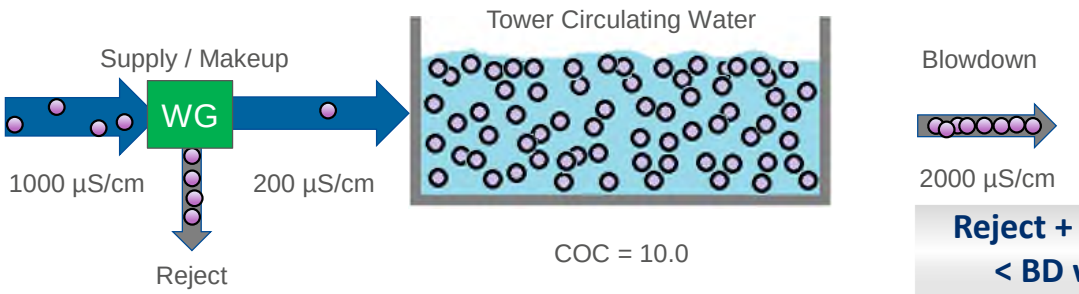
Water Usage - Conductivity Controlled COC

MARLEY

Without WaterGard



With WaterGard



Reject + BD w/ WG < BD w/o WG

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Marley WaterGard™ – Potential Water Savings

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Water quality varies LOCALLY. Establish a baseline *Starting Safe COC* as a first step in evaluating potential benefits of WaterGard

Potential WaterGard™ Savings	Starting Safe COC (without WaterGard)					
	1.5	2	2.5	3	4	5
Wastewater (Discharge)	88%	77%	65%	53%	30%	6%
Water Usage (Withdrawal)	59%	38%	26%	18%	7%	1%

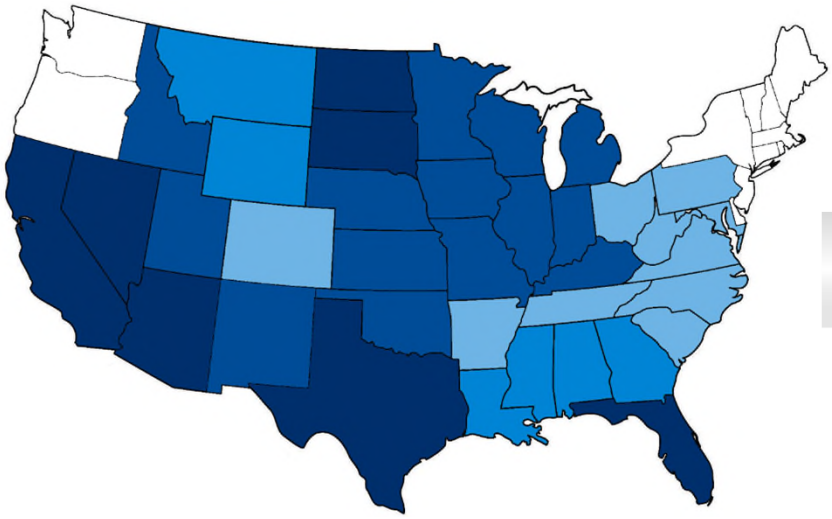
WaterGard Savings

*potential savings vary with supply water mineral content

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Water Usage – Water Quality Limits

MARLEY



Generalization!!!

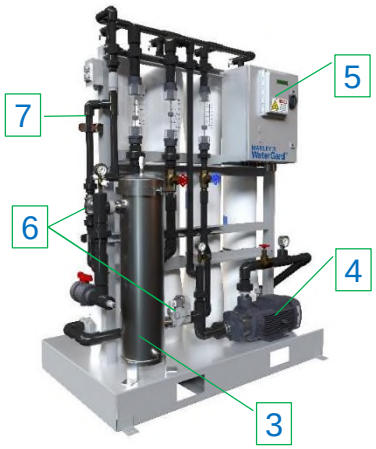
Water Quality Varies LOCALLY

\- Potential WaterGard Savings +

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Marley WaterGard™ - Components

MARLEY



Primary Components

1) Membrane filter(s)
2) Carbon bed (not shown, separate skid)
3) Sediment filter
4) Pump
5) Controller
6) Solenoid Valves
7) Internal Bypass

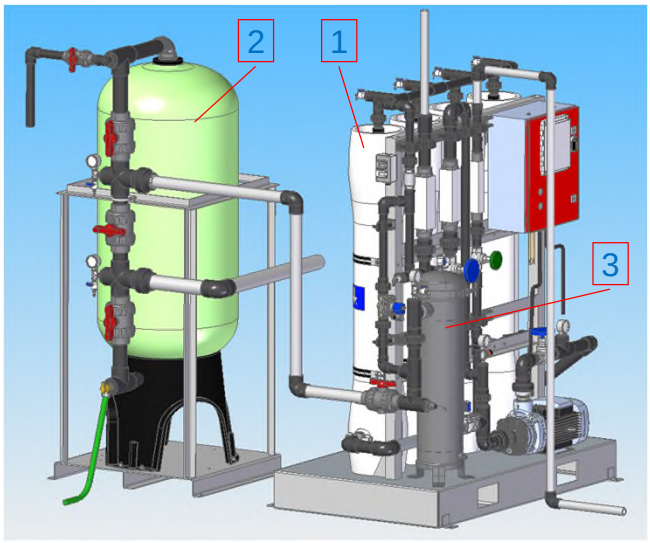
Additional System Requirements

- Chlorine Removal (Carbon Bed)
- Electronic water level makeup
- Conductivity controlled blowdown



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Marley WaterGard™ - Service



Simple to Service

Est. consumables replacement:

1. ~24 month membrane change
2. ~12 month carbon refresh (if equipped)
3. ~3 months sediment filter change

Augments existing water treatment

NOT a standalone complete water treatment system

Designed for indoor installation

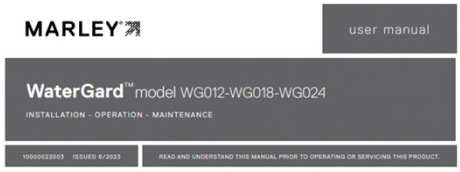
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Marley WaterGard™ - IOM

IOM for WG002 – WG009:
https://spxcooling.com/wp-content/uploads/10000022002-1.pdf

IOM for WG012 – WG024:
https://spxcooling.com/wp-content/uploads/10000022003.pdf

IOM for WG037 – WG091:
https://spxcooling.com/wp-content/uploads/10000022004.pdf



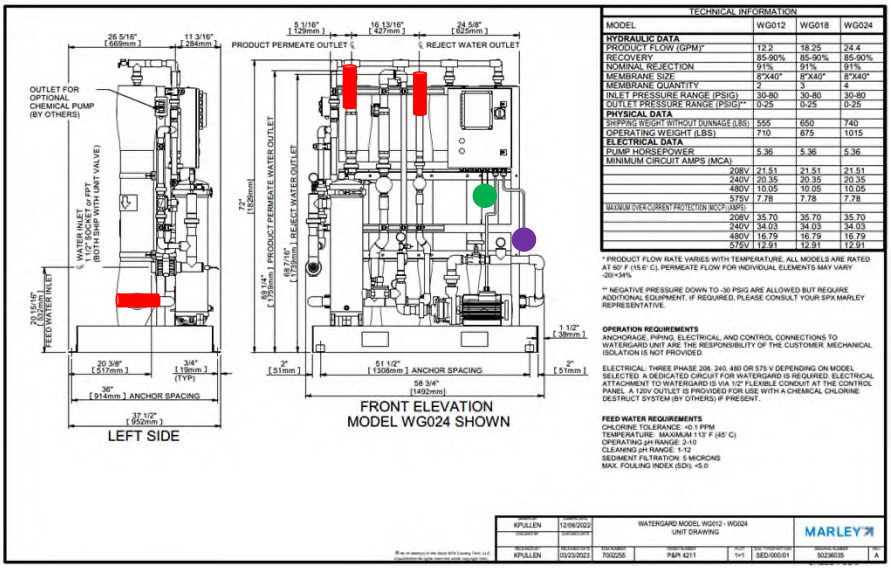


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Marley WaterGard™ - Install (pg 7-8 in specific unit's IOM)

MARLEY

Step 1 – Site Preparation
Step 2 – Piping Installation
Step 3 – Power
Step 4 – Controls



TECHNICAL INFORMATION

MODEL	WG012	WG018	WG024
HYDRAULIC DATA			
PRODUCT FLOW (GPM)*	12.2	18.25	24.4
RECOVERY	85-90%	85-90%	85-90%
NOMINAL REJECTION	91%	91%	91%
MEMBRANE SIZE	8"X40"	8"X40"	8"X40"
MEMBRANE QUANTITY	2	3	4
INLET PRESSURE RANGE (PSIG)	30-80	30-80	30-80
OUTLET PRESSURE RANGE (PSIG)**	0-25	0-25	0-25
PHYSICAL DATA			
SHIPPING WEIGHT WITHOUT DUNNAGE (LBS)	555	650	740
OPERATING WEIGHT (LBS)	710	875	1015
ELECTRICAL DATA			
PUMP HORSEPOWER	5.36	5.36	5.36
MINIMUM CIRCUIT AMPS (MCA)			
208V	21.51	21.51	21.51
240V	20.35	20.35	20.35
480V	10.05	10.05	10.05
575V	7.78	7.78	7.78
MAXIMUM OVERCURRENT PROTECTION (MOCP) (AMPS)			
208V	35.70	35.70	35.70
240V	34.03	34.03	34.03
480V	16.79	16.79	16.79
575V	12.91	12.91	12.91

* PRODUCT FLOW RATE VARIES WITH TEMPERATURE. ALL MODELS ARE RATED AT 60° F (15.6° C). PERMEATE FLOW FOR INDIVIDUAL ELEMENTS MAY VARY -20/+34%.

** NEGATIVE PRESSURE DOWN TO -30 PSIG ARE ALLOWED BUT REQUIRE ADDITIONAL EQUIPMENT, IF REQUIRED, PLEASE CONSULT YOUR SPX MARLEY REPRESENTATIVE.

OPERATION REQUIREMENTS
ANCHORAGE, PIPING, ELECTRICAL, AND CONTROL CONNECTIONS TO WATERGARD UNIT ARE THE RESPONSIBILITY OF THE CUSTOMER. MECHANICAL ISOLATION IS NOT PROVIDED.

ELECTRICAL: THREE PHASE 208, 240, 480 OR 575 V DEPENDING ON MODEL SELECTED. A DEDICATED CIRCUIT FOR WATERGARD IS REQUIRED. ELECTRICAL ATTACHMENT TO WATERGARD IS VIA 1/2" FLEXIBLE CONDUIT AT THE CONTROL PANEL. A 120V OUTLET IS PROVIDED FOR USE WITH A CHEMICAL CHLORINE DESTRUCT SYSTEM (BY OTHERS) IF PRESENT.

FEED WATER REQUIREMENTS
CHLORINE TOLERANCE: <0.1 PPM
TEMPERATURE: MAXIMUM 113° F (45° C)
OPERATING pH RANGE: 2-10
CLEANING pH RANGE: 1-12
SEDIMENT FILTRATION: 5 MICRONS
MAX. FOULING INDEX (SDI): <5.0

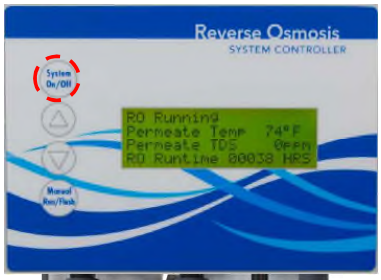
KPULLEN	12/06/2022	WATERGARD MODEL WG012 - WG024 UNIT DRAWING			MARLEY
KPULLEN	03/23/2023	7002050	P&P 4211	SED1000-01	5023A035 A

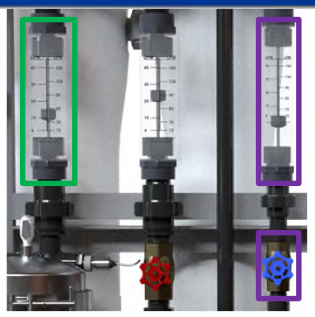
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Marley WaterGard™ - StartUp (pg 9 in specific unit's IOM)

MARLEY

1. Press ON button.→ Fill Up, Turn OFF. Let the membranes soak for 30 min.
2. Turn the unit ON again. Repeat until full.
3. Run for at least 30 minutes
4. Balance the reject flow and permeate flow to a 50:50 ratio.
5. Run for another 30 min.
6. Set reject flow to within 10% - 15% of the permeate flow.





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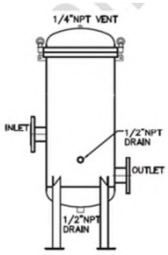
Marley WaterGard™ - Sediment Filter Change Out

MARLEY

Type 1

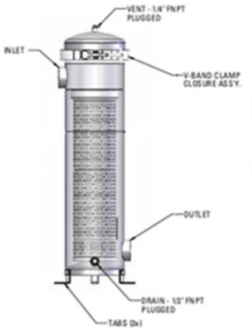


Type 3



WaterGard Model	Filter Size	Number of cartridges	Filter Removal	IOM Location
WG002 – WG004	2 5/8" ø x 20"	1	**Type 1:** Unscrew housing to remove filter	Document 10000022002 Pg 25
WG007 – WG009	4 1/2" ø x 10"	1	**Type 1:** Unscrew housing to remove filter	Document 10000022002 Pg 25
WG012 – WG024	6" ø x 23"	1	**Type 2:** Loosen hand screw, remove top and filter	Document 10000022003 Pg 30
WG037 – WG055	2 5/8" ø x 30"	7	**Type 3:** Unscrew bolts to remove top and filters	Document 10000022004 Pg 30
WG061 – WG091	2 5/8" ø x 20"	11	**Type 3:** Unscrew bolts to remove top and filters	Document 10000022004 Pg 30

Type 2



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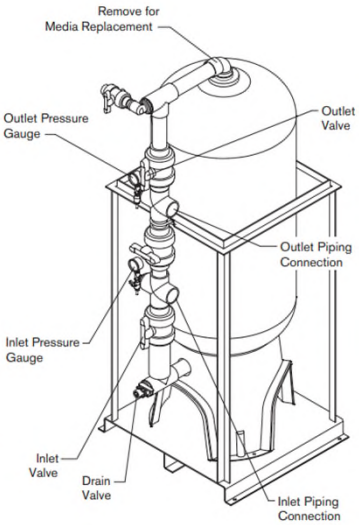
Marley WaterGard™ - Carbon Filter Change Out

MARLEY

WaterGard Model	Carbon Filter Size (cu. Ft.)	Number of models	Carbon Type	IOM Location
WG002 – WG004	0.5	1	Cartridge Filter	Document 10000022002 Pg 26
WG007 – WG009	0.5	2	Cartridge Filter	Document 10000022002 Pg 26
WG012 – WG018	3	1	Granular Activated Coal (GAC) Filled Tank	Document 10000022003 Pg 30-31
WG024 – WG049	10	1	Granular Activated Coal (GAC) Filled Tank	Document 10000022004 Pg 31-32
WG055 – WG091	10	2	Granular Activated Coal (GAC) Filled Tank	Document 10000022004 Pg 31-32



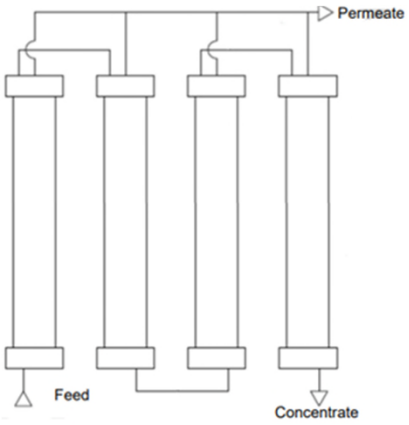
External Carbon Filter (if equipped)



Carbon Filter 10 cu ft

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Marley WaterGard™ - Membrane Filter Change Out



WaterGard Model	Membrane Quantity	Membrane Size	Membrane Array	Membrane Housing Size	IOM Location
WG002	2	4”ø x 40”	1:1	Single	Document 10000022002 Pg 24-25
WG004	4	4”ø x 40”	1:1:1:1	Single	
WG007	6	4”ø x 40”	2:2:2	Single	
WG009	8	4”ø x 40”	3:2:2:1	Single	
WG012	2	8”ø x 40”	1:1	Single	Document 10000022003 Pg 24-29
WG018	3	8”ø x 40”	1:1:1	Single	
WG024	4	8”ø x 40”	1:1:1:1	Single	
WG037	6	8”ø x 40”	2:2:2	Double	Document 10000022004 Pg 24-30
WG049	8	8”ø x 40”	4:2:2	Double	
WG055	9	8”ø x 40”	3:3:3	Triple	
WG061	10	8”ø x 40”	4:2:2:2	Double	
WG073	12	8”ø x 40”	6:3:3	Triple	
WG091	15	8”ø x 40”	6:6:3	Triple	

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Marley WaterGard™ - Install in Green Bay, WI



Simple to Service

Est. consumables replacement:

~24 month membrane change
~12 month carbon refresh (if equipped)
~3 months sediment filter change

Augments existing water treatment

NOT a standalone complete water treatment system

Designed for indoor installation

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MARLEY®

user manual

WaterGard™ model WG012-WG018-WG024

INSTALLATION - OPERATION - MAINTENANCE

10000022003_A ISSUED 9/2024

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



contents

Note

This manual contains vital information for the proper installation and operation of the Marley® WaterGard™ system. Carefully read the manual before installation or operation and follow all instructions. Save this manual for future reference.

Technical Information....4
System Requirements....5
Schematics and Components....6
Carbon Tank option....7
Rigging....8
Physical System Requirements....8
Electrical Requirements....9
Piping Connections....9
Startup and Operation....10
System Shutdown....13
Automatic System Standby and Restart....13
WaterGard Controls....14
Operating Status Messages....15
Fault Condition Display....17
Controller Adjustment....19
Conductivity Calibration....20
Standard Setpoints....22
Troubleshooting....23
Maintenance....25
Membrane Replacement....26
Parts List....36
System Log....37

overview

This User Manual as well as those offered separately on other components, etc., are intended to assure that the WaterGard system serves you properly for the maximum possible time. Since product warrantability may well depend upon your actions, please read this User Manual thoroughly prior to operation.

This User Manual provides information regarding general installation and operation. Any deviation from, change or modification to the User Manual, the original design conditions or the original intended use of the equipment may result in improper installation and/or operation.

Any such deviation, change or modification shall be the responsibility of the party or parties making such deviation, change or modification. SPX Cooling Tech expressly disclaims all liability for any such deviation, change or modification. The equipment shall be warranted in accordance with the applicable SPX Cooling Tech Certification of Limited Warranty.

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.

⚠ Warning

Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.

⚠ Caution

Indicates presence of a hazard which will or can cause personal injury or property damage if ignored.

Note

Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.

Technical Data

Table 1

Specifications			
Model	WG012	WG018	WG024
Performance			
Nominal Rejection	91%		
Rated Product Permeate Flow – gpm*	12.2	18.2	24.4
Recovery	85-90%		
Membranes			
Size	8" x 40"	8" x 40"	8" x 40"
Quantity	2	3	4
Type	Low fouling spiral-wound composite		
Inlet Pressure Range - psig	30-80		

* Product permeate flow rate varies with temperature. All models are rated at 60°F (15.5°C). Product permeate flow for individual elements may vary -20 +25%.

Table 2

Maximum and Minimum Flow					
Model	Product Permeate Flow - gpm			Reject Minimum gpm	Reject Maximum gpm
	Minimum 50°F	Minimum 60°F	Maximum 77°F		
WG012	10	12.2	15	1.22	2.25
WG018	16	18.2	20	1.83	3.0
WG024	21	24.4	26	2.44	3.9

Table 3

Feedwater Requirements	
Maximum Chlorine Concentration	< 0.1 ppm
Maximum Operating Temperature	113° F
Maximum Feedwater Turbidity	1.0 NTU
Maximum Feedwater SDI	5.0
Oil and Grease	Max 0.1 mg/L
Operating pH Range	2-10
Cleaning pH Range	1-12
Sediment Filtration	5 microns

System Requirements

For WaterGard to function correctly these items are required:

- Two dry contacts from a generic water level controller. One signal for turning the unit on (Makeup On) and one for switching the unit into bypass operation (Low Level Alarm). SPX Cooling offers multiple WaterGard Ready options for liquid level control including the Marley LLC (liquid level control) probe style) and the Marley LLC+u (ultrasonic) water level control system.
- Municipal potable water is required, however other sources are possible please consult SPX for more information.
- Municipal potable water will have residual chlorine levels that are too high for WaterGard, therefore, a method of removal is required when any water source has a free residual chlorine level above the requirements shown in the Feedwater Requirements **Table 3**. This can either be done by purchasing a carbon tank through SPX Cooling or using liquid chemical chlorine destruct from a chemical water treater.
- A conductivity blowdown controller is required to monitor the water saving WaterGard offers. This can be purchased with the WaterGard system.

WaterGard can remove up to 91% of an individual ion. How much of an individual ion is removed depends on the ion. In some cases, the incoming water in a galvanized evaporative product may have too low of a calcium value ($<$50 ppm as $CaCO_3$) or pH may be too low ($<$6.5) making the water corrosive after WaterGard treatment. In these situations, it is recommended to initially fill the system with unfiltered feed water. If the system level is low enough, the internal bypass will automatically fill with unfiltered water. Otherwise, if the system level isn't low enough the external bypass will need to be engaged by jumping the low-level alarm. For LLC applications, once the system level is above the low-level alarm a delay timer will continue to fill the unit for 20 seconds, then WaterGard will start and operated normally. For Opti FC/LLC+u controls application, once the water level is above low-level alarm, the unit will keep bypass open until water level reaches the "makeup ON" setpoint. For additional information on soft water and its impact on tower metallurgy consult you Marley sales representative.

WaterGard operates by rejecting ions down a small, concentrated waste stream. This is typically 10-15% of the feedwater stream. Due to this, water savings are not possible when the evaporative system operates at higher cycles of concentration (COC). Any evaporative system's starting COC at 7 or higher can result in increased water usage, not water savings.

Schematics and Components

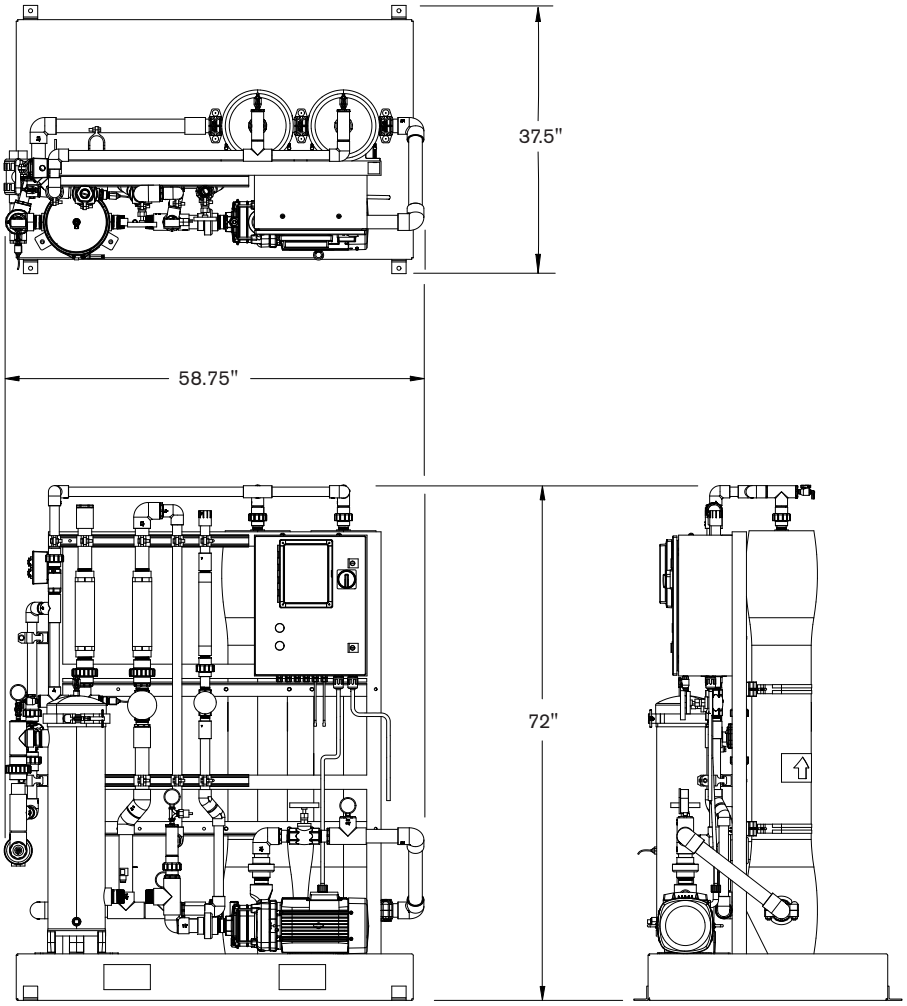
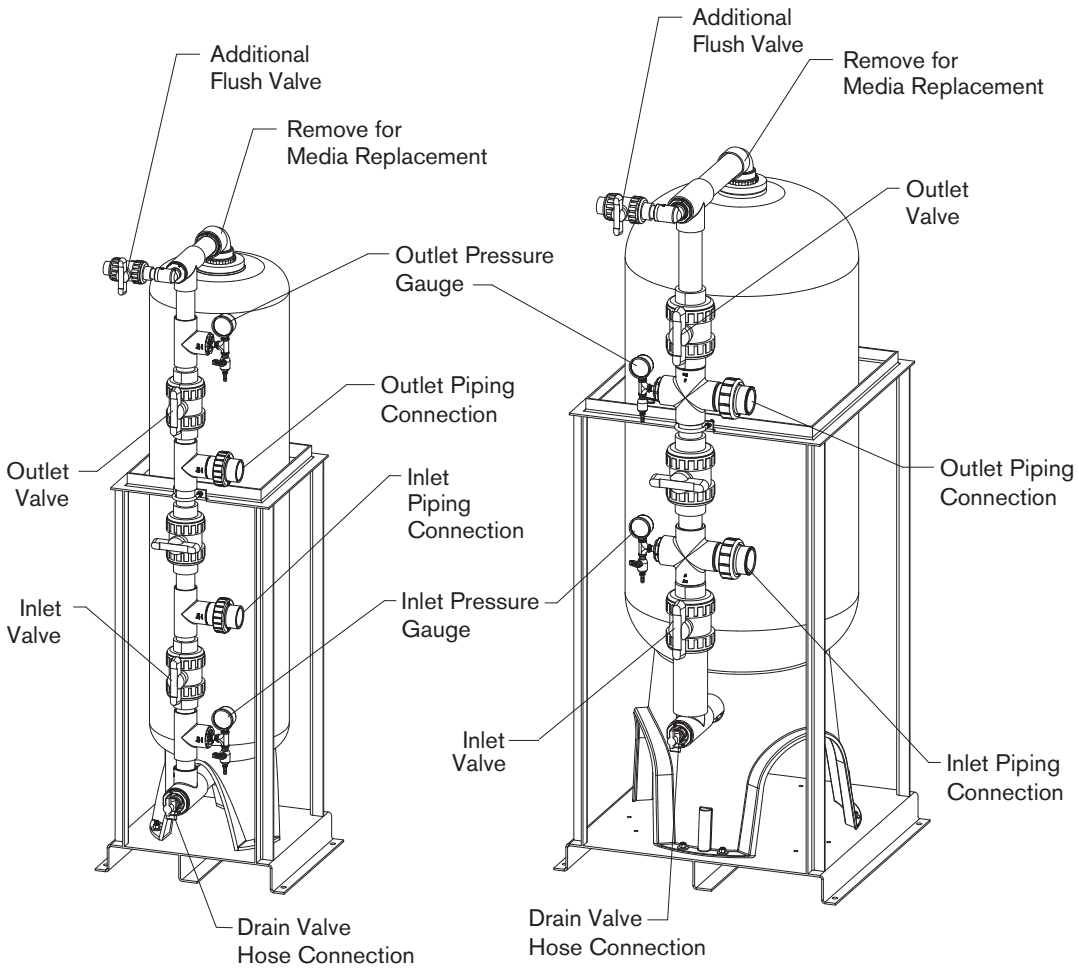


Figure 1

WG012 through WG024 Component Dimensions (WG024 shown)

Carbon Tanks *option*



Carbon Filter 3 cu ft (WG012 and WG018)

Carbon Filter 10 cu ft (WG024)

Figure 2

installation

Rigging

The WaterGard unit should be lifted and moved by a forklift. If the WaterGard unit is lifted by a crane it should be lifted from the bottom using a platform. The unit should be secure to the platform using the anchor locations. A test lift should be done in order to determine the weight centerline.

⚠ **Caution**

Do not allow rigging straps to contact system components.

Physical System Requirements

- WaterGard is for indoor use **only**. If the end user desires the unit to be placed outdoors it is the sole responsibly of the end user to protect the unit from freezing and inclement weather conditions.
- Ideally WaterGard should be located out of direct sunlight. If this is not possible some components may experience discoloration from direct UV rays due to sunlight. This is mainly an aesthetic issue and won't adversely impact performance.
- WaterGard should be located on a level floor or housekeeping pad.
- Floor load rating must be sufficient to accept WaterGard weight.
- The location must be dry and frost-free.
- Normally, inlet water temperature should not exceed 77°F. Water temperatures from 77°F to 113°F will negatively impact the quality of the water. Anything above 113°F may impact the integrity of the membrane.
- Feedwater to the WaterGard unit must not contain chlorine or oil. For more information refer to **Table 3**.
- A floor drain close to the unit is required that can carry away the reject flow from the WaterGard system. See **Table 2** for reject flow requirements.
- The water pressure at the WaterGard inlet when in operation, must be a minimum of 30 psi, and must not exceed a maximum of 80 psi. If the pressure exceeds the maximum stated pressure, or if it fluctuates to pressures exceeding 80 psi, install a pressure-reducing valve at the inlet.
- The flow of inlet feedwater supplied to the WaterGard unit shall be an uninterrupted flow at 30 psi minimum, and at a minimum flow rate of twice the rated product permeate water flow of the WaterGard unit purchased. See **Table 2** for minimum flow rates.
- WaterGard should be additionally secured in areas where necessary using seismic and wind rated anchor bolts and straps. All applicable local codes shall be followed.

Electrical Requirements

⚠ **Warning**

Conduit and water pipes are NOT an acceptable ground.

- All wiring must be properly sized, rated, and connected in accordance with local, state, and national electrical codes. The system is pre-wired and tested at the factory. See provided sales drawing for additional details.
- The WaterGard unit should be on a dedicated circuit originating at a service disconnect panel. Refer to unit nameplate for correct voltage information.
- The electrical voltage and phase must match and be verified to the WaterGard unit that was purchased.

⚠ **Caution**

Do not operate pump dry. Damage to pump seal and shaft may occur.

Piping Connections

- All piping, valves, etc. for the product permeate water outlet of the WaterGard unit must be made of PVC, PP, PEX, or corrosion-resistant stainless steel. Local plumbing codes must be observed and followed.
- The carbon filter (if present) must be installed upstream from the WaterGard unit. This is designed to remove any residual chlorine present in the feedwater stream. For information on pipe sizes for each unit reference the installation and/or sales drawing.
- In cases where it is not desired to fill the evaporative unit's collection basin during startup, a section of piping can be added downstream of the WaterGard unit to send the product water to the drain, in order to startup WaterGard.

⚠ **Caution**

Properly secure all pipe runs. Pipe movement may cause damage to WaterGard and/or pipe. Ensure waste drain line is adequately sized and free flowing to handle the reject flow. Reject flow rates can be found in Table 2.

The drain for the WaterGard unit must be designed and constructed to provide for connection to the sanitary waste system through an air gap of 1"or two pipe diameters, whichever is larger.

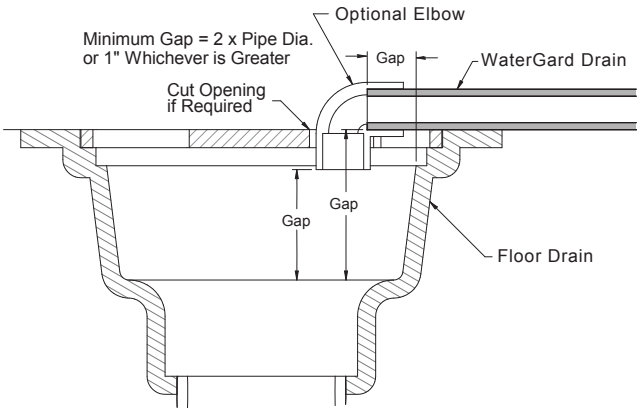


Figure 3

Startup and Operation

Note

WaterGard membranes cannot be used immediately, they must be filled with feedwater and allowed to soak for a minimum of 30 minutes, see step 14.

⚠ Caution

Never completely close the waste stream, recirculating or pump discharge valve while the unit is running. Closing these valves beyond the minimum flowrates will cause irreparable damage to the membranes.

1 WaterGard and evaporative product arrangements should have been setup during the initial quoting. Refer to the Marley controls literature kit for configuration drawings and user manuals for laying out piping and electrical connections.

2 Connect the carbon filter (if present) to your potable water supply. The carbon filter will need to be flushed for 30 minutes before being piped into WaterGard. Use the garden hose connection in **Figure 2** to flush the carbon tank. To flush, reverse the flow through the tank. Multiple flushes may be needed if pressure drops below 30 psi.

3 If liquid chemical chlorine destruct is being used, setup the system upstream of WaterGard and plug in the chemical pump into the provided electrical receptacle on the WaterGard unit. See the installation drawing in the WaterGard literature kit for additional information.

operation

4 Connect WaterGard to your potable water supply downstream from the carbon tank or chlorine destruct. If blending both warm and cold water to improve product flow rate, do not exceed 77°F.

5 Verify the installation of the sediment filter cartridge(s) inside its housing.

6 The reject to drain connection coming out of the WaterGard system is for reject water. The water from this will go directly to the drain.

7 Connect the WaterGard product permeate line to the evaporative product's makeup line. In the case of a single WaterGard unit to a single evaporative product/makeup supply point, no additional external makeup valve is needed. All other configurations require a makeup solenoid valve to be installed at the evaporative product and connected to a Marley control panel. See configuration drawings in the literature kit for more information.

8 Connect WaterGard to a dedicated electrical power supply. Refer to unit nameplate for voltage information.

9 Connect the WaterGard LLC controls makeup and low-level alarm into the appropriate lead suspended from the WaterGard LLC control panel. If local code prevents the use of these leads refer to the configuration drawings within the literature kit for terminal block locations.

10 In cases where it is not desired to fill the evaporative unit's collection basin, a jumper will need to be added to the low-level alarm contact in either the LLC control panel or the WaterGard control panel.

11 Open the WaterGard feedwater inlet valve.

12 Partially open the vent on top of the sediment filter, this can be closed once all the air has escaped.

13 Turn on power at the disconnect on WaterGard control panel.

14 Press the WaterGard control button to the ON position. Then immediately press the "Manual Run/Flush" button twice to activate the flushing operation. Continue this until water flows stabilizes in the flow meters. Once this occurs turn the WaterGard off by pressing and holding the system On/Off button. Let the membranes soak for a minimum of 30 minutes.

15 Press the WaterGard control button to the ON position. A 10 second pump delay will occur before the pump starts and normal operation occurs.

16 Once the pump has started, membrane inlet (pump) pressure should never exceed 135 psi. Use the valve on the discharge side of the pump to adjust the pressure to 105 psi. If pressures over 135 psi are observed it could be an indication of membrane fouling. Refer to the **Membrane Replacement** section in this manual.

17 Allow WaterGard to run for 30 minutes to allow components to fill with water, purge trapped air and to rinse the membranes of preservatives.

18 While purging, adjust the reject throttle valve and adjust to a 50:50 ratio flow through the reject flowmeter compared to the product permeate flowmeter. See **Figure 4**.

19 Once WaterGard has stabilized and all impurities and preservatives have been flushed, the water will have to stabilized. Set the product permeate water quality alarm value at the desired limit (Refer to the **Controller Adjustments** section) and adjust the reject throttle to maximize water savings. Ensure the flowrate doesn't pass the stated minimum flowrate on the WaterGard nameplate.

20 When WaterGard is running stable and within desired water quality limits, the product permeate hose or piping can be connected to the process system's piping or evaporative product's collection basin. During the initial fill of the system, the low-level alarm will be activated, this is by design. This allows for a rapid fill of the system. During this phase, unfiltered feedwater will be added to the system until the LLC signals WaterGard to turn off.

21 Record initial operating conditions on the System Log sheet in this manual and then periodically afterwards as determined by your Quality Department or Facilities Manager.

21 Use the provided valve locks to ensure valve positions don't change.

Note

The operating conditions should be recorded at least once each day WaterGard is operated.

System Shutdown

Less than 30 days. Press and hold the SYSTEM ON/OFF key (the display will show POWER OFF).

More than 30 days. Drain the system of as much water as possible by breaking unions or removing tubes. On startup, follow **Startup** procedure.

Automatic System Standby and Restart

System will automatically go into standby during the following conditions:

- Collection basin full
- Low inlet pressure

Once the collection basin water level drops below its actuation point WaterGard will restart.

Bypass

System will automatically go into bypass during the following conditions:

- When WaterGard is in a shutdown condition
  - – Low inlet pressure and has faulted 5 times or more
  - – Pretreat fault has been active for more than 2 seconds
- When the LLC low level alarm has been activated

WaterGard Controls

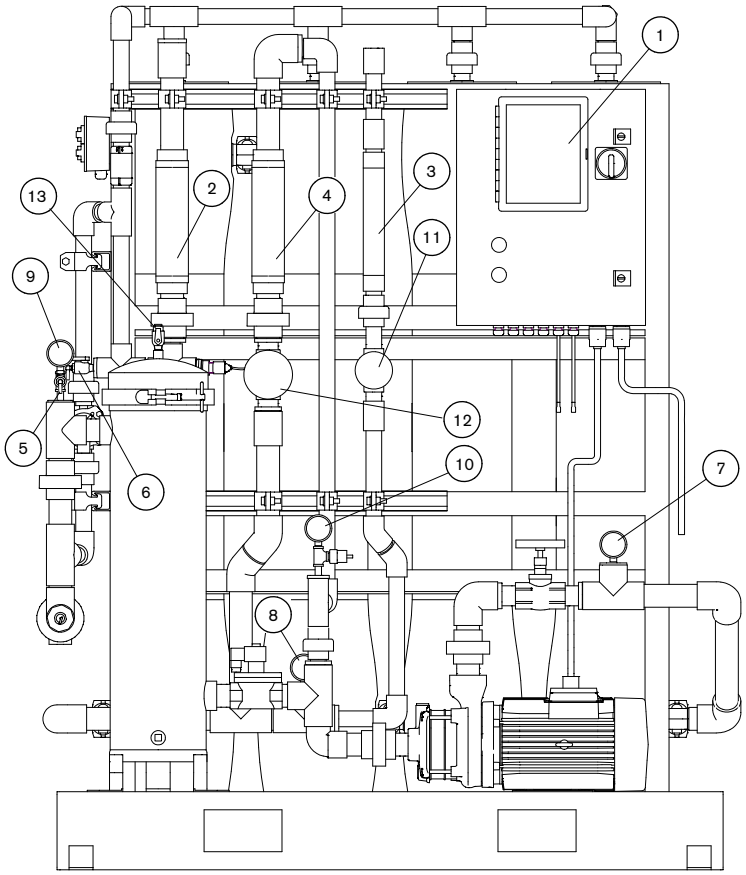


Figure 4

1 - Controller	8 - Reject Pressure psi
2 - Product Permeate Flow Meter	9 - Sediment Filter Inlet Pressure psi
3 - Reject Flow Meter	10 - Sediment Filter Outlet Pressure psi
4 - Recirculation Flowmeter	11 - Reject Flow Control Valve
5 - Inlet Feedwater Sample Port	12 - Recirculation Flow Control Valve
6 - Product Permeate Water Sample Port	13 - Sediment Filter Air Release Valve
7 - Membrane Inlet Pressure psi	
Item 10 – Item 9 = Differential Pressure	

Controller Operation

The unit has two modes of operation, a power off mode and an operating mode that are controlled by the SYSTEM ON/OFF key. In the power off mode the unit is effectively off. All outputs are turned off and the display shows POWER OFF. In the operating mode, the unit operates automatically. All inputs are monitored, and the outputs are controlled accordingly. Pressing and holding

the power key will toggle the unit from the operating to power off or from power off to operating. If power is removed from the unit, when power is reapplied, the unit will restart in the mode in which the power was removed.

Operating Status Messages

The main operating status of the unit is shown on the top line of the display:

POWER OFF: The unit is off.

RO RUNNING: WaterGard unit is operating.

RO STARTING: WaterGard unit is starting up.

TANK FULL: The unit is shut down due to a collection basin full condition.

PRETREAT: The Unit is shut down due to a pretreat lockout condition.

PRESS FAULT: The unit is shut down to a low-pressure fault condition.

The secondary operating status is shown on the second line of the display.

SYSTEM FLUSHING: WaterGard flush is active. The number is the minutes remaining in the flush cycle.

PUMP DELAY: The unit is in the WaterGard start delay. The number is the seconds remaining before the WaterGard pump starts.

Temperature—The current product permeate water temperature is shown on the second line. If equipped, the line will alternate with feed temperature.

Conductivity—The product permeate conductivity is shown on the second line. If equipped, the third line will show feed conductivity. These values will alternate with water temperature on second line and percent rejection on third line.

WaterGard Runtime—The current operating hours are shown on the bottom line. See **Figure 5**.



Figure 5

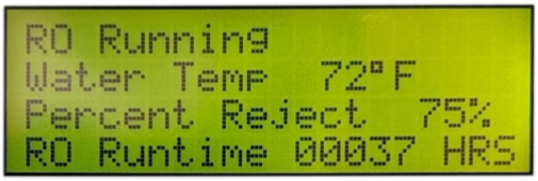


Figure 6

Warning Messages–Warning messages are also shown on the second line. If any warnings are active, the active warnings will alternate with normal displays for the bottom line.

Tank Full Operation–The unit can be operated with either the hanging probe Marley LLC or ultrasonic Marley LLC+u water level controls. Refer to the WaterGard LLC water level control User Manual for more information. When the water level sensor has been active for 5 seconds, the unit will shut down on tank full. TANK FULL will show on the display. When the tank full condition clears, the unit will come out of standby. The number is the tank full restart time and the unit will restart when this delay times out

Pressure Fault–If the pressure fault input becomes active (opens) and stays active for the number of faults programmed (see **Standard Setpoints** on page 22 for default settings), the unit will shut down for a pressure fault with internal bypass activated. The display will show SERVICE FAULT – LOW FEED PRESSURE, and the audible alarm will sound.

Low Pressure Auto Reset–If a pressure fault shut down occurs and the Auto Reset Setpoint is programmed to 0, the unit will remain shut down until manually reset. If the Auto Reset Setpoint (see **Standard Setpoints** on page 22 for default settings) is programmed to a value greater than 0, the unit will automatically clear the pressure fault and attempt to restart after this delay times out. If the number of consecutive pressure faults that occur is more than the allowed number, full shutdown of the unit will occur, and the internal bypass will be activated.

Pretreat–If the pretreat input becomes active (closes) and stays active for 2 seconds, the unit will shut down in a pretreat lockout condition. PRETREAT will show on the display and the unit will remain shut down with the internal bypass activated as long as the pretreat input is active.

Product Permeate Water High Conductivity–If the conductivity reading exceeds the programmed COND limit setpoint for the delay programmed in the conductivity product permeate water setpoint, the HI COND warning message will show on the display. This warning will clear when the conductivity drops below the setpoint. This should be set at 35% of the incoming water conductivity. Follow instructions in **Controller Adjustments** on page 19 to change the permeate alarm value if necessary.

When the High Conductivity warning message is active, the WaterGard alarm will be active until the product permeate water conductivity goes back into the acceptance quality range.

Alarm Output–The board Divert/Alarm has been programmed to operate as **Standard Setpoints** on page 20 shows, the relay will energize whenever a shutdown condition occurs. The relay will remain energized if the shutdown condition is active. S1 should be left as a powered output for the bypass feature to function.

Cross Reference Terms on Controller Screen

Tank–Refers to the water collection basin in the tower

Product Permeate–The water after having gone through the WaterGard membranes

RO–References WaterGard

Fault Condition Display

High Pressure Fault: Occurs when High Pressure Switch Closes

Line 1–Service Fault
Line 2–High System Pressure
Line 3–
Line 4–To Reset Push OFF/ON

Low Pressure Fault: System is responding to low pressure condition per system settings

Line 1–Service Fault
Line 2–Low Feed Pressure
Line 3–
Line 4–Restart in MM:S”

Pre Treat Fault: Pretreat Switch is closed indicating problem with the pretreat system

Line 1–Service Fault
Line 2–Pretreat
Line 3–
Line 4–Check Pretreat Sys

Permeate Conductivity Fault: Permeate conductivity is higher than the alarm setpoint

Line 1–Service Fault
Line 2–Permeate TDS xxx ppm or Permeate Cond xxx µS
Line 3–Alarm SP xxx ppm or Alarm SP xxx µS
Line 4–To Reset Push OFF/ON

Conductivity Probe Error messages:

Line 2 –Over-range
Measurement is out of range for the circuit, probe may also be shorted
Line 2–Probe shorted
Short circuit detected on temperature sensor in probe
Line 2–Probe not detected
Open circuit detected on temperature sensor in probe
Line 2–Probe Startup 1
Internal reference voltage too high to make valid measurement
Line 2–Probe Startup 2
Internal reference voltage too low to make valid measurement
Line 2–Probe Startup 3
Internal excitation voltage too high to make valid measurement
Line 2–Probe Startup 4
Internal excitation voltage too low to make valid measurement

Controller Adjustment

With the system ON, press and hold the UP and DOWN arrows and then press System On/Off. **Figure 7** shows the settings that can be changed at the controller.

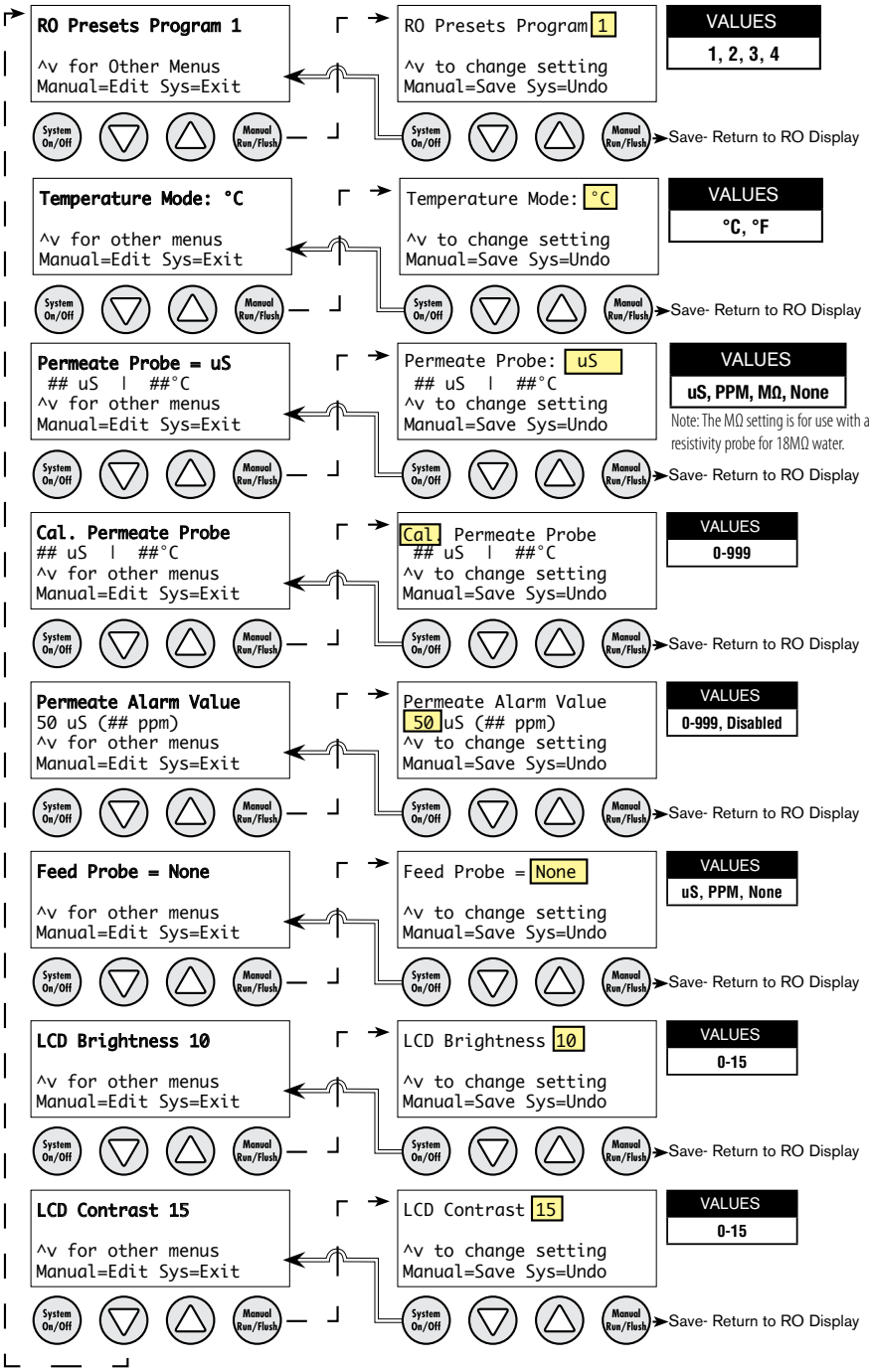


Figure 7

WaterGard Presets Program–Change program to number of program desired. Setpoints are shown in **Standard Setpoints** on page 22.

Temperature Mode–Select temperature unit desired.

Conductivity Calibration

The controller has been calibrated prior to shipment. It may be necessary to periodically calibrate the conductivity. If the controller should require calibration, follow the instructions below. Please contact your local Marley sales representative, if you have any questions regarding the procedure.

Because the conductivity measurement is affected by the physical environment in which it operates, it is best to calibrate while installed in the system and operating under normal conditions. This requires an accurate external conductivity measurement device to serve as a reference.

1 Operate WaterGard long enough for the membranes, operating temperature and product permeate conductivity reading to stabilize, ideally at least 10 minutes.

2 Take a sample of the product permeate and measure it with the reference meter.

3 With the system ON, press and hold the UP and DOWN arrows. With the UP and DOWN arrows depressed, press the System On/Off button.

4 Enter the Permeate Calibration menu using the down arrow. Once at the menu, follow the on screen directions and use the UP or DOWN arrow until the value on the controller matches the value obtained on the reference meter.

5 Exit and save the calibration.

6 The same procedure applies to the Feed Probe calibration.

Note

The probe calibration must be performed using solutions with conductivity of less than 900 ppm or µS. The conductivity calibration circuit will behave erratically if you attempt to calibrate using a higher value. When using a standard calibration solution, the NaCl ppm value can be used in place of the µs value if desired.

TDS to µS Conversions

Multiply	by	To Obtain
µS	1.9	TDS
TDS	.526	µS

Product Permeate Alarm Value–Select desired value for permeate alarm as outlined on page 16.

Display Adjustment–Change LCD brightness and LCD contrast to adjust for the application's best viewing experience.

Standard Setpoints

Parameter	Value	Program 1	Program 2	Program 3	Program 4
Timed Manual Run	Minutes	5	5	5	5
Collection Basin Level Switch delay (actuation and de actuation)	Seconds	2	2	2	2
Pressure Switch delay (actuation and de actuation)	Seconds	2	2	2	2
Pretreat Switch delay (actuation and de actuation)	Seconds	2	2	2	2
Pump start delay	Seconds	10	10	10	10
Pump start retry interval (restart delay after LP fault)	Seconds	10	10	10	10
Inlet Solenoid stop delay	Seconds	1	1	1	1
Low pressure fault shutdown, number of faults	Faults	5	5	5	5
Low pressure fault shutdown, time to count faults	Minutes	10	10	10	10
Low pressure fault shutdown, reset after shutdown	Minutes	60	60	60	60
Low pressure time out fault	Seconds	60	60	60	60
Flush Behavior		Low Pressure Flush	Low Pressure Flush	Low Pressure Flush	Low Pressure Flush
Startup Flush: Minutes from last flush	Minutes	0	0	0	0
Startup Flush: Duration	Seconds	0	0	0	0
Periodic Flush: Interval	Minutes	-	-	-	-
Periodic Flush: Duration	Seconds	-	-	-	-
Shutdown Flush: Time from last flush	Minutes	0	0	0	0
Shutdown Flush: Minimum operation	Minutes	0	0	0	0
Shutdown Flush: Duration	Seconds	60	120	180	240
Idle Flush: Interval	Minutes	0	0	0	0
Idle Flush: Duration	Seconds	0	0	0	0
Timed Manual Flush	Seconds	600	600	600	600
Alarm/Divert Relay*		Alarm	Alarm	Alarm	Alarm
WQ/Conductivity Shutdown Timer (0 = No Shutdown)		0	0	0	0

*Can be changed from controller. All other parameters require software changes. Contact your local Marley sales representative for assistance.

troubleshooting

⚠ Caution

Only those persons who have read the complete user manual or who have received authorization from the facility director should attempt to troubleshoot and/or repair the WaterGard system.

Trouble	Cause	Remedy
WaterGard will not start	WaterGard not supplied power	Reestablish power.
	Circuit breaker tripped	Reset the breaker.
	WaterGard in a FAULT condition	Check the WaterGard controller display for FAULT condition and correct the FAULT.
System has power but no water flow	Feed source not open	Open Incoming water valve.
	Feed pressure < 5 psi	Increase pressure to ≥ 30 psi.
	Sediment filter clogged	Check the sediment filter gauges for pressure drop. Replace the sediment filter if the pressure drop is 10 psi.
	Feed solenoid is not operating	Test the solenoid. Replace the coil or valve if it is defective.
Pump making excessive noise	Low pressure or flow rate feeding WaterGard	Check the sediment filter outlet gauge psi (must be ≥ 20 psi) and verify that the product permeate flow (flowmeter) is within range.
	Pump motor or impeller failing	Check membrane psi gauge to verify that it is within operating parameters. Replace the pump assembly if necessary.
Poor product permeate water quality	High chlorine levels	Replace membranes. Verify carbon or pretreatment is removing all chlorine.
	Fouled membrane	Replace membranes.
	Conductivity cell out of calibration	Verify the conductivity cell accuracy with a known good meter. Follow the Conductivity Calibration procedures on page 18 or replace cell if necessary.
	Reject flow rate too low	Insure reject flow rate is above the minimum requirements as shown in Table 2.
Low product permeate flow rate	Low pressure feeding membrane	Verify that the incoming tap water supply is fully open.
	Low pump psi	Pump should be operating at 70-120 psi.
	Reject gpm flow rate too high	Turn reject flow to equal product permeate flow with the throttle valve.
	Excessive PRODUCT line back pressure	Check for restrictions in the PRODUCT line.
	Low temperature incoming tap water	Consult temperature correction chart in Table 2 to determine if the product permeate flow rate is normal in relation to the feedwater temperature.
	Sediment filter clogged	Check the sediment filter gauges for pressure drop. Replace the sediment filter cartridge if the pressure drop is ≥10 PSI.
	Fouled membrane	Clean or replace membranes.

controls troubleshooting

⚠ Warning

Hazardous voltages are present when power is applied to the unit. Care should be taken when troubleshooting any of the input power or output circuits. When disconnecting or connecting any board or accessory, verify that power is off.

Before contacting SPX Cooling for technical help, verify the programming of all setpoints, check the display and the status of all lights and indicators. The more information available when you contact us, the easier it will be to determine the source of the problem.

Trouble	Cause	Remedy
System Inoperative	Verify power is applied to the power terminals L1 and L2.	If yes, check/replace the main fuse with Littelfuse 0234006P and check/replace CPU fuse with Littelfuse 0218.250P. If no, ensure WaterGard is plugged in.
Display Blank	Is system operational?	If no, refer to above. If yes, check ribbon cable and adjust display contrast and brightness.
Inlet Valve will not operate	Is the system in power off?	Power on system.
	Is the inlet LED lit?	If yes, verify power at inlet terminals. If no, replace board.
WaterGard pump will not operate	Is the system in power off?	If no, check power at pump. If yes, power on.
	Are any shut down conditions active?	If no, check power at pump. If yes, correct fault.
No or incorrect conductivity reading	Is sensor wired correctly?	If no, correct wiring.

Servicing

Note

If any component of the water treatment system is changed or replaced, the user should conduct appropriate tests to ensure that the revised system meets all standards to which it was initially tested.

⚠ Warning

Always remove WaterGard from the power source and turn off the water prior to any maintenance activities!

1 A daily/weekly **System Log** for the WaterGard system must be filled out completely each time the system is used. See page 37.

2 The membranes, carbon and sediment filter are non-durable components and will need to be exchanged periodically.

   a. The membranes will need to be cleaned or replaced when the flow of product permeate water decreases more than 15-20% assuming the water temperature remains constant, and no other issue is the root cause.

   b. The 5-micron sediment filter will need to be replaced whenever the differential pressure on the outlet is 10 psi or greater than the pressure on the inlet of the filter housing.

3 The accuracy of the conductivity display should be verified with a calibrated, hand-held meter at least annually. If the conductivity display is not within 5% of the hand-held meter readings, the controller should be calibrated in accordance with the procedures in **Controller Adjustments** on page 19.

System Preparation for Maintenance

1 Press the SYSTEM ON/OFF key (the display will show POWER OFF).

2 Turn off the main power switch to the system.

3 Unplug WaterGard line cord.

4 Turn off the potable feedwater supply to WaterGard.

5 Relieve the pressure from the system by opening the sample port on the front of the WaterGard unit.

Typical Service Intervals		
Task	Frequency	Estimated Replacement Time
Membrane replacement	Yearly or as quality degrades to more than 35% of incoming conductivity, whichever comes first.	15 minutes per membrane
Sediment filter replacement	Quarterly or when ΔP across Sediment filter is ≥10 psi.	5 minutes
Carbon filter replacement	Yearly or as chlorine starts to pass through. Refer to feedwater requirements for acceptable level.	120 minutes

Membrane Replacement

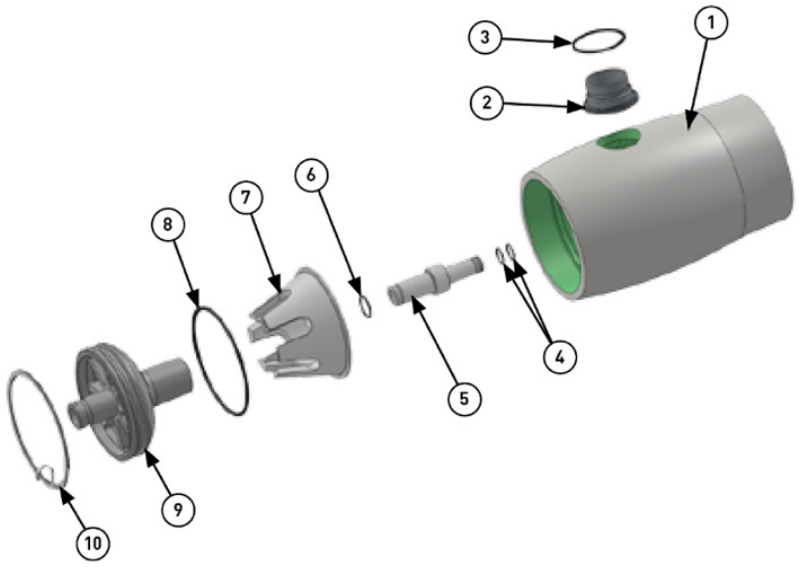


Figure 8

1 - Shell	6 - Adaptor Seal
2 - F/C Port	7 - Thrust Cone (only on concentrate end)
3 - F/C Port Seal	8 - Head Seal
4 - PWT Seal	9 - Elliptical Head
5 - Adaptor	10 - Retaining Plate

Removing the Vessel

1 **Relieve Pressure**–Shut off the feedwater supply and drain the unit of water by using the product and inlet sample ports. Check to ensure 0 psi on the sediment filter gauges.





2 **Disconnect Permeate Port**–Disconnect permeate piping as required at nearest union joints, being careful not to place undue stress on the threaded connections of the permeate port(s).





3 **Disconnect Inlet and Outlet Ports** – Disconnect the Victaulic couplings using a 9/16" deepwell socket. Once undone simply push the rubber gasket to one side to reveal the seam. Let the vessel drain any residual water.







4 Disconnect the retaining straps using a 1/2" socket.





5 Once steps 1-4 are complete, slowly remove the membrane vessel from the skid. Use caution, some water may be still be retained in the vessel causing the vessel to be heavy. If possible, use two people to remove and place in an appropriate location to remove the membrane.

Opening the Vessel

⚠ **Caution**

Do not tap on fittings, tapping on fittings could damage the ports.

6 Examine End Enclosure–Examine enclosure of vessel for corrosion. Metal oxidation products and mineral deposits can interfere with vessel disassembly. If any is evident, proceed as follows:

- Loosen any deposits with a small wire brush or medium grade 3M ScotchBrite™. See **Figure 9**.
- Flush away loosened deposits with clean water.

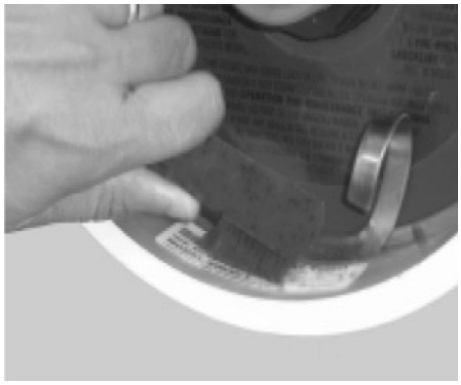


Figure 9

7 Removing Head Retaining Ring–Engage fore finger in the end tab of the retaining ring and lift up and out of the ring groove in the shell. Run fingers behind the retaining ring as it continues to exit the groove. See **Figure 10**.





Figure 10

8 Removing Head Assembly–Using a rubber mallet tap the elliptical head lightly. Do not use a metal hammer to tap the bearing plate.

- Carefully rock the head assembly back and forth to release the seal (care should be taken to avoid placing too much stress on the elliptical head threaded connection where the union and nipple assembly is connected).
- Once the head seal is broken, pull straight outward to remove the head assembly from the vessel.

Note

It may be necessary to rock the head slightly and / or tap the head inboard to break head seal bond.

⚠ Caution

Read all parts of this section before replacing elements. A record of element serial numbers and locations should be made and checked during loading. Do not scratch or damage the internal surface of the vessel when removing or installing elements.

Replacing the Elements

1 Remove element interface hardware.

- Remove thrust cone from the downstream (concentrate) end.
- Remove adapters from elements at each end. Ensure these adapters are retained and reused. The adaptors that comes with membrane kit are for connecting multiple adapters within a vessel and is not compatible.

2 . Element Removal–Remove elements from the vessel following element manufacturer's instructions. Clean off any excess lubricant from inside the vessel before removing elements.

3 . Element Loading–Examine the inside diameter of the vessel for scratches or imperfections that may affect sealing capability of head or element seals. Corrosion deposits or other foreign matter, including any excess lubricant, should be removed as described on page 29.

- Flush out the vessel with clean water to remove any dust and debris.
- Examine membrane element surfaces for any imperfection which could scratch the vessel bore. Pay particular attention to edges of anti-telescope device (ATD/brine seal carrier).This is the plastic piece on either end of the membrane. See **Figure 11**.

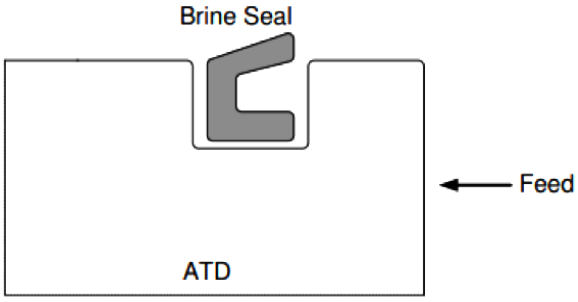


Figure 11

- **Option:** Using an approximate 50% mixture of glycerin in water, lubricate the inside of the vessel. This may be accomplished using a suitably sized swab soaked in the mixture. This procedure will ease membrane element loading and reduce chance of scratching the vessel bore.

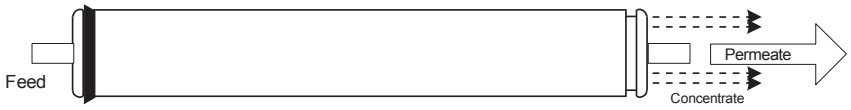


Figure 12

- Apply a light film of a non-petroleum based lubricant to the interconnection O-ring. (The amount should be just enough to give a luster to the O-ring. Excess must be removed to prevent possibility of element contamination).
- Ensure the components 4-9 in **Figure 8** at the bottom of the housing have not been misaligned.
- Match the flow direction arrow on the membrane with the flow direction arrow on the membrane housing and insert until seated.

⚠ Caution

Maintain careful element alignment during assembly procedure.

4 Install element interface hardware–Assemble adapter to element permeate tube at each end of vessel. Connect the central (permeate) tube of the membrane element, with an adapter on each end to the permeate port in the head at both ends of vessel. Pressurizing the vessel without both adapters installed could result in explosive head failure. The bottom end assemblies of the vessel should already be installed. See previous section on alignment.

- •. Install Head Seals (if not already installed).
- Install the thrust cone over the permeate port on the head assembly at the downstream (concentrate) end of the vessel. See **Figure 13**.

⚠ Caution

Serious damage may result if the thrust cone is not installed in the correct location. This is only applicable to housings that have the flow direction downward.



Figure 13

Closing the Vessel

⚠ Caution

Read all guidelines in this section before attempting to close the vessel.

Check the head assembly for corrosion as described in the head rebuilding section. Corroded parts can result in catastrophic failure. Do not pressurize vessel until after visual inspection to ensure that retaining ring are fully seated. Never attempt to repair a fiberglass shell.

Do not proceed until elements and adapters have been installed in the vessel following guidelines in **Replacing the Elements** section on page 30.

1 Inside surface inspection–Inspect the vessel inside surface for any corrosion deposits or other foreign matter. If any are found, clean the surface using a medium or fine grade of ScotchBrite and a mild soap solution, clean each end of the vessel inner surface up to 8" from each end of the vessel. Rinse away all loosened deposits from the shell inside surface using clean fresh water.

- Inspect the vessel inside surface for scratches or other damage that could cause leaks. Vessels that leak must be replaced.
- Inspect feed/concentrate port seals and attachments for internal and external damage or deterioration.

2 Shell and Head Lubrication–Work O-ring lubricant into shell area behind the retaining ring groove and approximately 1/2" into the vessel inside diameter.

- Ensure entire head seal is covered with a thin layer of O-ring lubricant, with no dirt or dust contamination.

Note

Any remaining lubricant should be cleaned from the vessel bore before applying fresh lubricant. Glycerin is a commercially available lubricant that will not foul membranes.

3 Install Head–Hold the head assembly square to the axis of the shell by grasping the permeate port. Slide it straight in until a slight resistance is felt.

- Grasp tightly and push the head in as far as it will go (a sharp, forceful thrust or light tapping with a rubber mallet may be necessary to enter the head into the vessel bore). When the head is correctly positioned, the locking groove will be exposed.

4 Install Head Interlock–Carefully wipe out any debris or moisture from the head retaining ring groove. The groove must be clean and dry before proceeding.

- With the head assembly installed in the shell, place the tip of the head Retaining ring in the retaining ring groove. (The non-bent tab end)

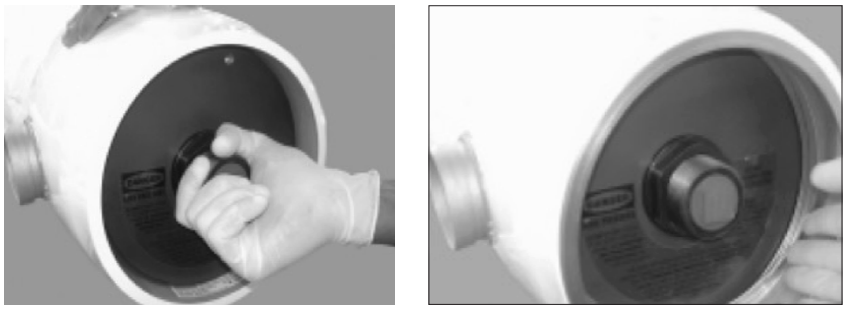


Figure 14

- Begin installing the retaining ring into the groove as you rotate your hand around the inside of the shell. See **Figure 14**.
- Continue until the entire retaining ring is installed in the groove.
- Verify that the retaining ring is fully seated in the groove before proceeding.

5 Reconnect Permeate Piping–Reconnect manifold piping to the vessel permeate port. Using Teflon tape or anaerobic sealant on all threaded connections will help ensure a leak-free assembly.

6 Pre-pressurization Checks

⚠ Caution

It is vitally important that the following checks be carried out before any attempt is made to pressurize the vessel.

Head Assembly–Verify the following at each end of the vessel:

- Head assembly is in good condition, with no evidence of damage or corrosion
- Port nut is snug (left-hand thread)
- Head retaining ring is properly placed

Membrane Elements–Verify that…

- Elements are installed in the vessel
- Element adapters are installed at each end of the vessel
- Thrust cone is installed at the downstream end of the vessel

Piping Connections–Check all piping connections to ensure that they will provide a leak-free seal.

7 Pressurization–After following the above pre pressurization checks, pressurize the vessel. Soak the membranes for 30 minutes before use, see **Startup and Operation** section on page 10.

- Return to normal operation and ensure membrane inlet pressure is set to 105 psi.

Sediment Filter Replacement

1 Shut off feedwater supply and relieve pressure on the sediment filter housing by opening the inlet sample port. Check to ensure 0 psi on the sediment filter gauges.

2 Unscrew bolt on V-band clamp and remove top cap.

3 Lift old filter out of the housing.

4 Lube O-ring on filter with plumbers grease and insert. Ensure filter seats properly. The O-ring should not be visible.

5 Reinstall the filter housing cap.

6 Turn feedwater back on, and return to normal operation.

Carbon Filter Replacement *option*

Vacuuming out the Media

1 Close inlet and outlet ball valves.

2 Open drain valve and completely drain all water from unit. Check to ensure 0 psi on inlet and outlet gauges.

3 Loosen union on outlet ball-valve and prewash outlet and spin entire assembly counterclockwise and remove.

4 Vacuum out carbon media with a shop vacuum and refill with appropriate amount in **Table 4**.

⚠ Caution

Wear a mask to protect against any dust generation during the refill process.

5 Reinstall top assembly and tighten unions.

6 Ensure drain valve is closed. Open prewash inlet and prewash outlet and rinse until water is clear.

7 Close prewash inlet and outlet and open inlet and outlet valves to return to operation.

Table 4

Model	Carbon Tank Volume
WG012	3 cu ft
WG018	3 cu ft
WG024	10 cu ft

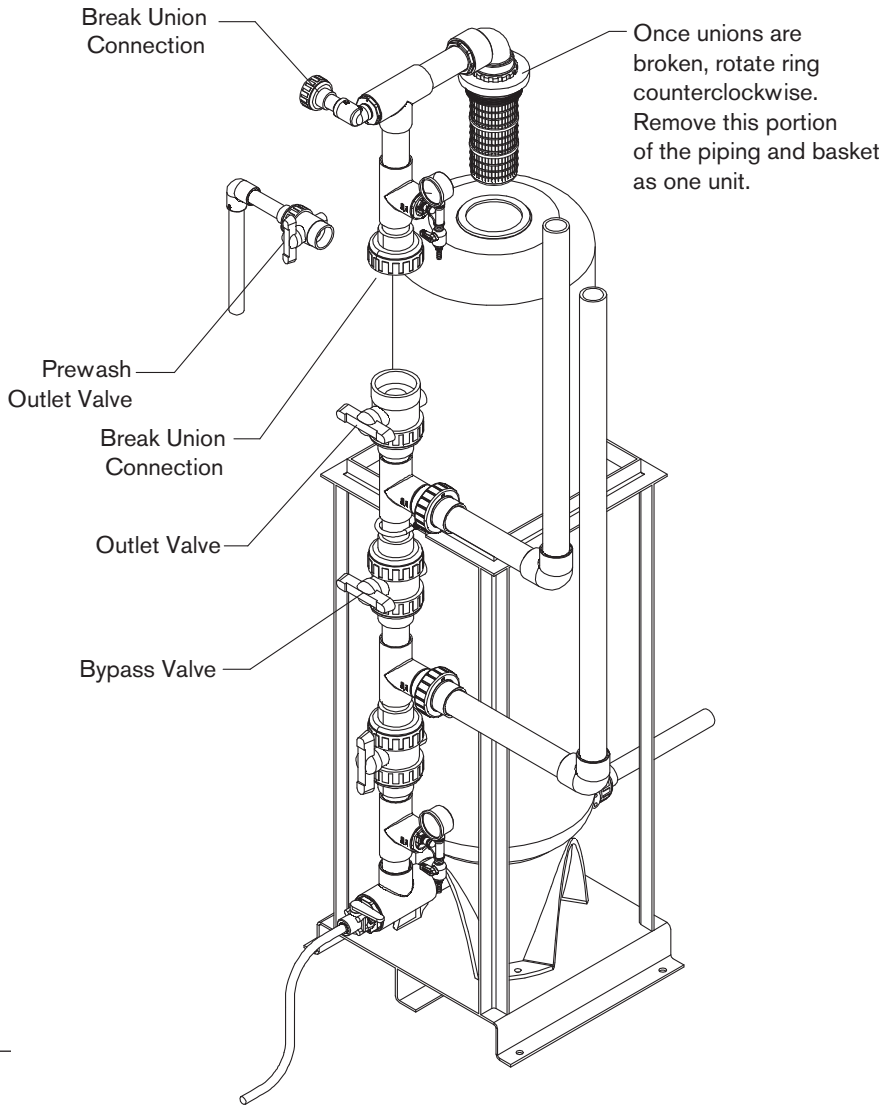


Figure 15

Removal of Carbon Basket Assembly

parts list

Note

Contact your Marley Sales Representative or SPX Cooling for pricing.

Part Number	Description
	WaterGard Membrane
2800085	Replacement Membrane 8" x 40"
2800124	Replacement Head Seal
2800058	Plumbers Silicone Grease
2800065	Test strips for Measuring Residual Chlorine
	Sediment Filter
2800089	5-micron Sediment Filter Cartridge
2800091	Sediment Filter Gasket
	Carbon Filter (option)
2800093	3 cu ft Carbon Tank - WG012 and WG018
2800096	10 cu ft Carbon Tank - WG024
2800094	Single Bag – 1 cu ft of Carbon
	Miscellaneous
2800095	Pump
2800077	Main Fuse
2800078	CPU Fuse
2800079	Terminal Board (TB-5)
2800080	Board with Screen (CPU-4)
	Replacement Kits
2800106	WG012 Membrane Replacement Kit (annual kit)
2800107	WG018 Membrane Replacement Kit (annual kit)
2800108	WG024 Membrane Replacement Kit (annual kit)
2800117	WG012 and WG018 Carbon Replacement Kit (annual kit)
2800118	WG024 Carbon Replacement Kit (annual kit)
2800122	WG012, WG018, WG024 Sediment Replacement Kit (6 month kit)
2800086	Head Seal, Retaining Ring, Elliptical Head Kit

system log

WaterGard System Log						
Date	Chlorine ppm	Filter DP	Membrane psi	Conductivity µS	Reject gpm	Product Permeate gpm

system log

WaterGard System Log						
Date	Chlorine ppm	Filter DP	Membrane psi	Conductivity µS	Reject gpm	Product Permeate gpm

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SPX TECHNOLOGIES

Water Monitoring Systems (Marley Liquid Level Controls LLC)

Objective: Learn how to wire up a Marley liquid level control probes and trouble shoot issue with the units. Gain a better understanding of the information included in the LLC User Manual and discuss tips and dos and don’ts.

Scenario: Customer has all his units wired up to power and each probe is connected to the terminal strip. Customer solenoid (for water make-up) will not turn on correctly. Customer needs help with trouble shooting his system.

Notes / Take Away Points:

Water Monitoring & Controls Systems

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Water Level Management

Cooling towers cool process water which flows to a cold-water (CW) basin before being recirculated. A means of monitoring the level of water in the CW Basin is used to replace evaporated water back into the process cooling loop.

Marley offers three options for water level management:



Makeup
Float Valve



Conductivity
Probe

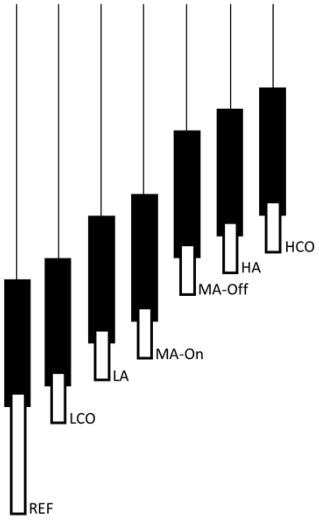


Ultrasonic

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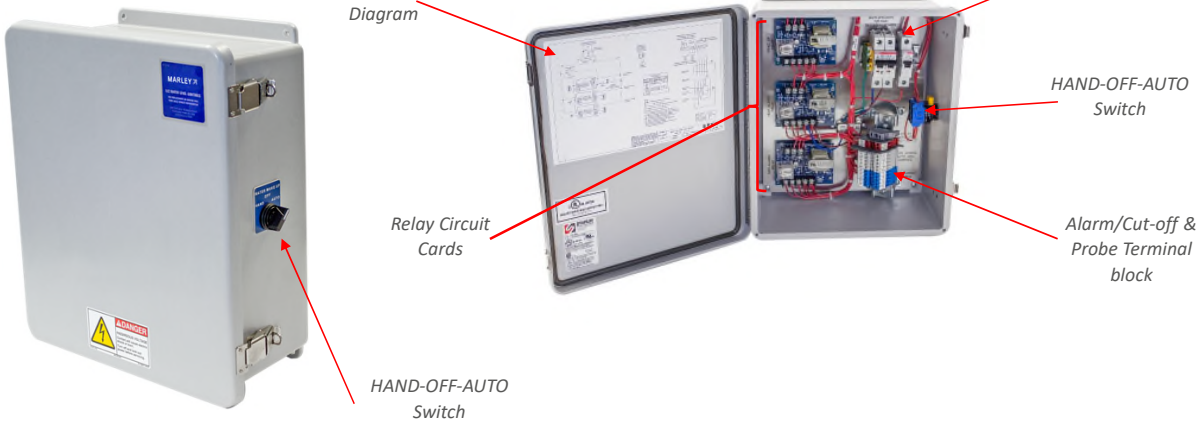
Probe Set Configurations

- Standard Probe Set
  - Reference (REF)
    - The REF probe will always be the lowest probe – it also has the longest probe.
    - This probe is constantly emitting a small amount of electricity into the water that will allow the panel to detect when other probes are submerged.
  - Makeup On (MA-On)
  - Makeup Off (MA-Off)
- Optional Add-Ons
  - Low Cut Off (LCO)
  - Low Alarm (LA)
  - High Alarm (HA)
  - High Cut Off (HCO)



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Conductivity Probe LLC Panel

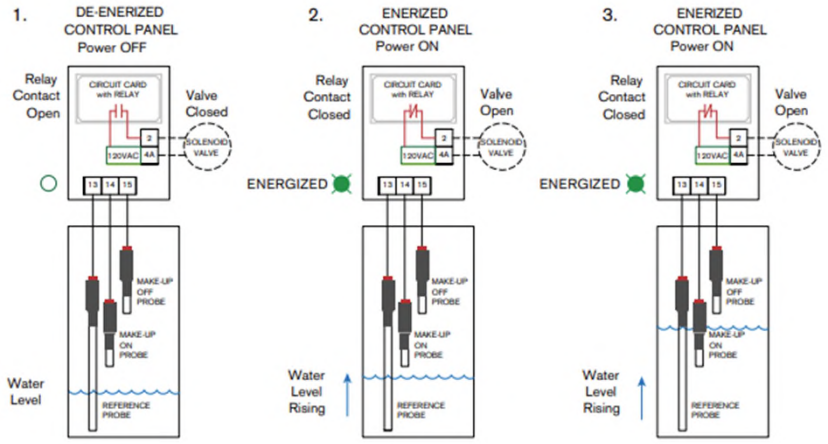


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Probe Functionality

Water Makeup Control – Sequence of Operation – B Card

Selector Switch in AUTO Position

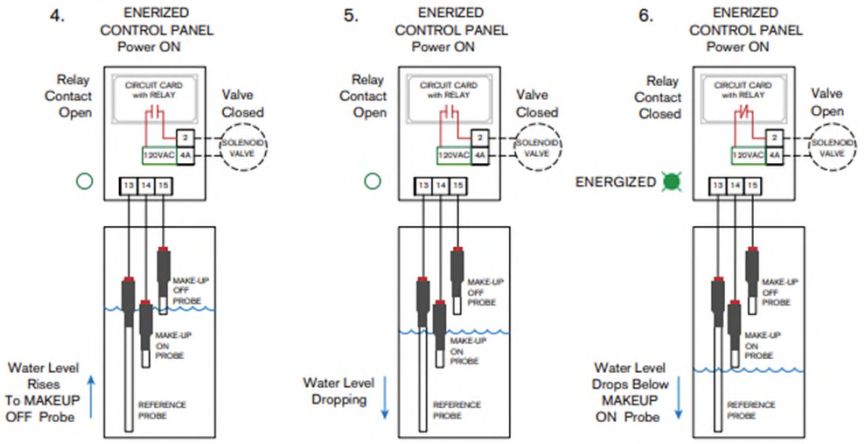


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Probe Functionality

Water Makeup Control – Sequence of Operation – B Card

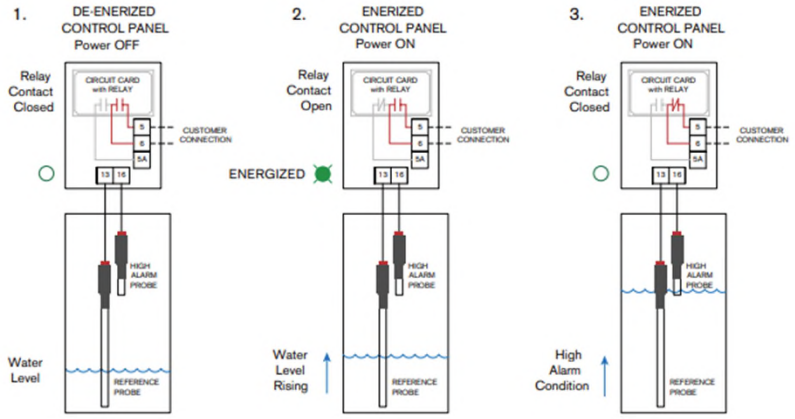
Selector Switch in AUTO Position



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Probe Functionality

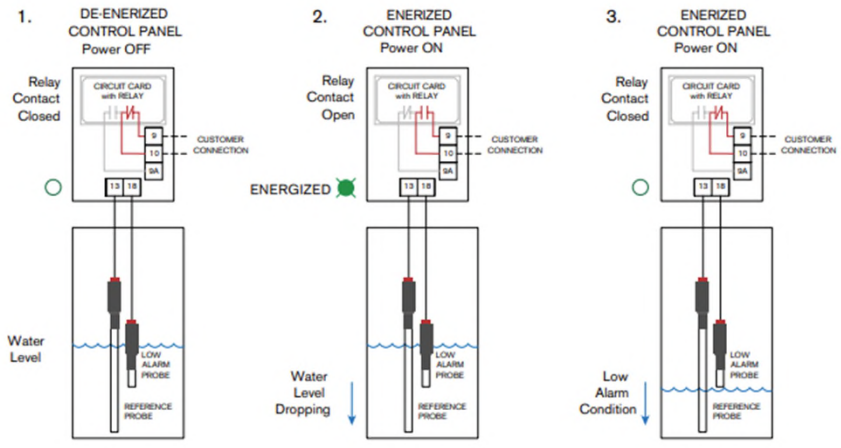
High Level Alarm – Sequence of Operation – B Card



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Probe Functionality

Low Level Alarm – Sequence of Operation – A Card



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MARLEY®

user manual

LLC water level control

INSTALLATION - OPERATION - MAINTENANCE

Z0628617_C ISSUED 8/2023

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



contents

Note

This manual contains vital information for the proper installation and operation of the LLC controls. Carefully read the manual before installation or operation and follow all instructions. Save this manual for future reference.

Quick Start Guide....4
Description....5
Operation....6
Water Makeup Function....7
HAND-OFF-AUTO Switch....7
Internal Components....8
Electrode Probe Assembly....9
Operation Sequence Illustrations....9
Water Makeup Control Sequence....10
High-Level Alarm Sequence....11
High-Level Cutoff Sequence....11
Low-Level Alarm Sequence....12
Low-Level Cutoff Sequence....12
Troupleshooting....13
Electrode Probe Part Numbers....14
Relay Circuit Card Part Numbers....15
Part Numbers....15
Wiring Diagrams....16

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.

⚠ Warning

Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.

⚠ Caution

Indicates presence of a hazard which will or can cause personal injury or property damage if ignored.

Note

Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.

introduction

These instructions are intended to assure that field connections are completed properly and the control system operates for the maximum time possible. Since product warranty may depend on your actions, please read these instructions thoroughly prior to operation.

If you have questions about the operation and/or maintenance of this control system and you do not find the answers in this manual, please contact your Marley sales representative.

⚠ Warning

Hazard of electrical shock or burn. Be sure to turn off power to the panel before servicing. If working on equipment out of site of panel disconnect, lockout using standard lockout procedure.

Safety First

The Marley control system uses UL listed components installed in accordance with the National Electric Code. The location of the cooling tower and field installation of the control system can affect the safety of those responsible for installing, operating or maintaining the tower and controls. However, since SPX Cooling Technologies does not control the tower location, or field installation, we cannot be responsible for addressing safety issues that are affected by these items.

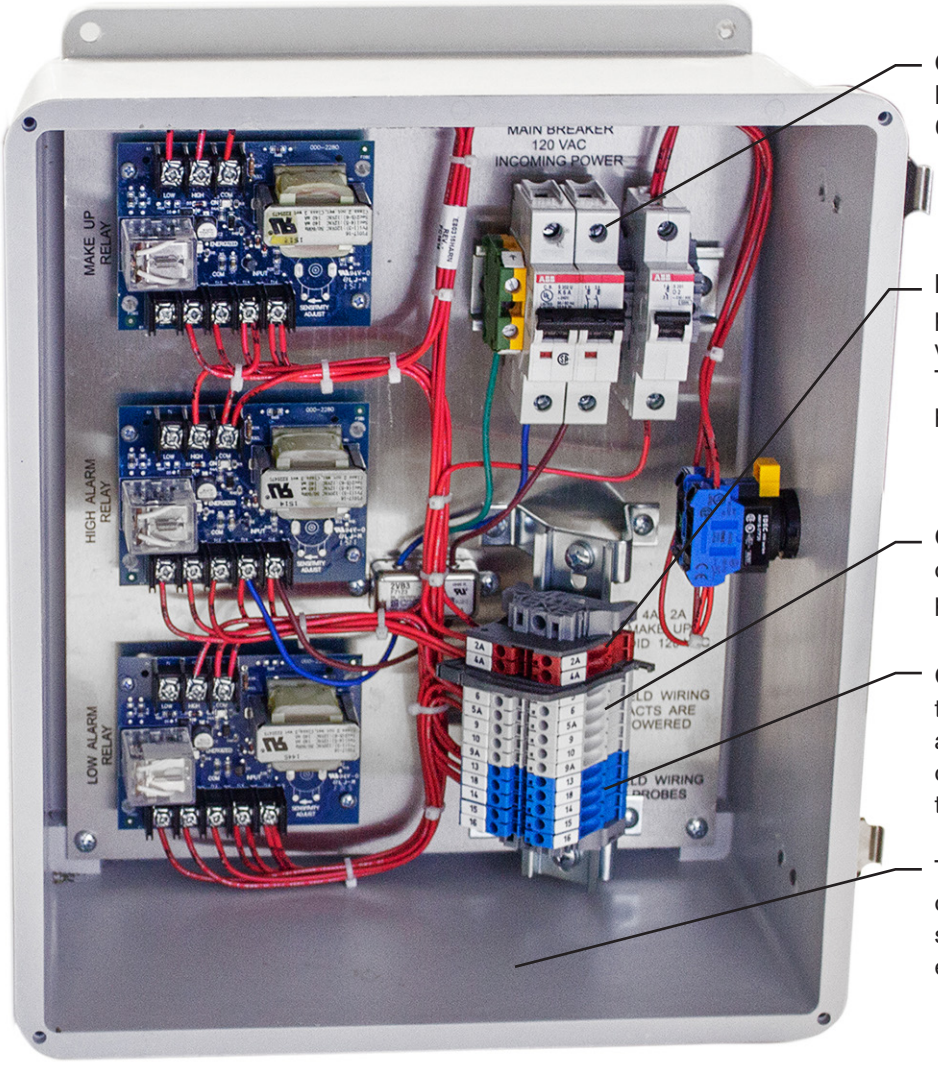
⚠ Warning

The following safety issues should be addressed by those responsible for installation, maintenance or repair of the tower and controls:

- Access to and from the control panel (including the customer supplied main disconnect/branch circuit protection.)
- Proper grounding of electrical control circuits.
- Sizing and protection of branch circuits feeding the control panel.
- Qualification of persons who will install, maintain and service the electrical equipment.

These are only some of the safety issues that may arise in the design and installation process. Marley strongly recommends that you consult a safety engineer to be sure that all safety considerations have been addressed.

Other safety issues are addressed in literature supplied with your tower. You should closely review the literature prior to installing, maintaining or repairing your tower.



Connect incoming power here. Panel requires 120VAC 1 phase, 6 amp power with ground.

If a makeup solenoid circuit is provided, connect the solenoid wires here at points 4A and 2A. This circuit provides 120 VAC power for the solenoid.

Connect alarm and/or cutoff control wiring to the grey terminal points.

Connect water level probe wiring to the blue terminals. The probes are generally located in the cold water basin of the cooling tower.

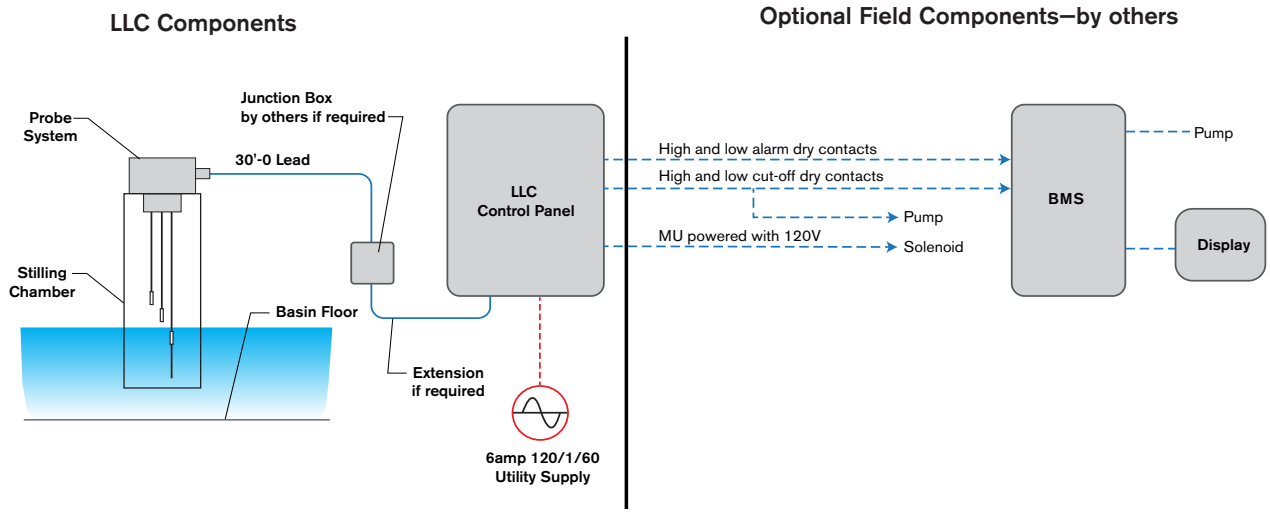
To avoid water getting into the control panel, all conduit entries should be into the bottom of the enclosure.

Note: If the control panel is furnished with a water makeup selector switch located on the right-hand side of the enclosure:

HAND: position: Solenoid will energize. **OFF:** position: Solenoid is de-energized

AUTO: Solenoid will operate depending on water level in relation to water probe height.

SYSTEM DIAGRAM



The Liquid Level Control systems are used to accomplish five different functions:

- Water Makeup
- Low Water Alarm
- Low Water Cutoff
- High Water Alarm
- High Water Cutoff

The most common application of a water level control system is water makeup. The system regulates the amount of water in the tower basin and keeps it within normal operating levels. This makeup system is used to control a remotely installed water solenoid valve. When the water level drops below a prescribed, preset level, the solenoid valve is energized by the control system to fill the basin to its proper level.

High and low water alarms can be utilized to give warnings associated with abnormal operating water levels. To provide indication of these types of alerts, the control system provides dry contacts to interface with various digital control systems or can be connected to user supplied alarm indicators to signal when corrective action is required.

Low-water cutoffs are commonly used to protect pumps from operating without sufficient water. When used in unattended operating environments, the low-water cutoff is configured to shut the pump off, thus preventing costly repairs. Dry contacts can be wired directly in series with pilot duty controls or to digital control systems to initiate the shutdown of protected equipment during low-water situations.

Operation

The LLC water level control system consists of special purpose liquid sensing relays on one or more individual circuit cards connected to a probe assembly located in the cold-water basin. Each circuit card contains one relay and external signaling is provided by each of these special purpose cards. The individual relay provides a “Form C” normally open and normally closed dry contact. The circuit card activates the relay using “through the water” continuity by way of the senor probes located in the cold-water basin of the cooling tower.

Utilizing water’s ability to conduct electricity, a circuit path can be established between one probe tip and the other. Current conducts through the water across probes of dissimilar length. One common or reference probe is present in all systems and is shared by all functions of the system. This probe can be identified by its length. It is the longest probe in the system and extends the deepest into the basin. The current path is routed between all other probe tips and this one “common”. When the water level reaches the shorter probe, the circuit is completed and the relay responds, opening or closing relay contacts corresponding to a fixed level. For low-level control, the ground reference probe and a slightly shorter probe provide the circuit. When the water level drops below this tip, the continuity between this probe and the reference probe is interrupted and the relay contacts transfer. The distance from the tip of the low probe to the floor of the basin determines the minimum water level that is allowed before an alarm is produced or pump operation is interrupted.

The number of additional probes is determined by the individual application. As an example, in a “water makeup” system there are three probes. One reference and two standard or short-tipped probes. The tip of the reference probe is normally positioned slightly above the basin floor with the additional probe tips positioned at different heights dictated by their specific function. The Makeup system would have one probe at a height to begin or start filling the basin and another positioned higher to complete or stop filling. A probe for a High Alarm or High Cutoff would be positioned at a level to activate when the basin water exceeds its normal operating level and logically a Low Alarm or Low Cutoff would be positioned to detect a low water level nearer the bottom of the basin. Again, signaling is achieved in two ways. High Level and Makeup cards react when the water provides a completed circuit or continuity between its sensor and the reference probe. The second type of signal is for Low Level detection. The Low Level cards react when the water is not present and opens the circuit or disrupts the current flow between its probe and the reference.

operation

A water level control system can be configured to meet various combination requirements. Since one individual circuit card is responsible for each function, the size and circuitry varies in proportion to the number of operations desired. For example, a water level makeup control will require a control panel with one circuit relay card and three probes. A system configured for water makeup that includes a high alarm and a low alarm, will require three circuit cards and five probes—one circuit card for the water makeup option, one for high operation and one for low.

Water Makeup Function

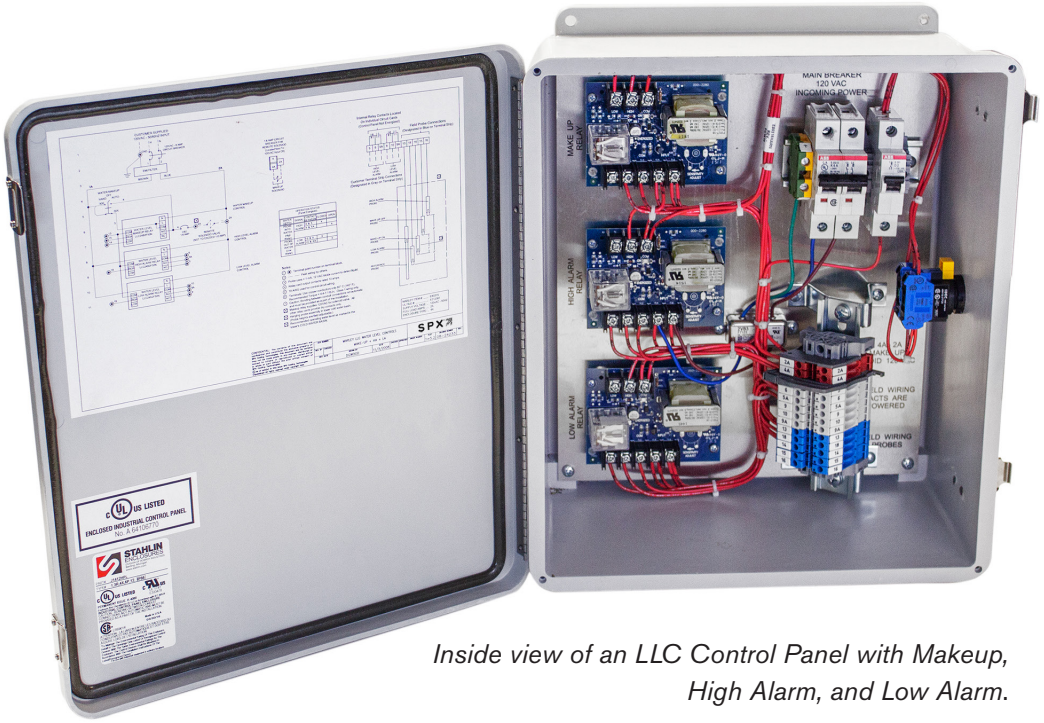
A system is designed for alarms and/or cutoff indication only would not be equipped with the water makeup function.

The circuitry for water makeup in the LLC control panel provides an independent circuit breaker for direct connection to a 110-120VAC water solenoid valve. This added feature allows customer installation without having to provide an additional power circuit to energize the solenoid. The solenoid is connected to terminals 2A and 4A as represented on the control's specific wiring diagram.

Purpose and Function of the HAND-OFF-AUTO Switch



Located on the right side of the control's enclosure is a HAND-OFF-AUTO switch. This switch is used primarily at cooling tower startup and in maintenance procedures where the tower basin is empty or has been drained. When the tower's basin needs to be manually filled, the switch is placed in the HAND position. This selection bypasses the probe assembly's feedback and directly energizes the solenoid valve connected to the water supply. Once the cooling tower basin is filled, the switch is placed in the AUTO position to allow the adjusted probe assembly to monitor and sustain the proper operating level. Placing the switch in the OFF position completely interrupts any monitoring or fill action normally provided by the LLC control panel. Normal tower operation depends upon the HAND-OFF-AUTO switch being positioned in the AUTO mode at all times.



Inside view of an LLC Control Panel with Makeup, High Alarm, and Low Alarm.

Internal Components of the LLC Control Panel

LLC control panels are built to UL and CUL standards and are designed to provide the numerous configurations needed for cooling tower applications. All LLC control panels include a main circuit breaker with an additional circuit breaker and a HAND-OFF-AUTO switch provided when the system includes a water makeup circuit. The additional circuit breaker provides an exclusive control circuit for a 120VAC water solenoid valve. High and low circuit relay cards and the appropriate terminal connections comprise the rest of the components necessary for the specific configuration. The raised terminal strip provides easier access to make the necessary connections of the water probe assembly and customer interface.



Stainless Steel Electrode Probe Assembly

The electrode probe tips are stainless steel suspended from a noncorrosive PVC enclosure box with 30 feet of wire for each probe. A galvanized or stainless steel stilling chamber is installed over the probes to calm the water for accurate readings.

Illustrations Describing Operation Sequence

The next three pages are simplified illustrations representing the sequence of operation for each type of circuit card:

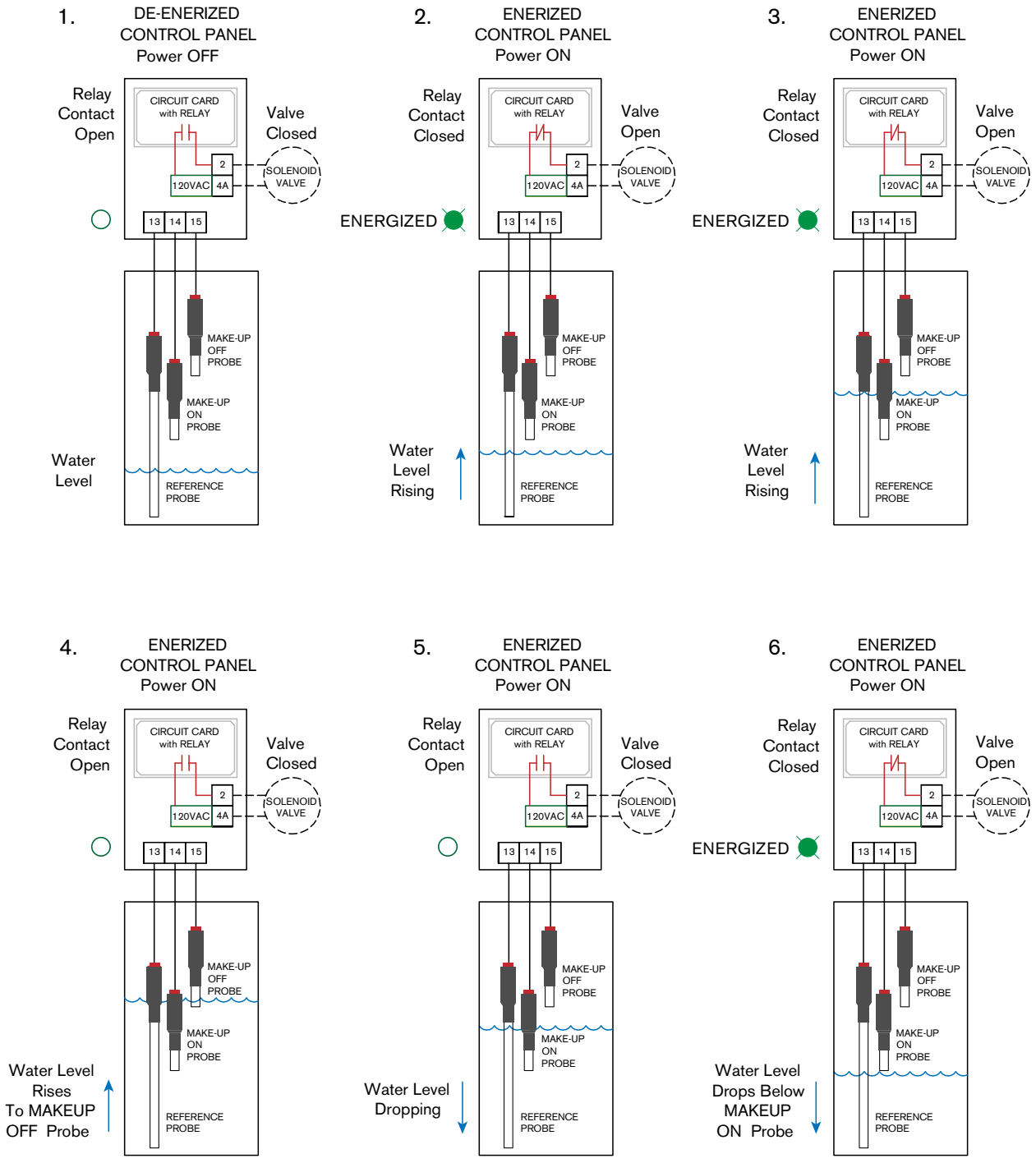
- Page 10 – Makeup
- Page 11 – High Alarm – High Cutoff
- Page 12 – Low Alarm – Low Cutoff



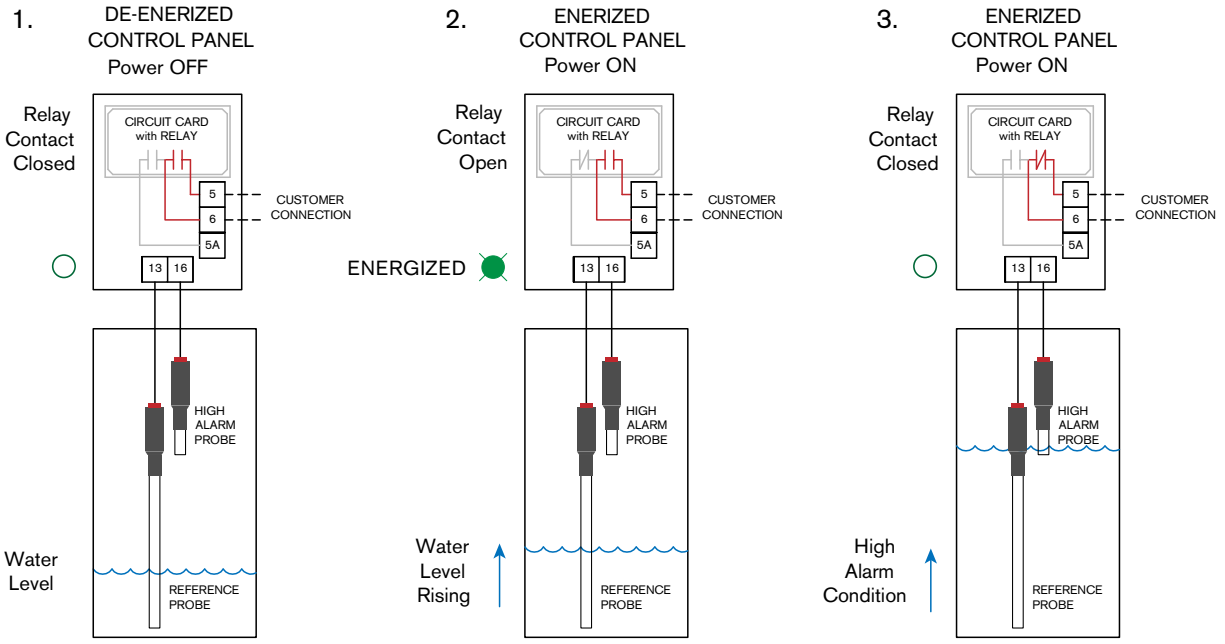
Each relay circuit card has two green indicator lights. The ON light indicates the card is powered and ready to function. The ENERGIZED light indicates when the probe system is functioning and should be used when troubleshooting.

Water Makeup Control – Sequence of Operation – B Card

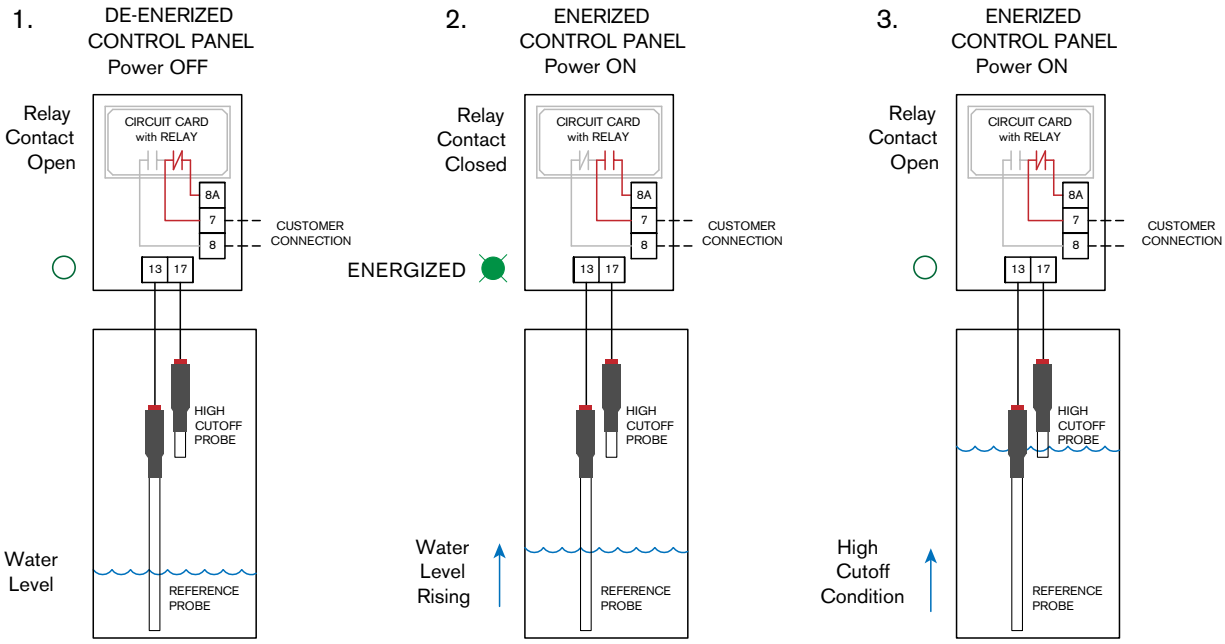
Selector Switch in AUTO Position



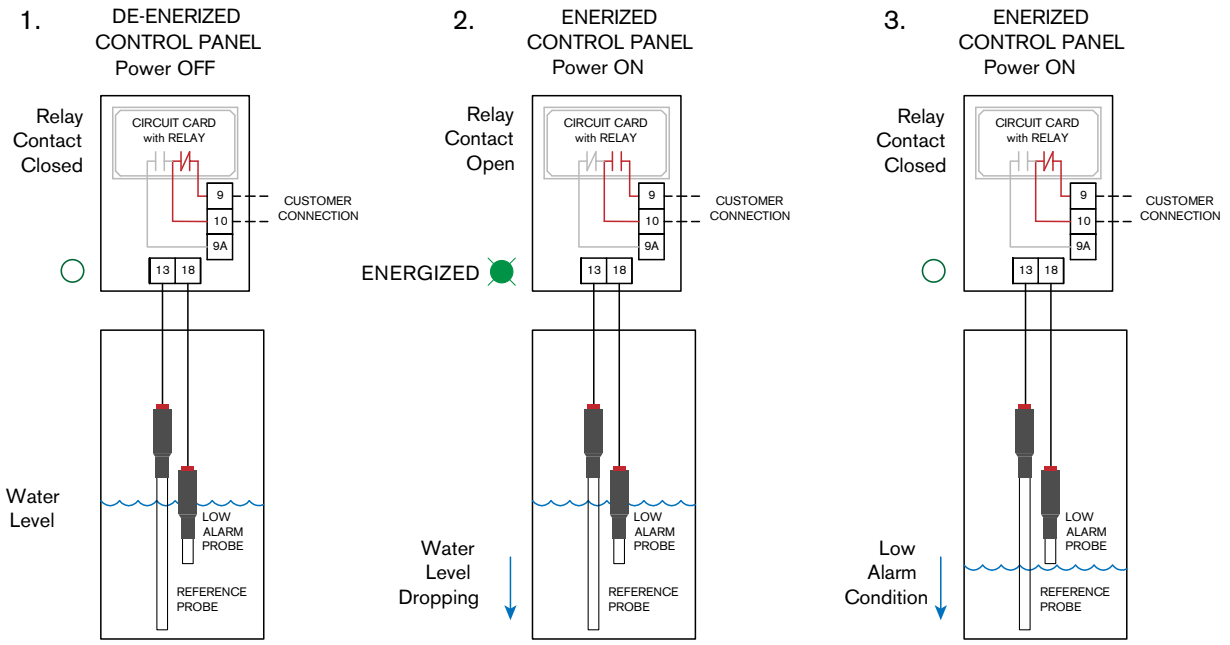
High Level Alarm – Sequence of Operation – B Card



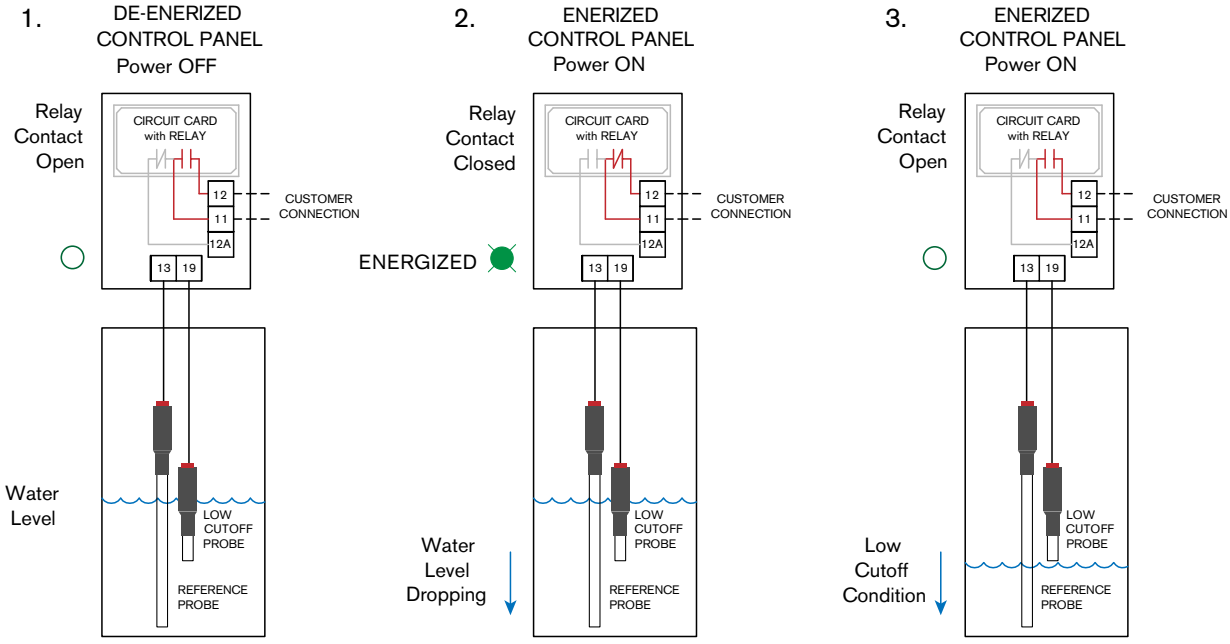
High Level Cutoff – Sequence of Operation – B Card



Low Level Alarm – Sequence of Operation – A Card



Low Level Cutoff – Sequence of Operation – A Card



troubleshooting

The control panel has been tested before shipment and most issues lie outside of the control panel e.g. proper probe connections to the control panel and probe tip level heights in the basin of the cooling tower.

In an effort to troubleshoot the system please check the following:

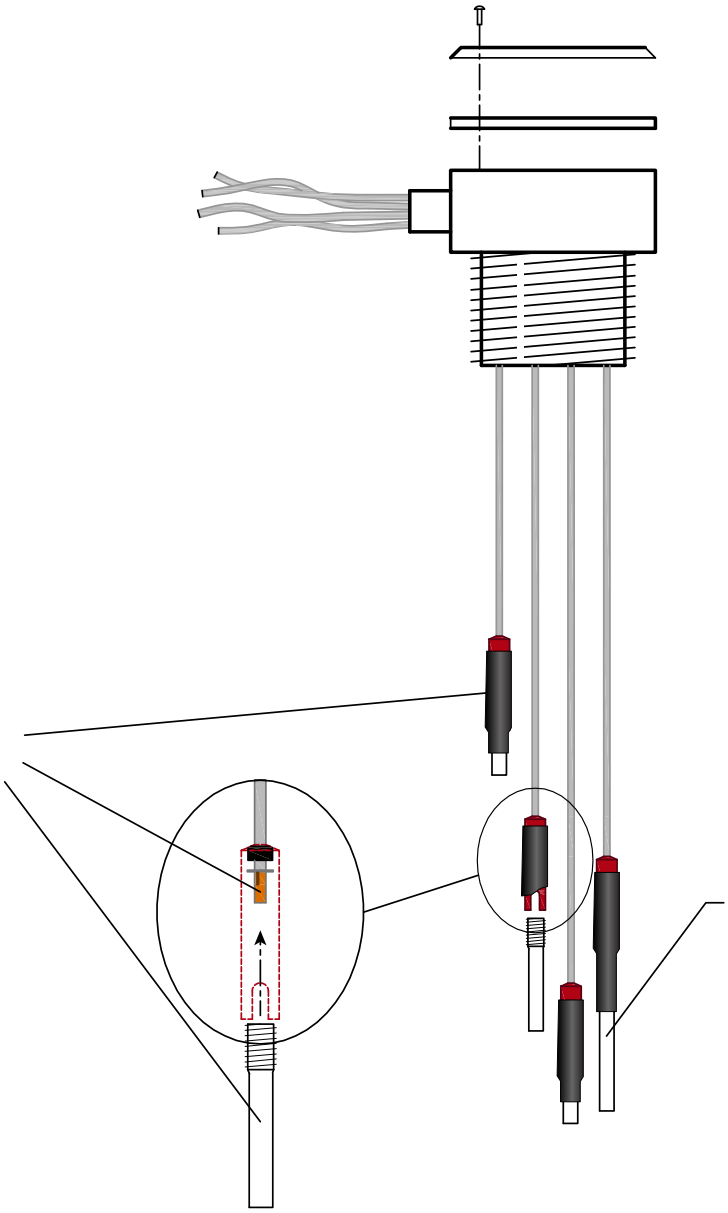
- Check probe heights in the stilling chamber. The levels may be factory set but if in question contact your Marley sales representative for level height information. Probe wire height is secured using an adjustable cord grip located inside the conduit box located on top of the stilling chamber.
- Check if probe wires are connected correctly at the user terminal strip located inside the control panel. Each probe wire is printed with an identifying number on the black insulation of the wire every few inches. For example the reference probe is always #13 and needs to be connected to terminal point #13 in the control panel.
- If probe wires are extended in the field, check to make sure the extension wire is numbered correctly and connections are secure.
- After time, contaminates may build up on the probe tips. Clean tips with an abrasive cleaning pad and make sure the tips are screwed in making a good connection.
- If provided, the make-up selector switch on side of the control panel must be in AUTO position

Checking the power circuit for the makeup solenoid

- Rotate the selector switch to the HAND position. The solenoid should energize allowing makeup water to flow into the cooling loop. Inside the control panel is a single-pole circuit breaker which must be in the ON position to power the circuit.

Checking control panel functionality

- To determine the control panel works as designed check the green LED lights on each circuit card and watch the relays change state in the clear cased relays located on each level card. Refer to the charts on pages 10 through 12 for LED light sequence of operation.
- Another method is to remove probe wiring from the terminal strip and simulate water level by using jumper wires at the probe terminal points. For example a jumper wire from #13 to #16 would indicate high-water alarm.



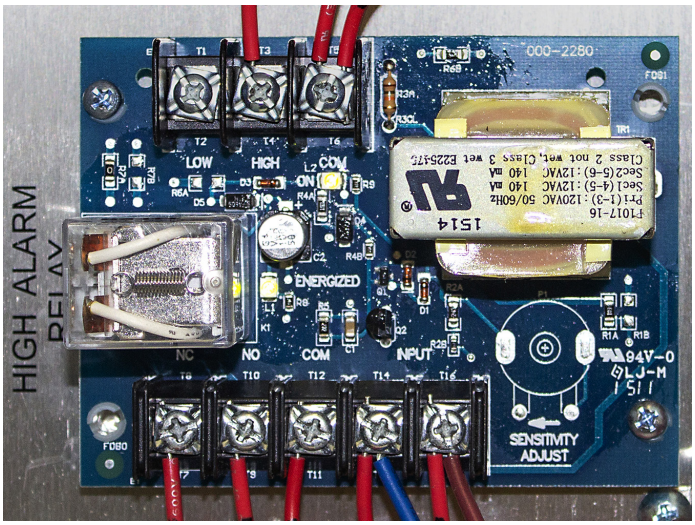
Threaded Probe Tip Standard
Part Number 2580240
Includes red cap and small hat-shaped copper crimp-on connector

Probe,
Reference/GND
"Tip Only"
Part Number D20718

Electrode Probe Assembly

Additional part numbers can be found on the next page

parts list



Relay Circuit Card

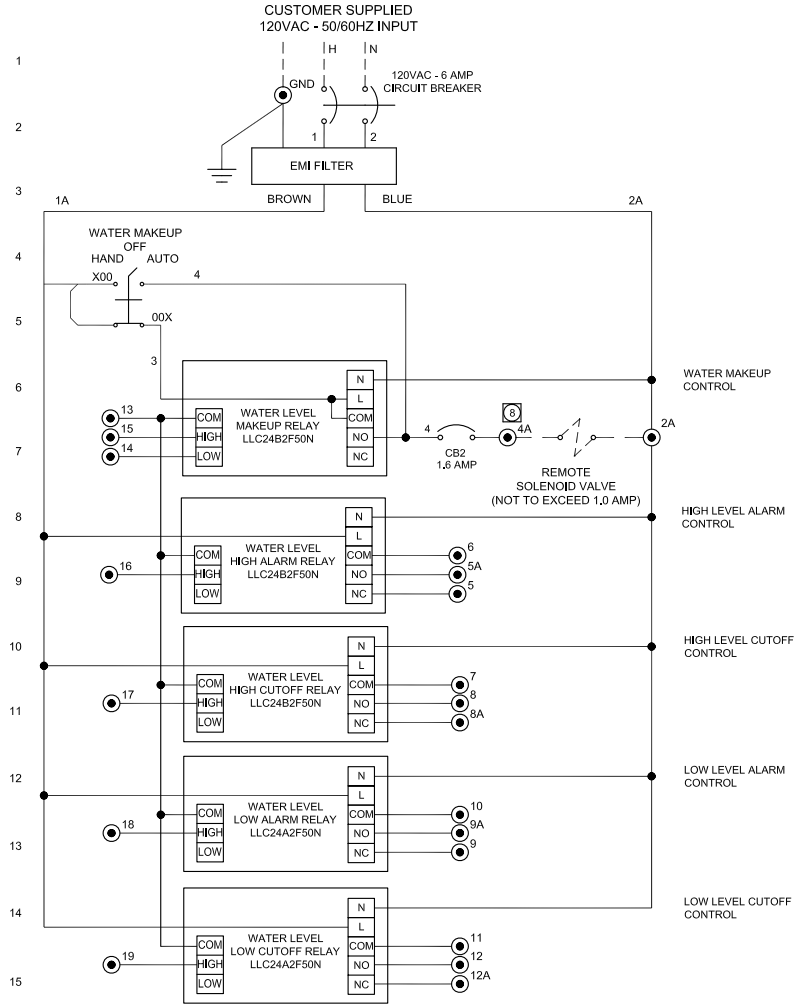
Part Number **D55194** – Used for Makeup, High Alarm and High Cutoff (LLC24B2F50N)

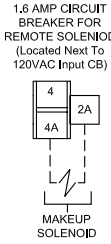
Part Number **D55195** – Used for Low Alarm and Low Cutoff (LLC24A2F50N)

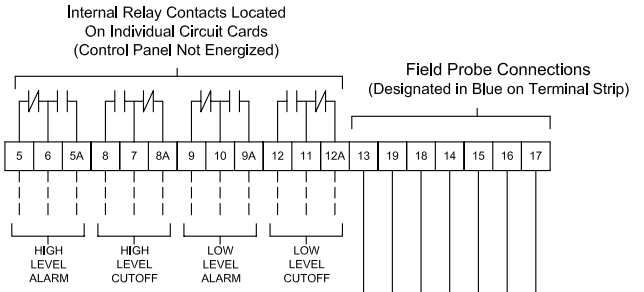
Part Number	Description
2038884	H-O-A Switch
D55194	Makeup Relay Card
D55194	High Alarm Relay Card
D55194	High Cutoff Relay Card
D55195	Low Alarm Relay Card
D55195	Low Cutoff Relay Card
C74516	Standard Probe Sensor (Complete with tip and 30 ft wire)
D20711	Standard Probe Sensor (Complete with tip and 30 ft wire)
D20707	Reference / GND Probe Sensor (Complete with tip and 20 ft wire)
D20712	Reference / GND Probe Sensor (Complete with tip and 50 ft wire)
2580240	Standard Probe Sensor 3.5" Stainless Steel Tip
D20718	Reference / GND Probe Sensor 6" Stainless Steel Tip
203887	Terminal Blocks Kit (2 Gray, 2 Blue and 1 End)
D81756	EMI Filter
D20707	Reference Marked #13
2220852	Makeup On Marked #14
2220854	Makeup Off Marked #15
2220855	High Alarm Marked #16
2220856	High Cutoff Marked #17
2220857	Low Alarm Marked #18
2220859	Low Cutoff Marked #19
C74516	Generic Level No Wire #

wiring diagrams – contents

Drawing Number	Description	Page
08-24248	Makeup High Alarm High Cutoff Low Alarm Low Cutoff	17
08-24233	Makeup High Alarm Low Alarm	18
08-24218	Makeup	19
08-24219	High Alarm	20
08-24220	Low Alarm	21
08-24221	High Cutoff	22
08-24222	Low Cutoff	23
08-24230	High Cutoff Low Alarm	24
08-24231	Low Cutoff Low Alarm	25
08-24232	High Cutoff Low Cutoff	26
08-24228	High Cutoff High Alarm	27
08-24229	Low Cutoff High Alarm	28
08-24225	Makeup High Cutoff	29
08-24224	Makeup Low Alarm	30
08-24223	Makeup High Alarm	31
08-24234	Makeup High Alarm High Cutoff	32
08-24235	Makeup High Alarm Low Cutoff	33
08-24236	Makeup High Cutoff Low Alarm	34
08-24237	Makeup Low Alarm Low Cutoff	35
08-24238	Makeup High Cutoff Low Cutoff	36
08-24239	High Alarm High Cutoff Low Alarm	37
08-24240	High Alarm Low Alarm Low Cutoff	38
08-24241	High Alarm High Cutoff Low Cutoff	39
08-24242	High Cutoff Low Alarm Low Cutoff	40
08-24243	Makeup High Alarm High Cutoff Low Alarm	41
08-24244	Makeup High Alarm Low Alarm Low Cutoff	42
08-24245	Makeup High Alarm High Cutoff Low Cutoff	43
08-24246	Makeup High Cutoff Low Alarm Low Cutoff	44
08-24247	High Alarm High Cutoff Low Alarm Low Cutoff	45







OPERATION STATUS (Panel Energized)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH	6 & 5	X	
	ALARM	6 & 5A		X
	HIGH	7 & 8		X
	CUTOFF	7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW	10 & 9	X	
	ALARM	10 & 9A		X
	LOW	11 & 12		X
	CUTOFF	11 & 12A	X	

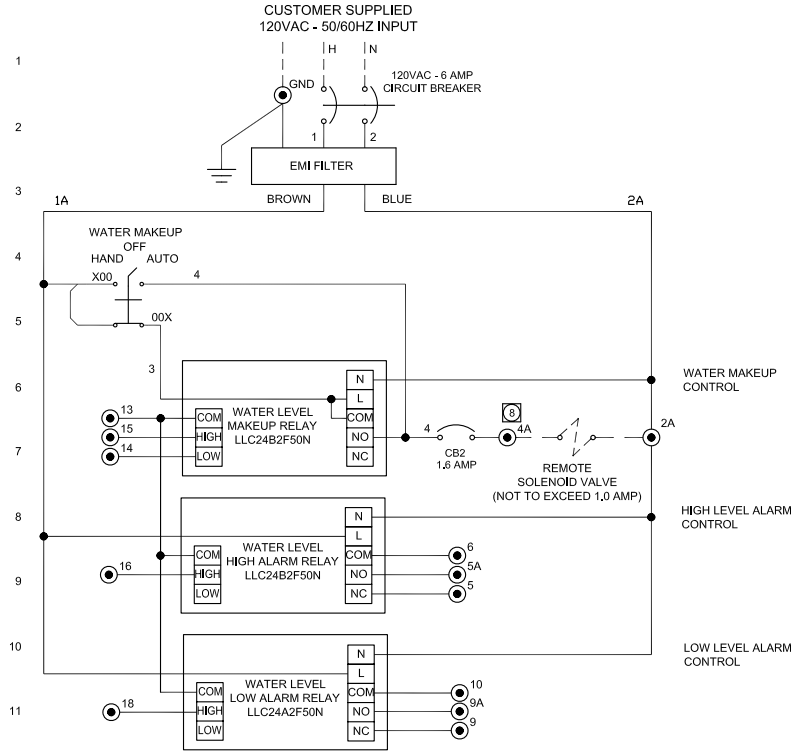
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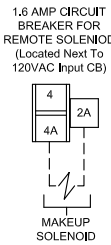
1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

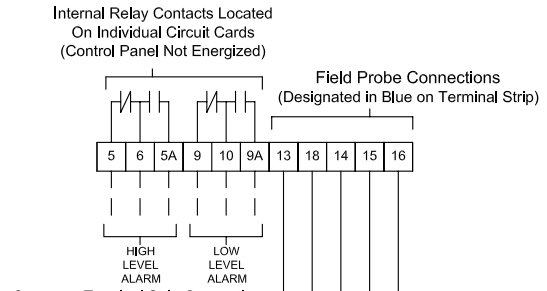
MARLEY ITEM #:	E80330
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

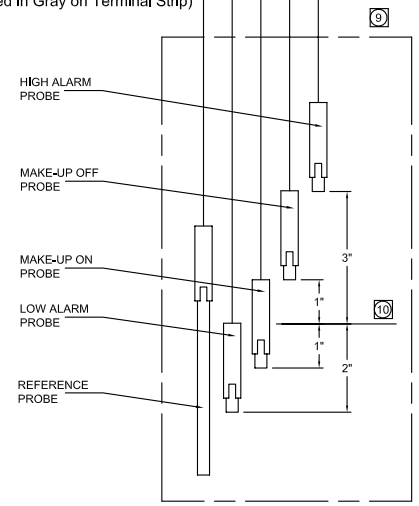
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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + LA + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/18/2008				1=5.2	08–24248	









OPERATION STATUS (Panel Energized)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

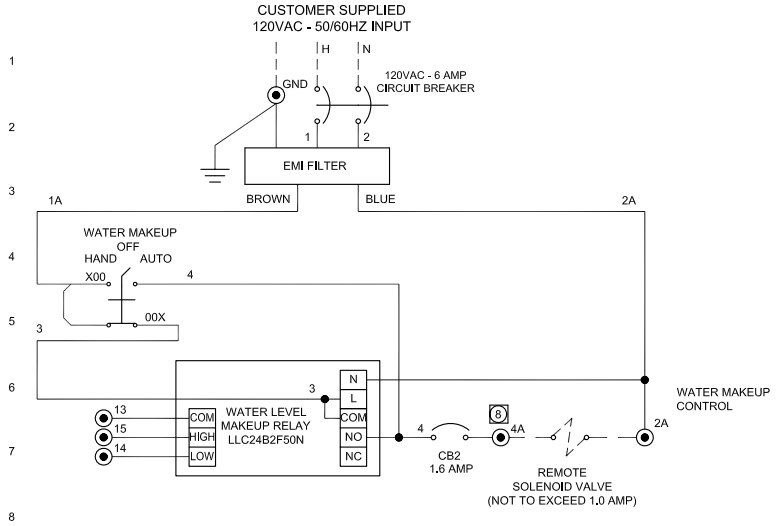
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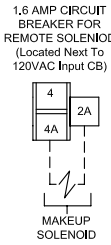
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

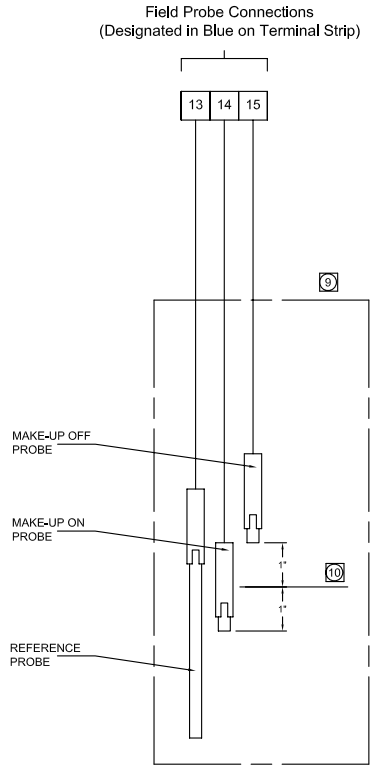
MARLEY ITEM #: E80315
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + LA							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/3/2008				1=5.2	08–24233	







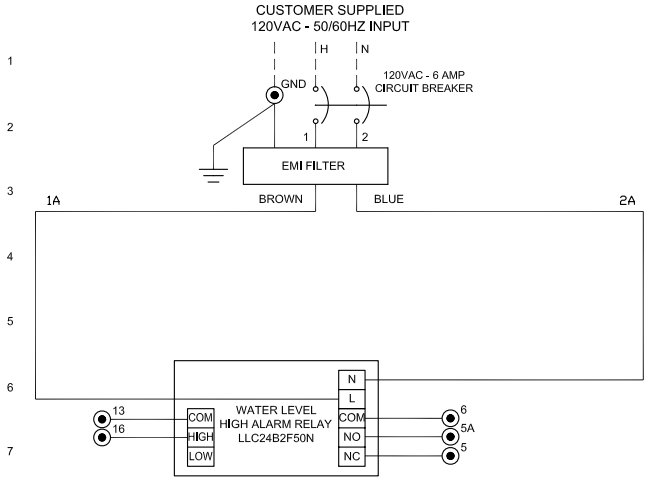
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

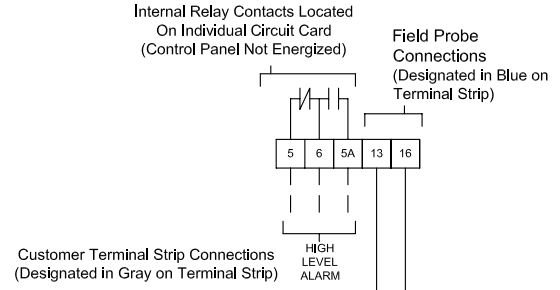
MARLEY ITEM #:	E80300
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24218	



HIGH LEVEL ALARM CONTROL



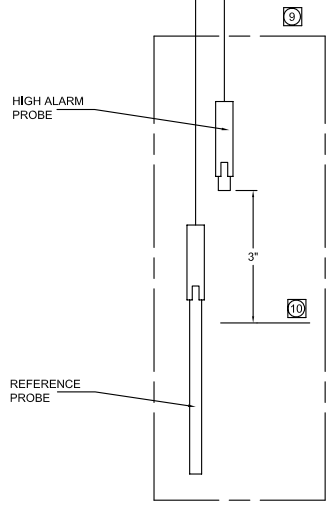


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X

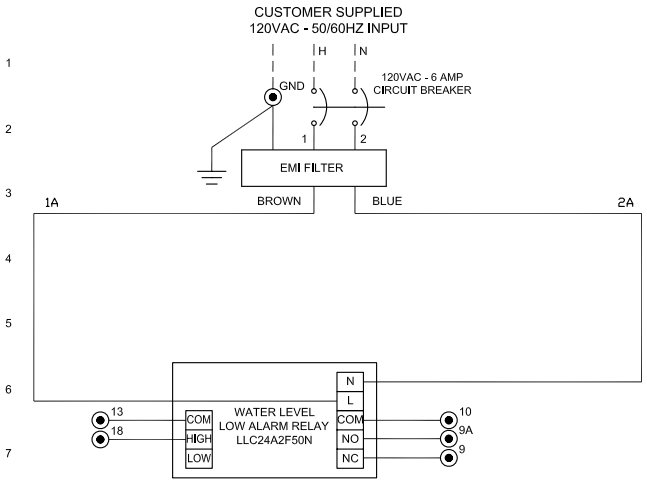
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80301
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	HIGH LEVEL ALARM							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24219	



LOW LEVEL ALARM CONTROL

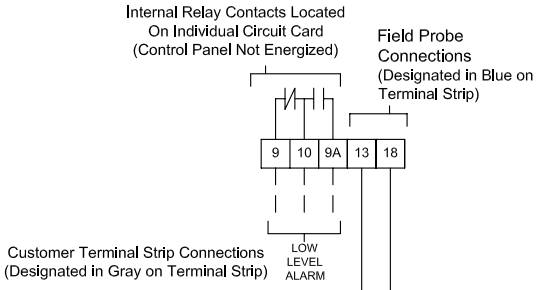
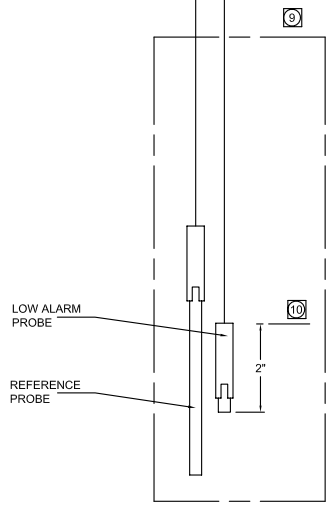


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X



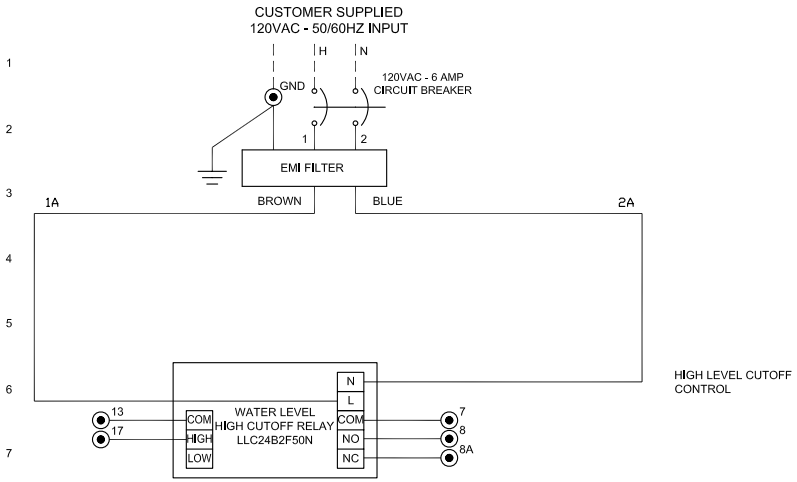
Notes:

1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80302
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	LOW LEVEL ALARM							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24220	



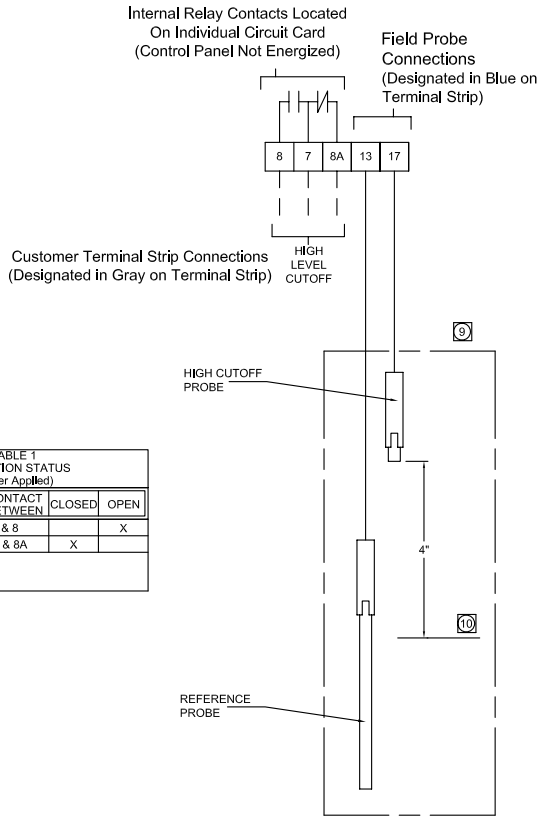


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	

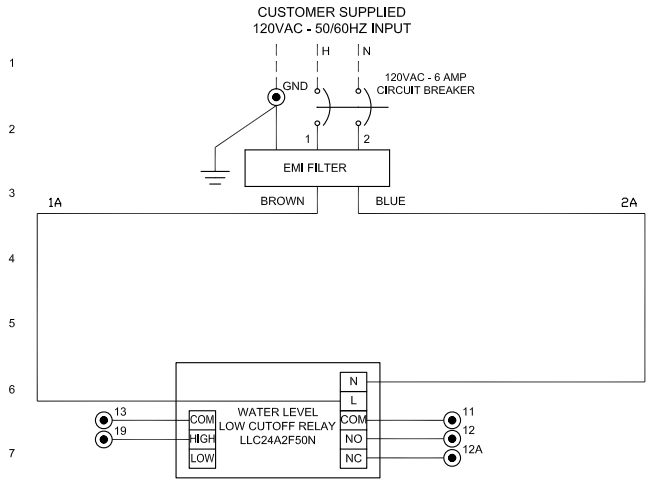
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the Installation.
8. Relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

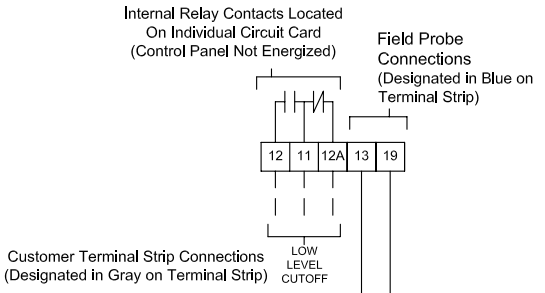
MARLEY ITEM #: E80303
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	HIGH LEVEL CUTOFF							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/28/2008				1=5.2	08-24221	



LOW LEVEL CUTOFF
CONTROL



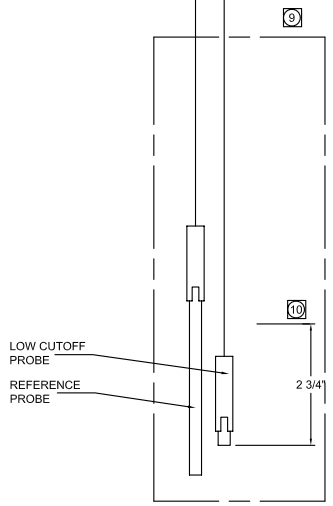


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

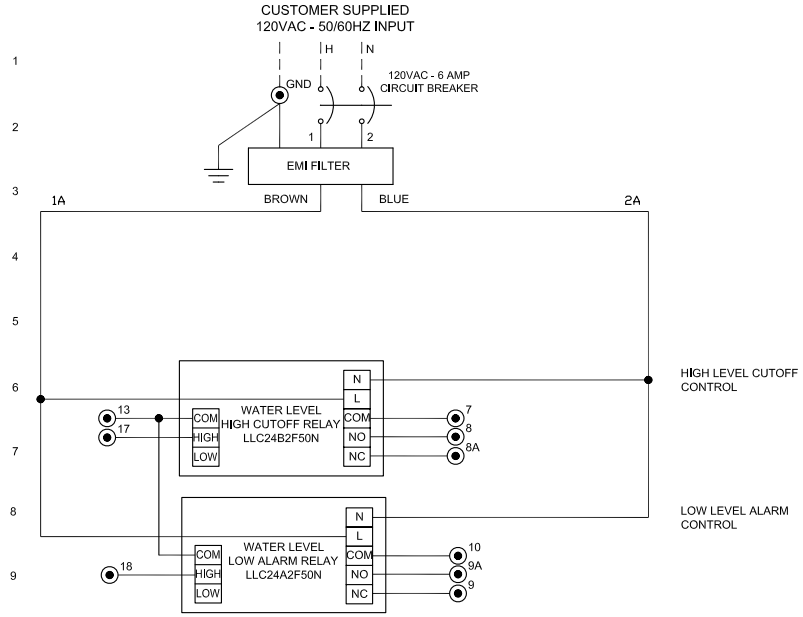
Notes:

1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80304
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	LOW LEVEL CUTOFF							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	08/25/2008				1=5.2	08–24222	



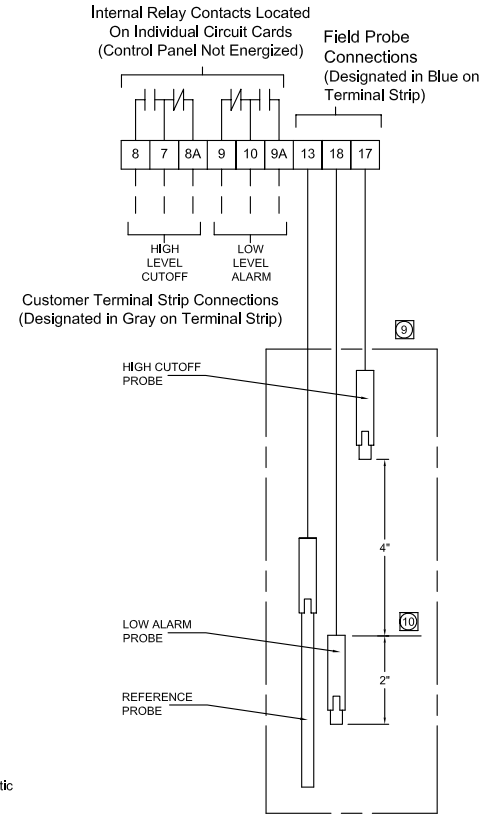


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

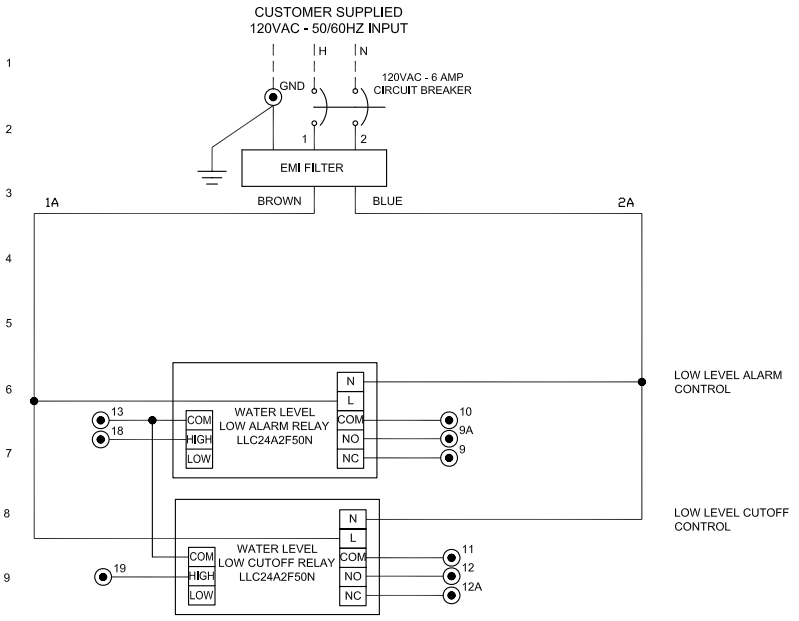
Notes:

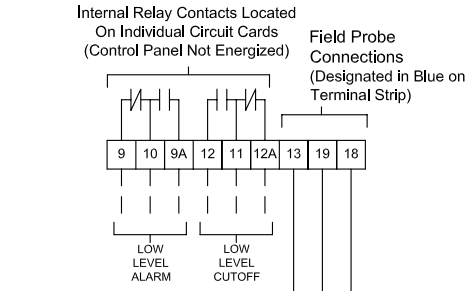
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80312
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS LA + HCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24230	





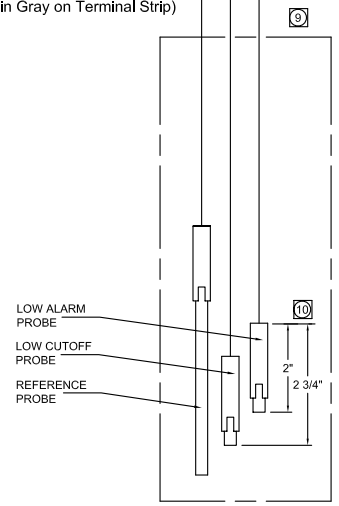


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

Notes:

1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80313
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS LA + LCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–242231	

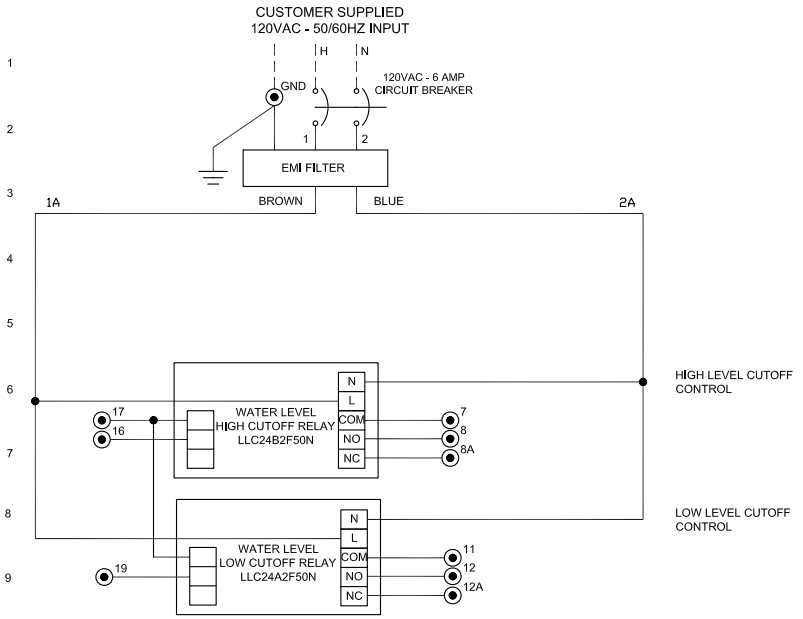
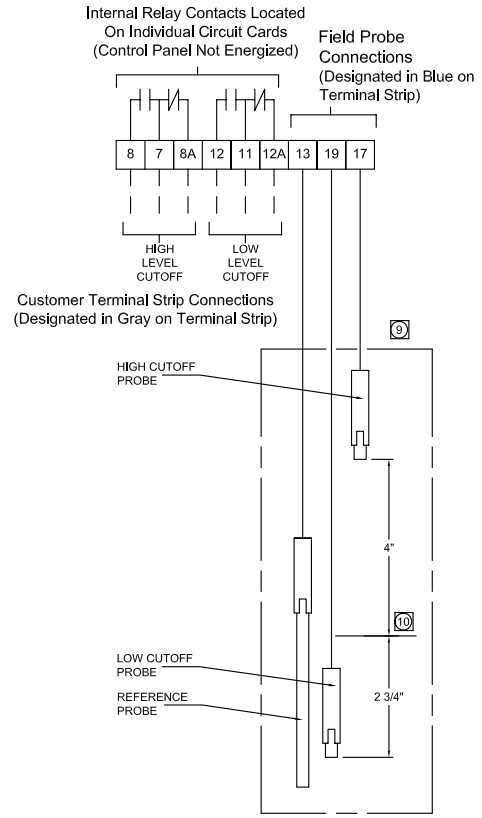


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

Notes:

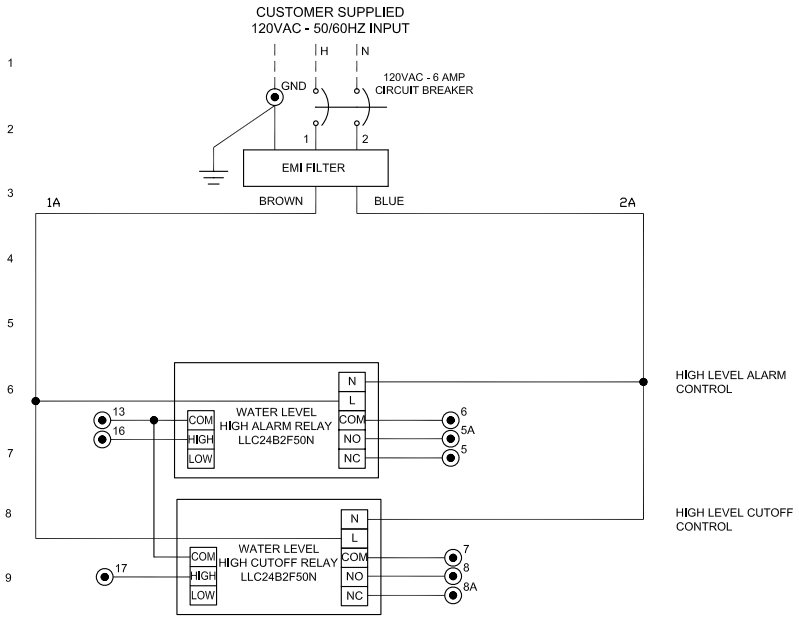
(1) ◉ Terminal point number on terminal block.
(2) — — — — Field wiring by others.
(3) Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
(4) Relay card output contacts rated 10 amps.
(5) 18 AWG used for control circuit wiring.
(6) Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
(7) Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
(8) Relay cards provide dry contacts only.
[9] Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
[10] Recommended operating water level as marked in the tower's COLD WATER BASIN.



MARLEY ITEM #:	E80314
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS HCO + LCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24232	



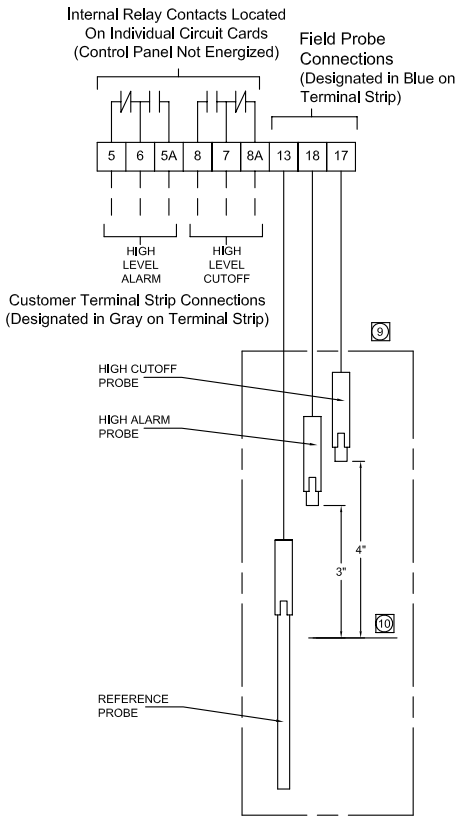


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	

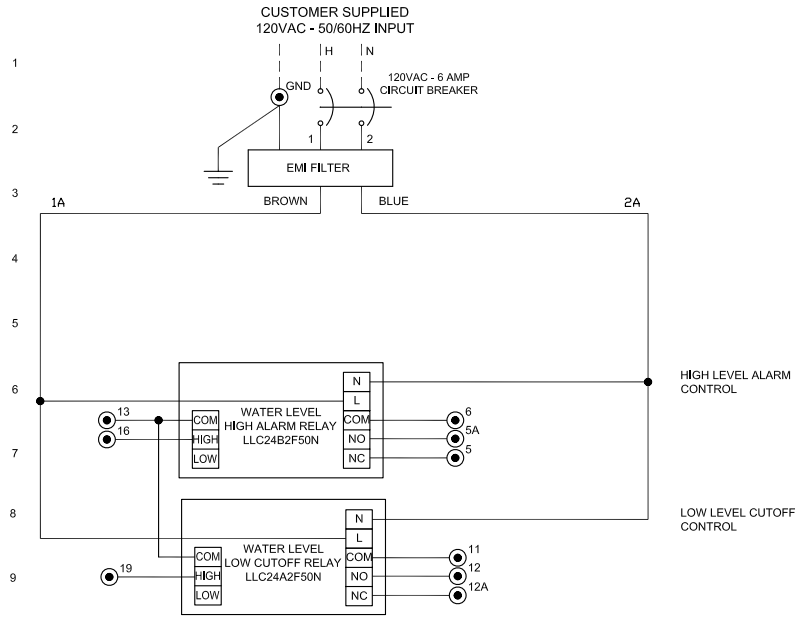
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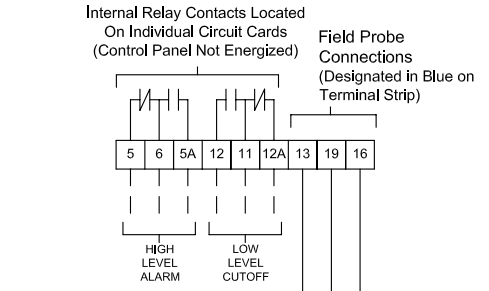
1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80310
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS HA + HCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	08/11/2008				1=5.2	08–24228	





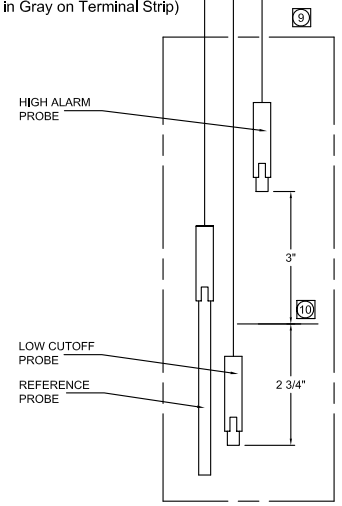


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

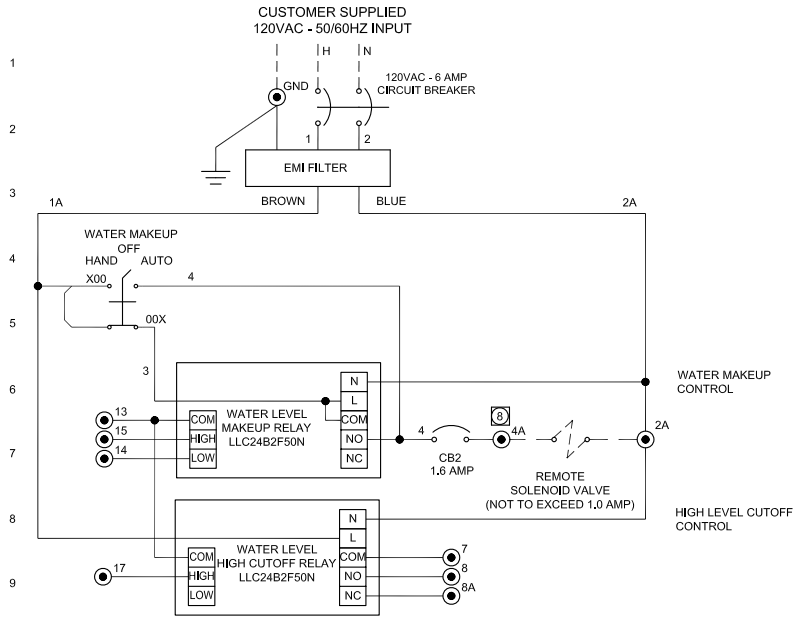
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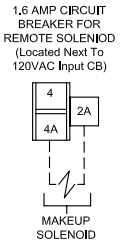
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80311
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		WATER LEVEL CONTROL SYSTEM				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	HA + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24229	





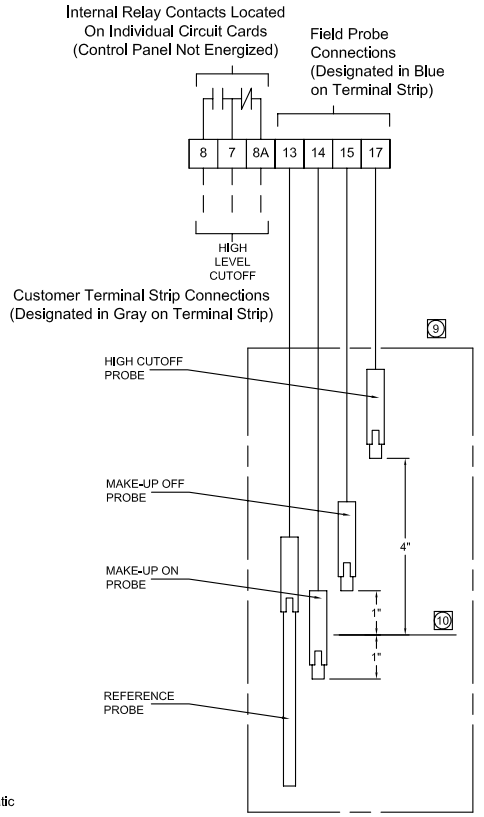


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH	7 & 8		X
	CUTOFF	7 & 8A	X	

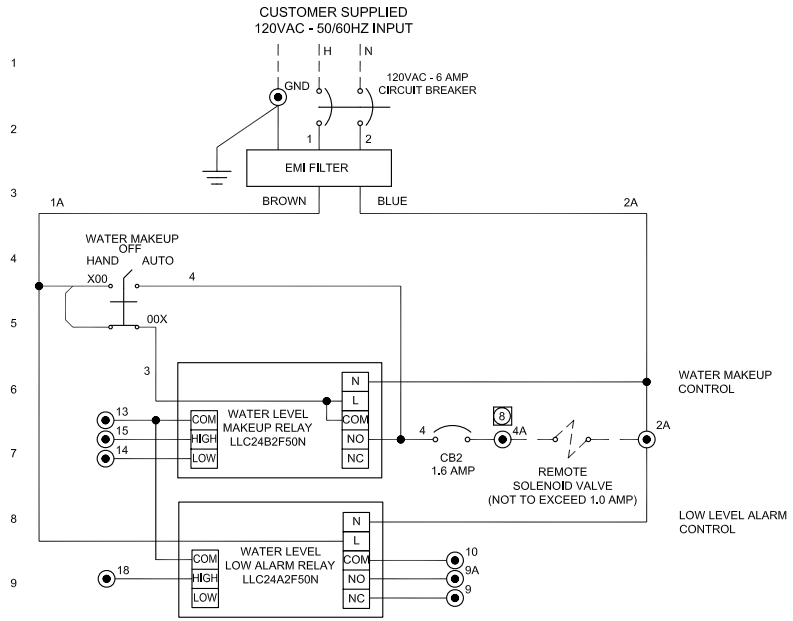
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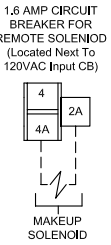
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. The other relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80307
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24225	





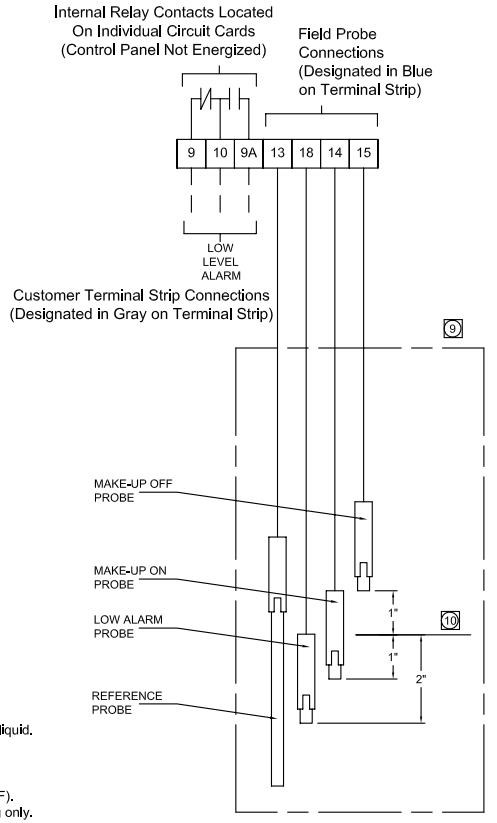


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

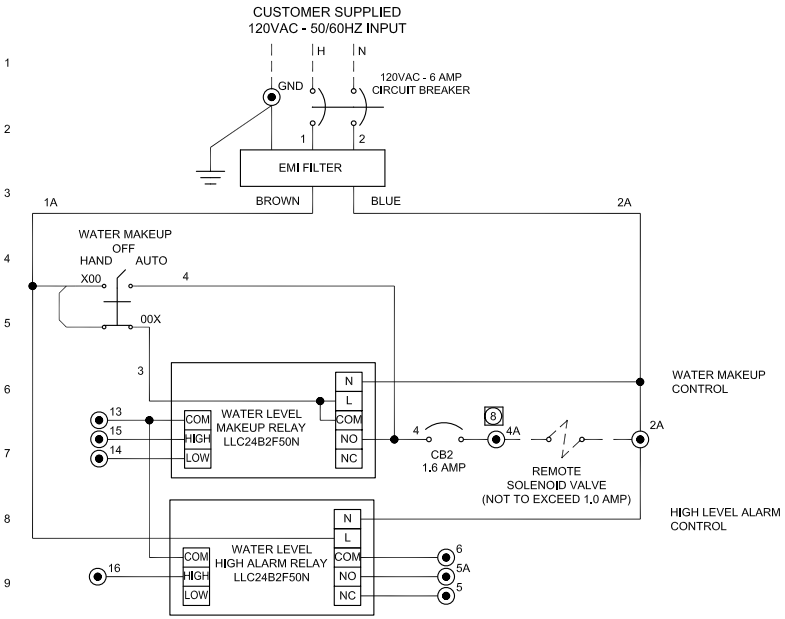
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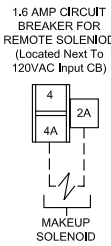
1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. The other relay card provides dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80306
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + LA							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24224	





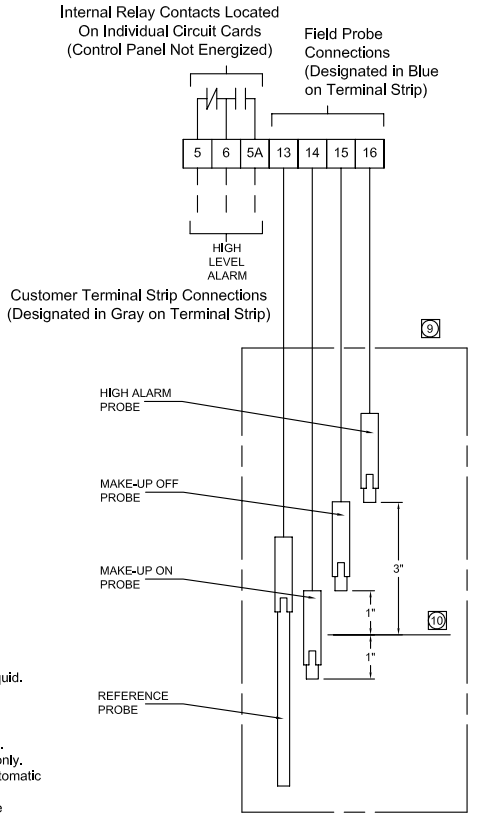


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X

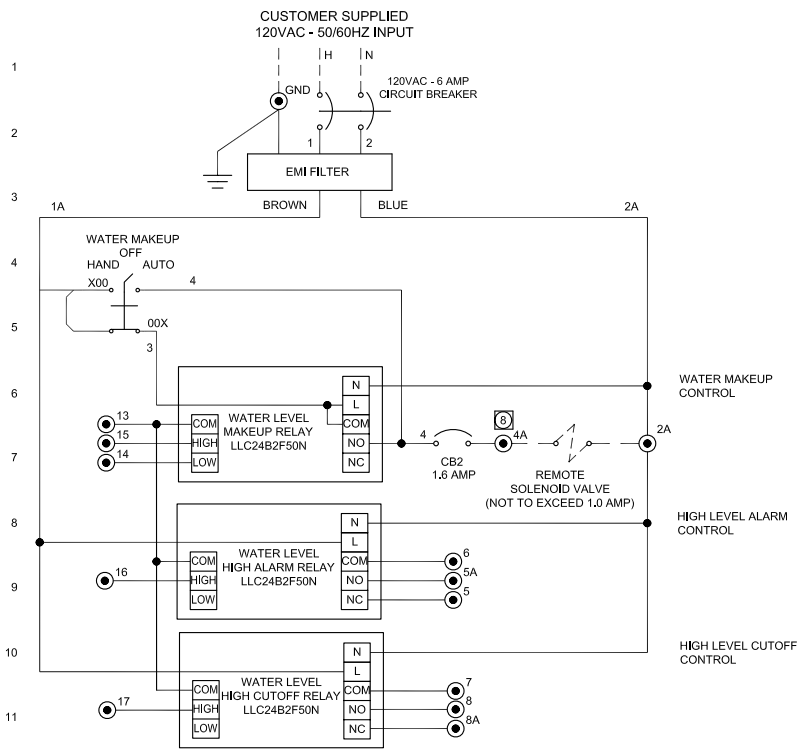
Notes:

(1) ◉ Terminal point number on terminal block.
(2) —— —— Field wiring by others.
(3) Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
(4) Relay card output contacts rated 10 amps.
(5) 18 AWG used for control circuit wiring.
(6) Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
(7) Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
[8] Makeup relay supplies 120VAC for solenoid valve. The other relay card provides dry contacts only.
[9] Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
[10] Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80305
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24223	



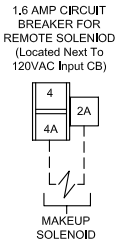
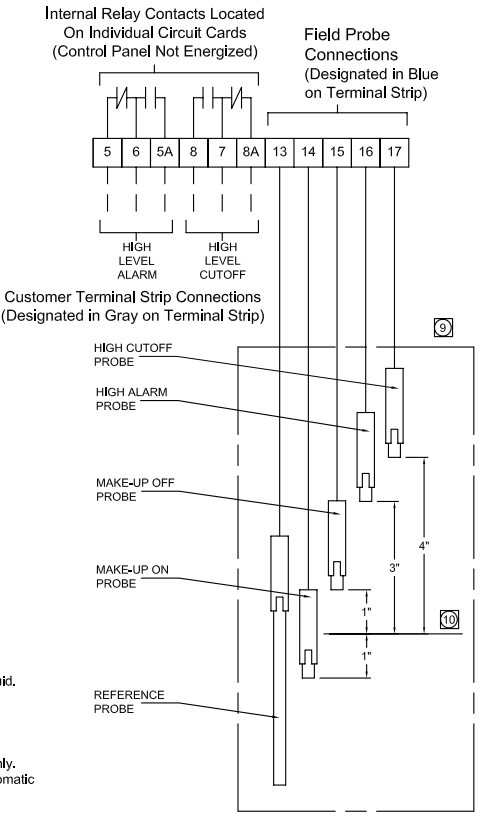


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	



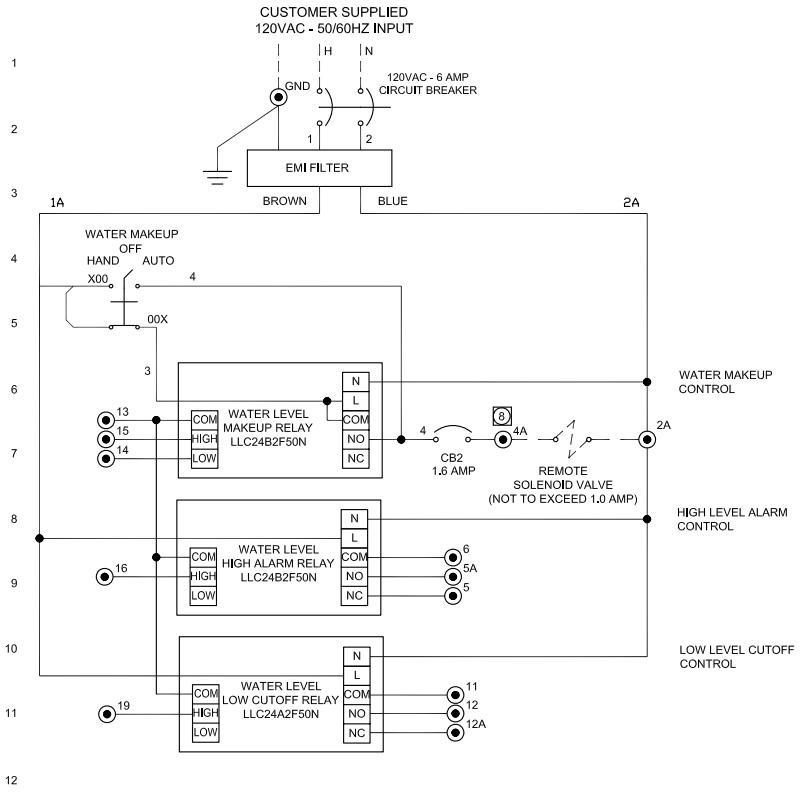
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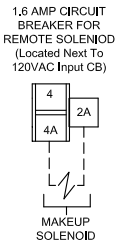
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80316
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX. COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + HCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24234	





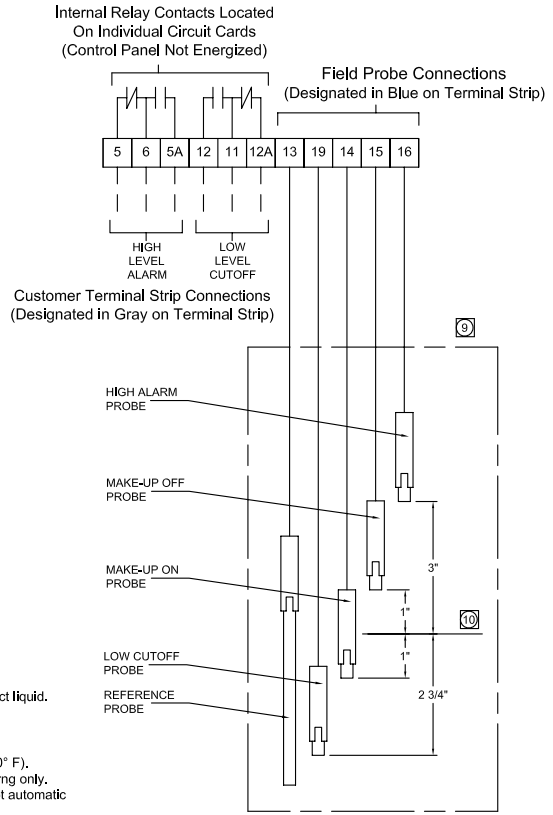


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

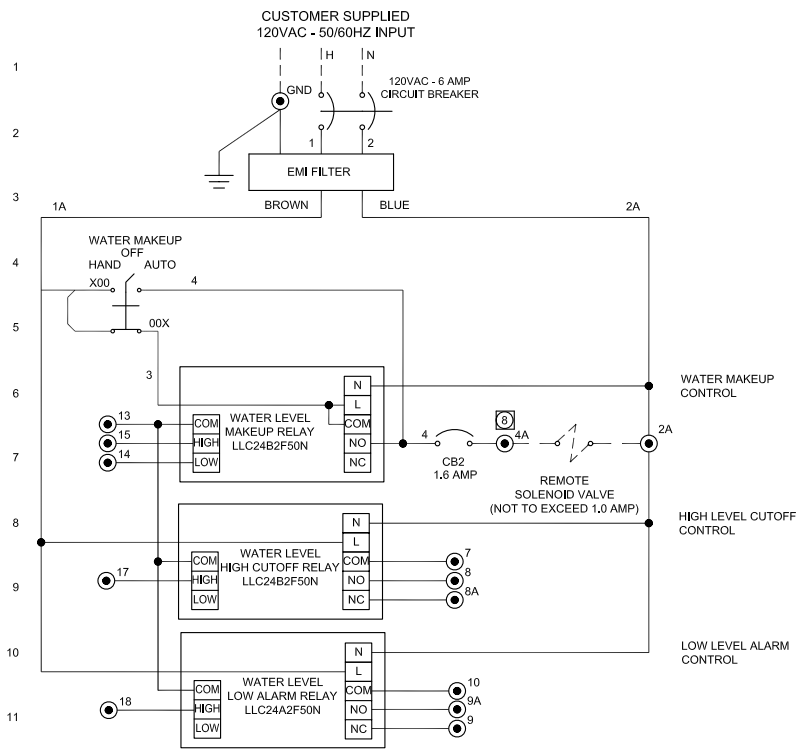
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80317
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX. COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24235	



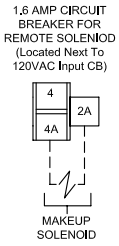
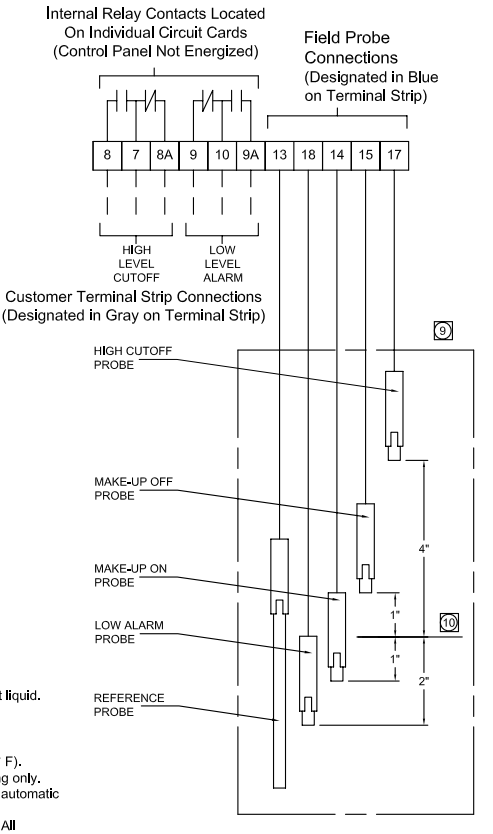


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

Notes:

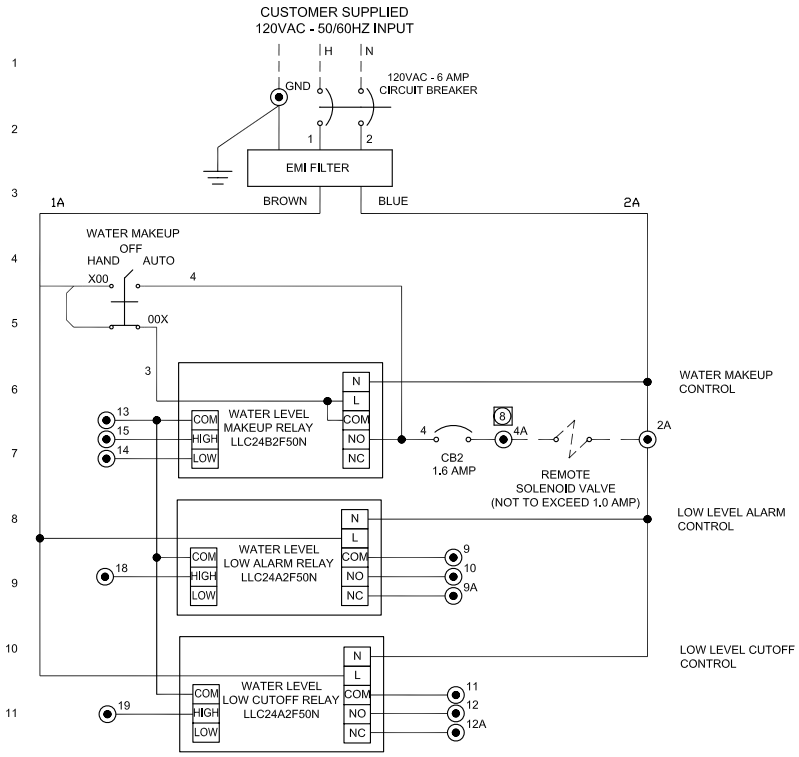
1. Terminal point number on terminal block.
2. Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.In. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

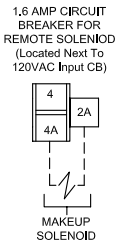


MARLEY ITEM #: E80318
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP LA + HCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24236	





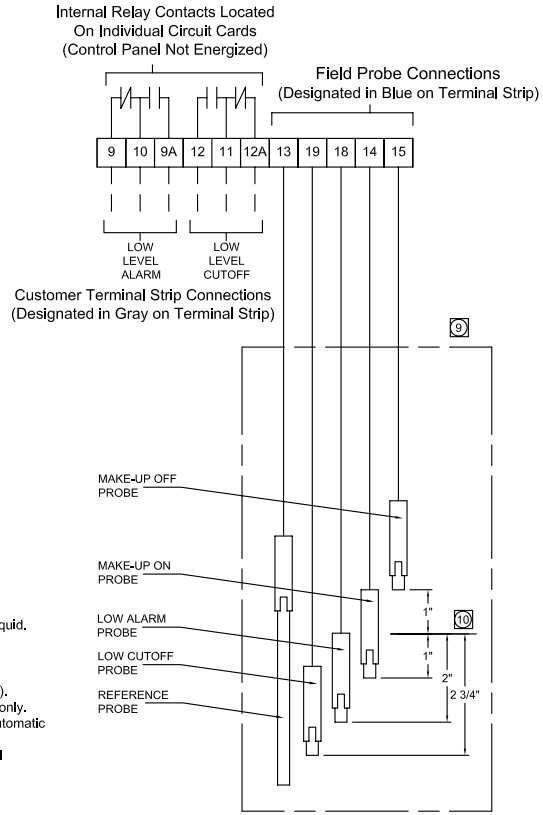


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

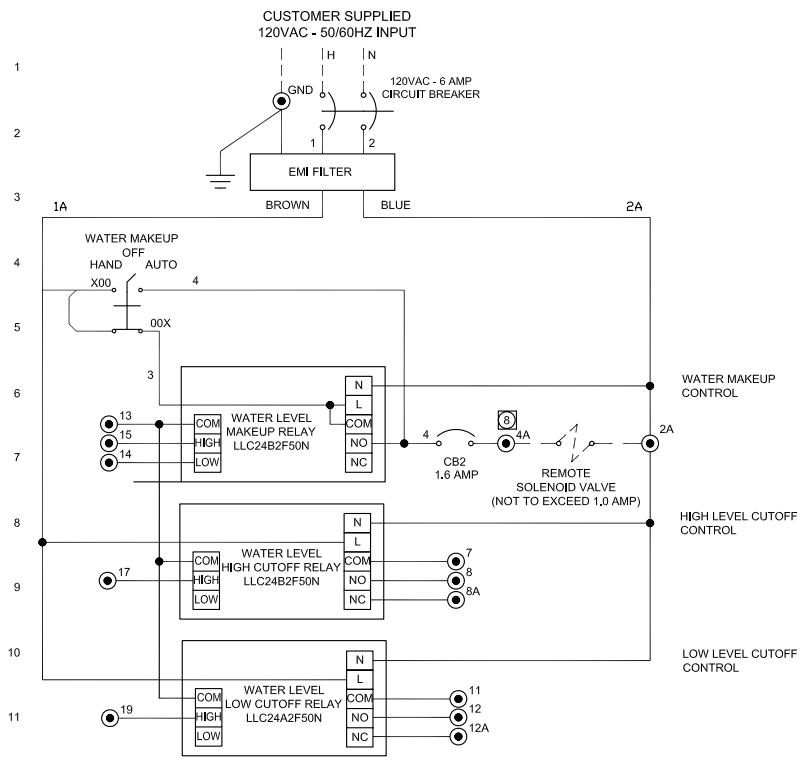
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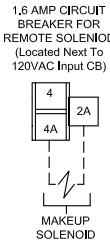
1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wiring only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80319
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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REV. BY	CHECKED	MAKE–UP + LA + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24237	





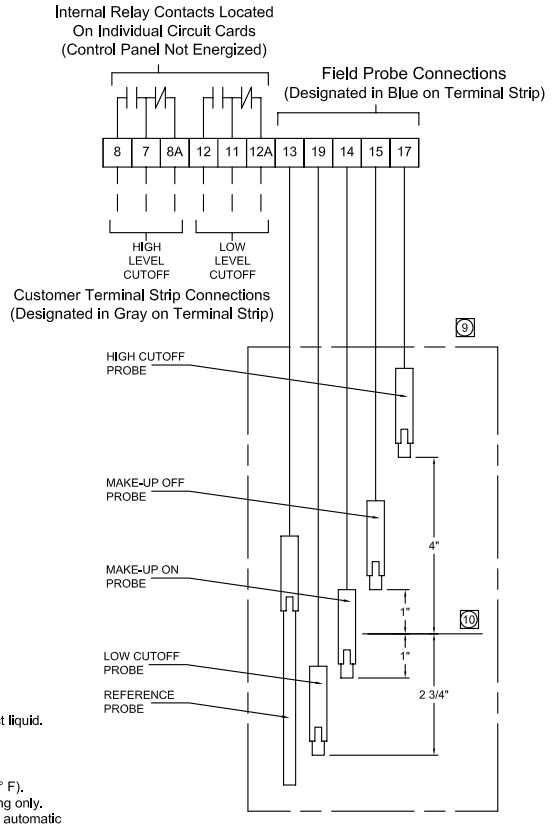


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

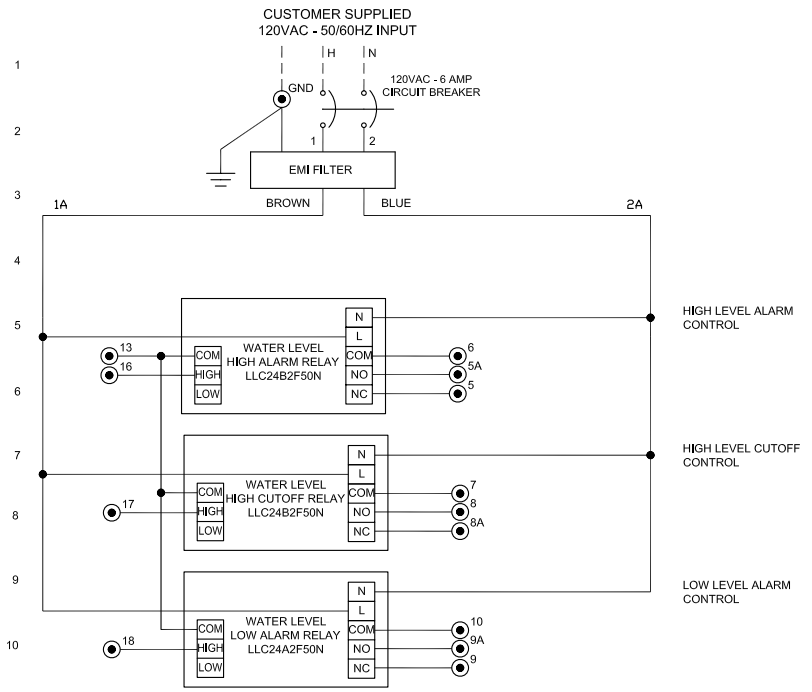
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80320
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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REV. BY	CHECKED	MAKE–UP + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24238	



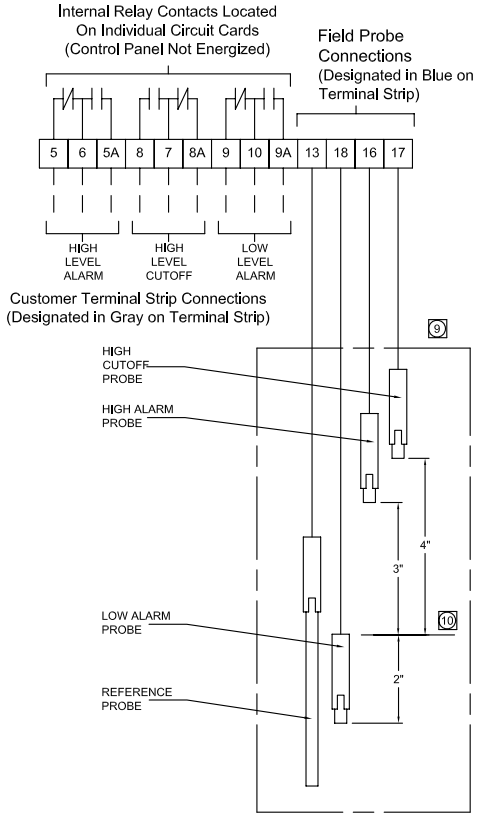


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

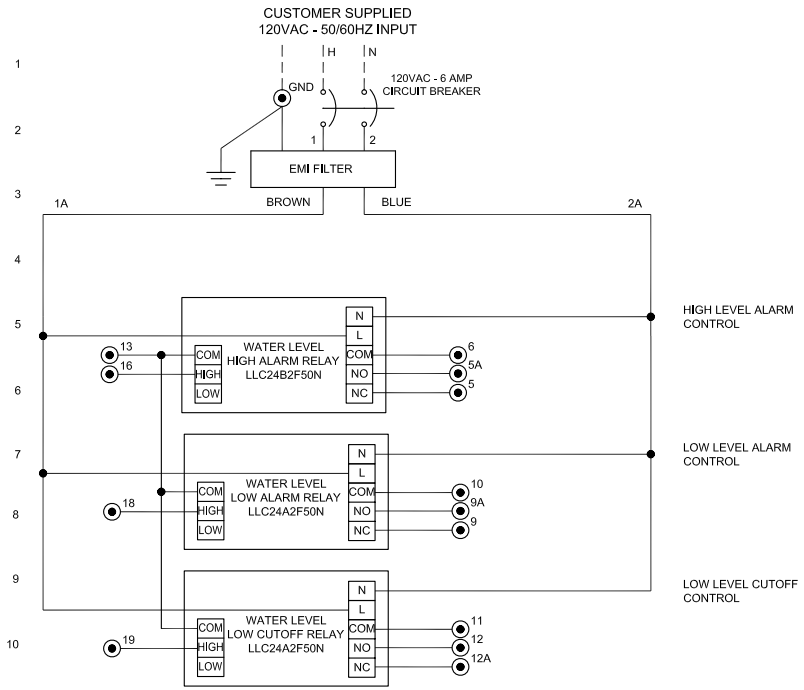
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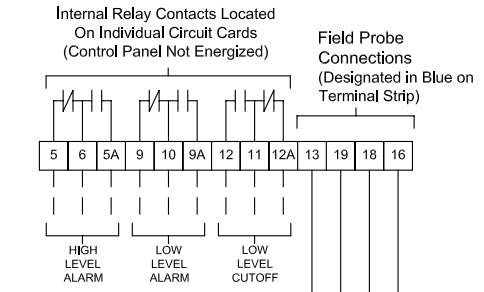
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80321
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	HA + LA + HCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08-24239	





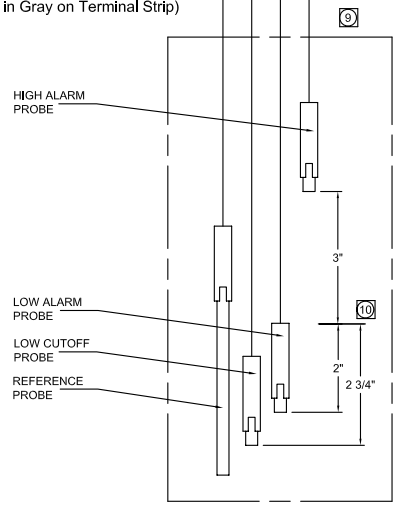


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

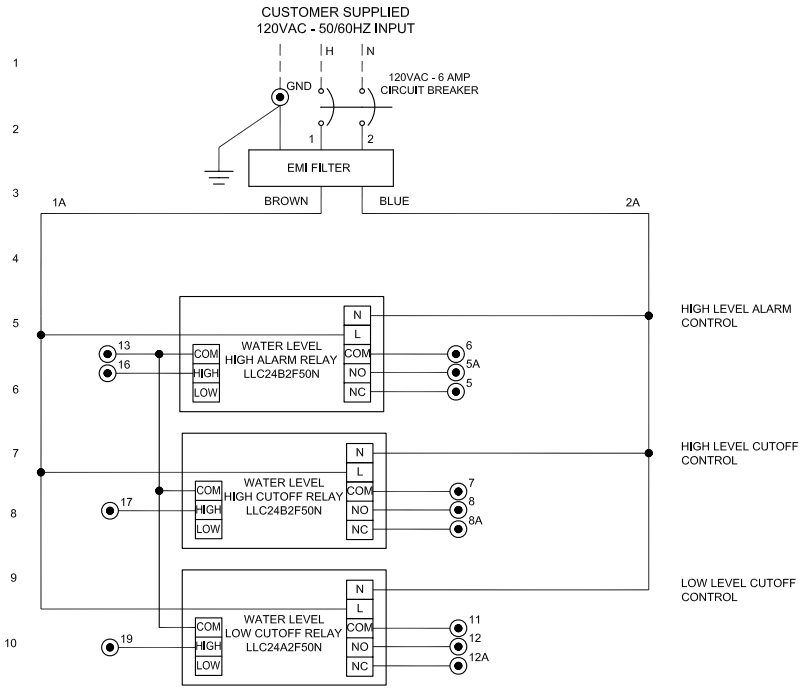
Notes:

(1) ◉ Terminal point number on terminal block.
(2) —— —— Field wiring by others.
(3) Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
(4) Relay card output contacts rated 10 amps.
(5) 18 AWG used for control circuit wiring.
(6) Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
(7) Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
(8) Relay cards provide dry contacts only.
[9] Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
[10] Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80322
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS HA + LA + LCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24240	



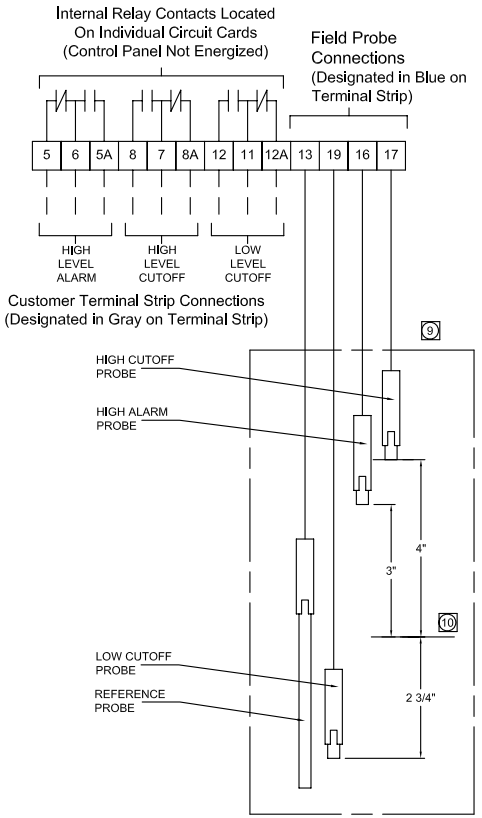


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

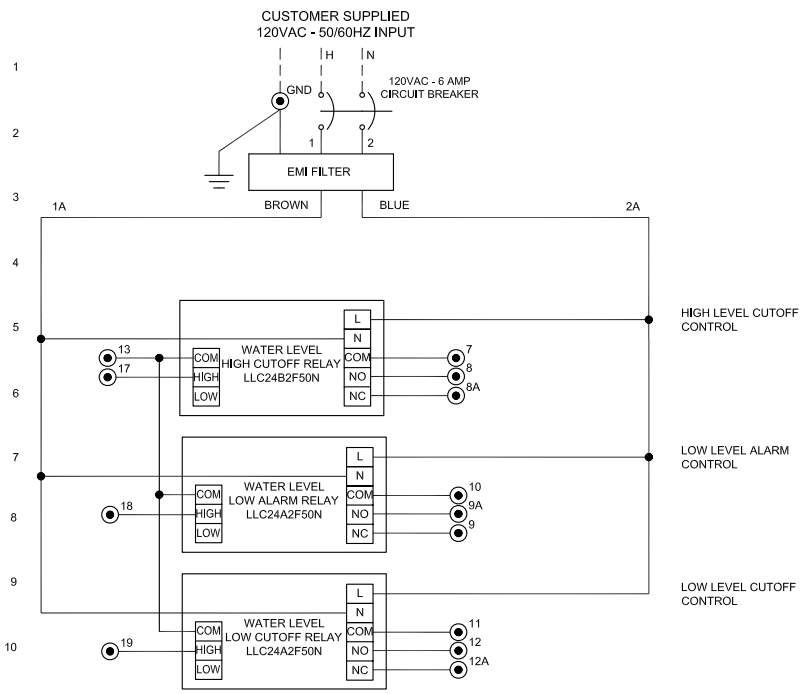
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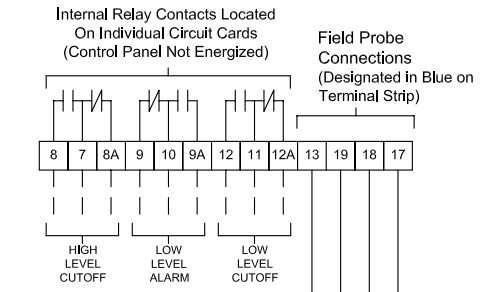
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80323
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	HA + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08-24241	





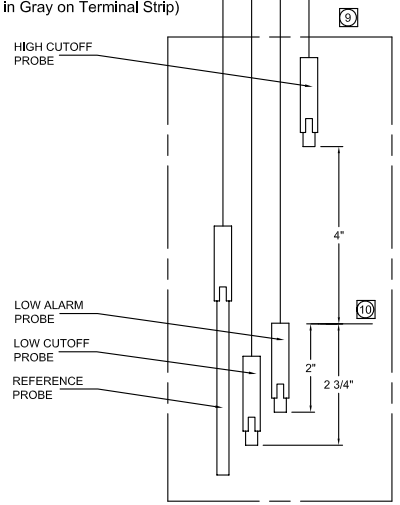


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)				
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
	LOW ALARM	10 & 9	X	
		10 & 9A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

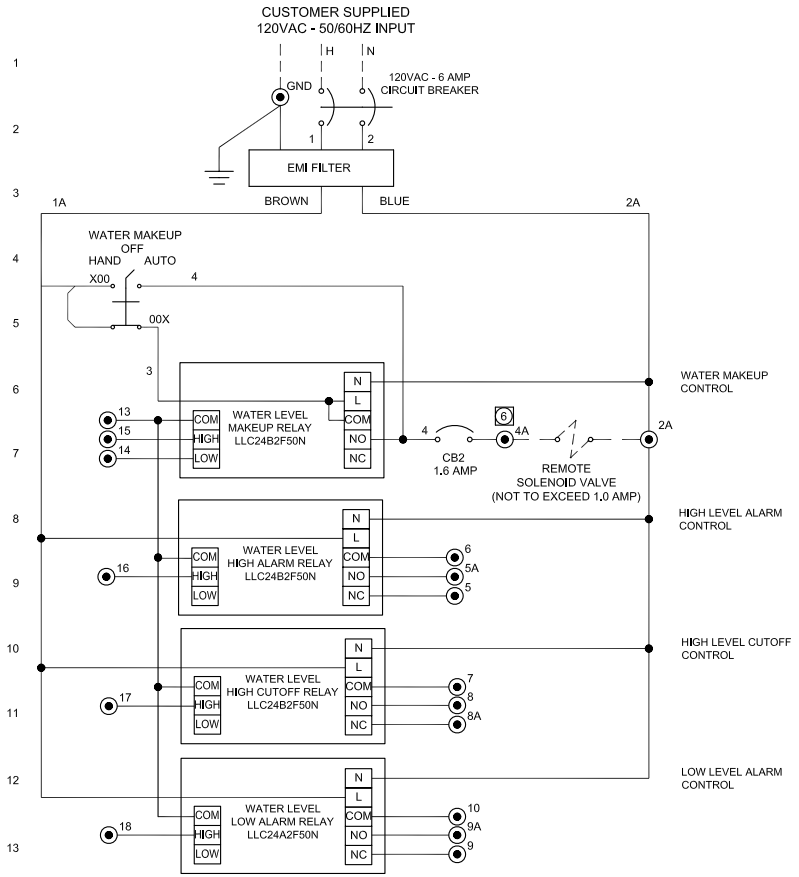
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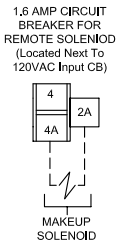
1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80324
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATERE LEVEL CONTROLS LA + HCO + LCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/26/2008				1=5.2	08–24242	





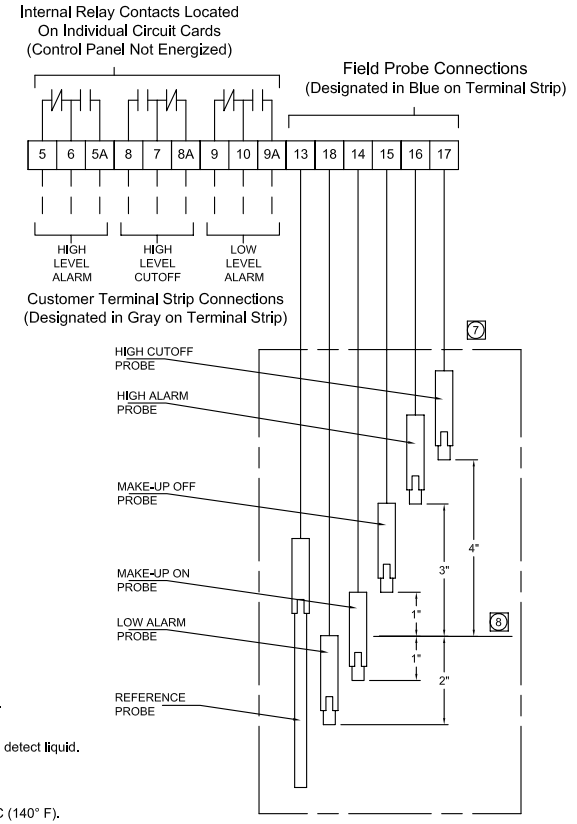


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

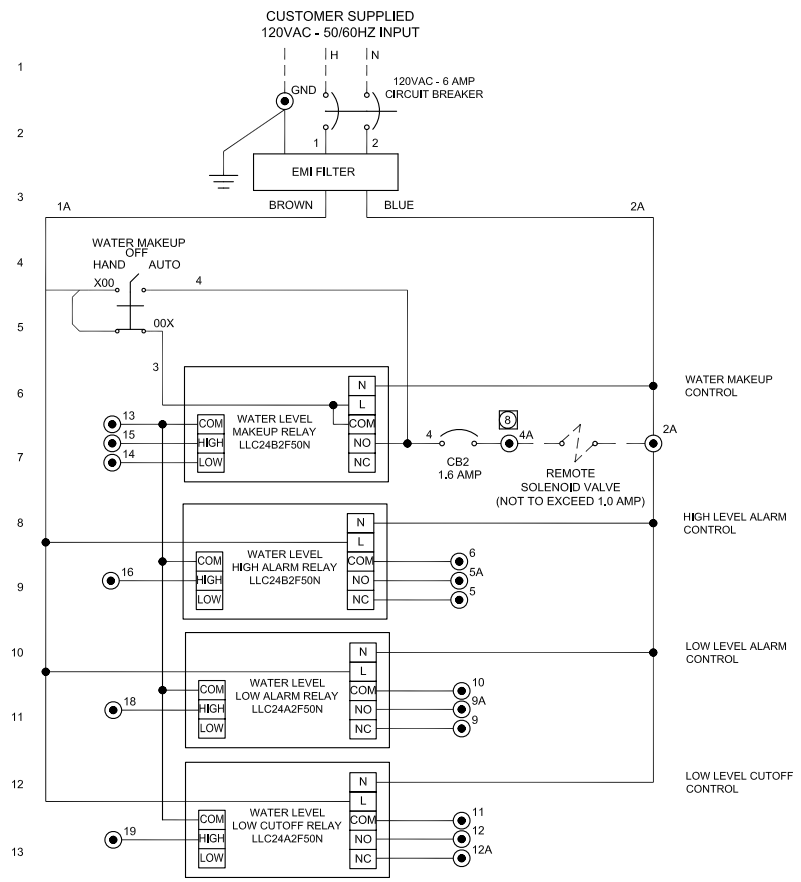
Notes:

1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #: E80325
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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REV. BY	CHECKED	MAKE–UP + HA + LA + HCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	08/11/2008				1=5.2	08–24243	



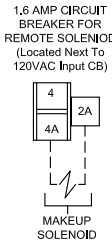
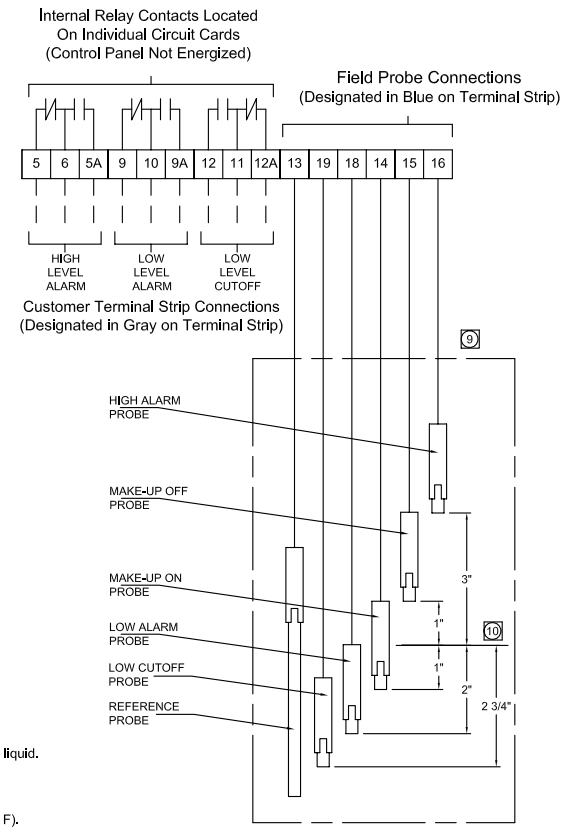


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	



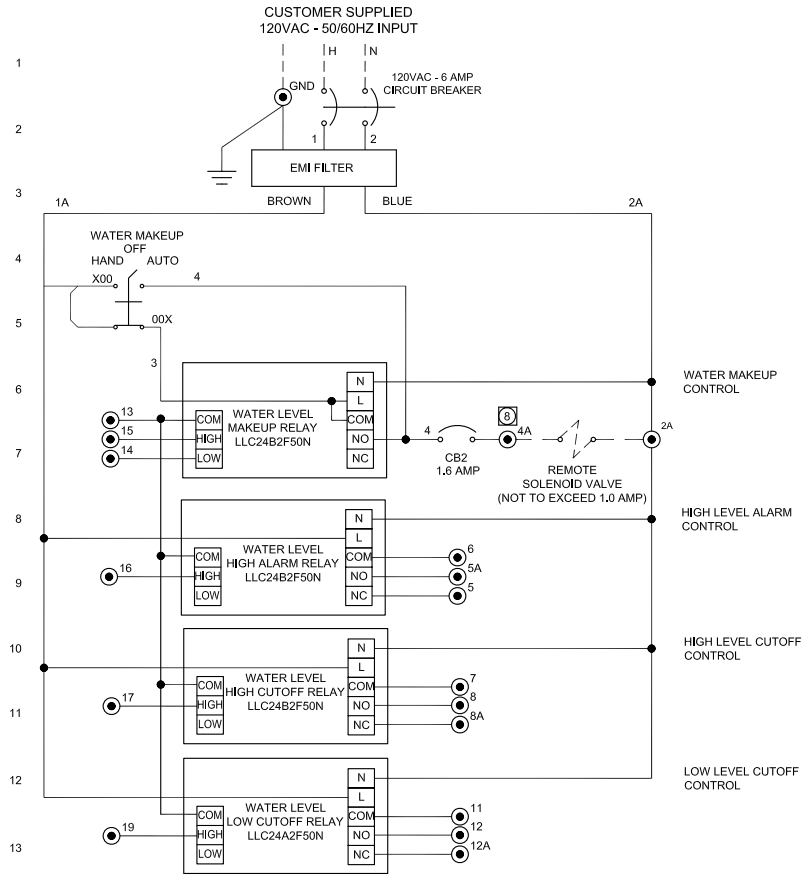
Notes:

1. Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

MARLEY ITEM #:	E80326
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + LA + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/18/2008				1=5.2	08–24244	



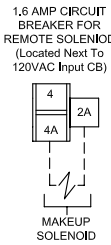
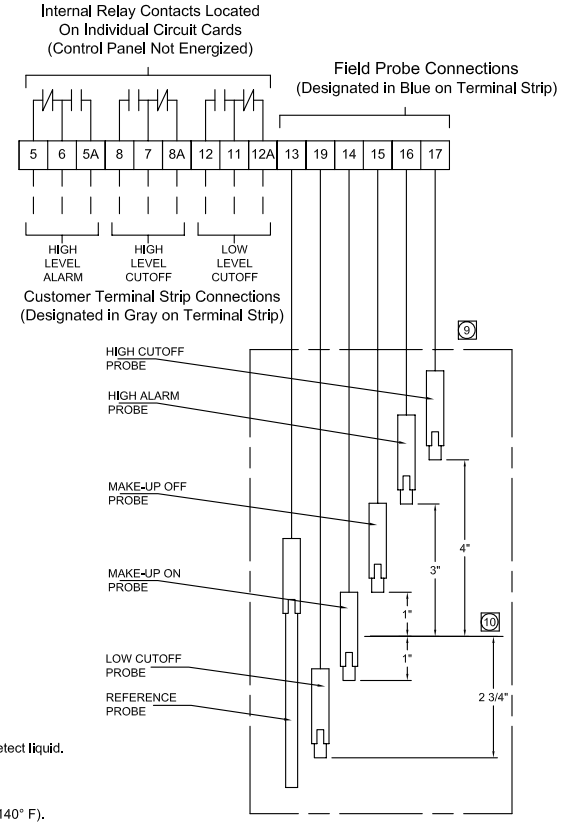


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

Notes:

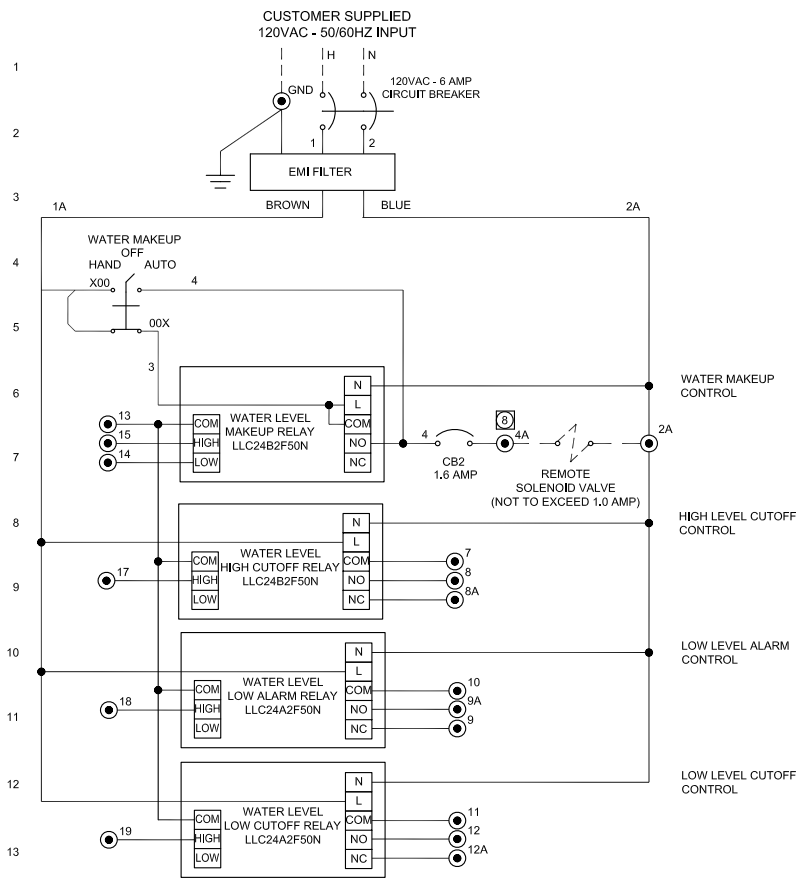
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 lb.in. Class 1 wirng only.
7. Caution: Bonding between conduit connections not automatic and must be provided as a part of the installation.
8. Makeup relay supplies 120VAC for solenoid valve. All other relay cards provide dry contacts only.
9. Hanging probe assembly in tower cold water basin. (Probe heights are field adjustable.)
10. Recommended operating water level as marked in the tower's COLD WATER BASIN.

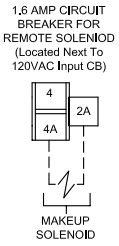


MARLEY ITEM #: E80327
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + HA + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/19/2008				1=5.2	08–24245	





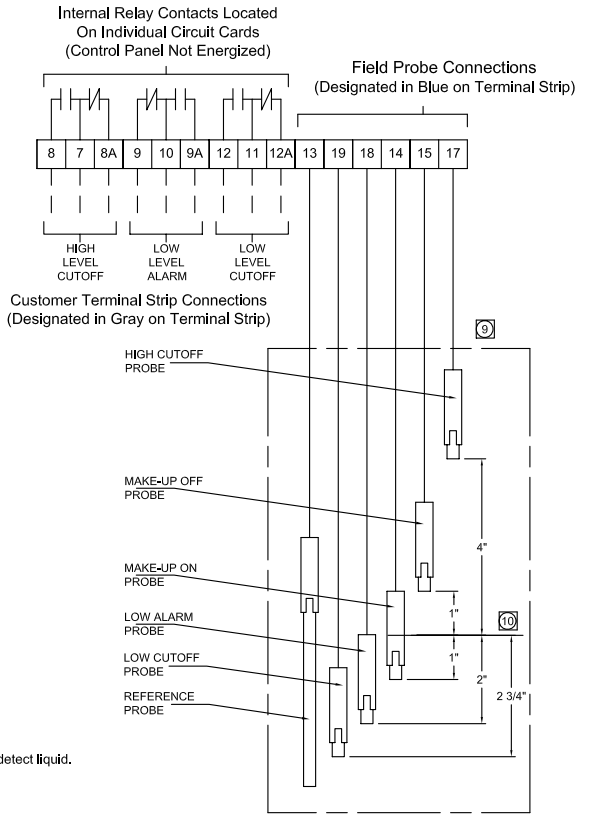


TABLE 1
OPERATION STATUS
(Power Applied)

WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

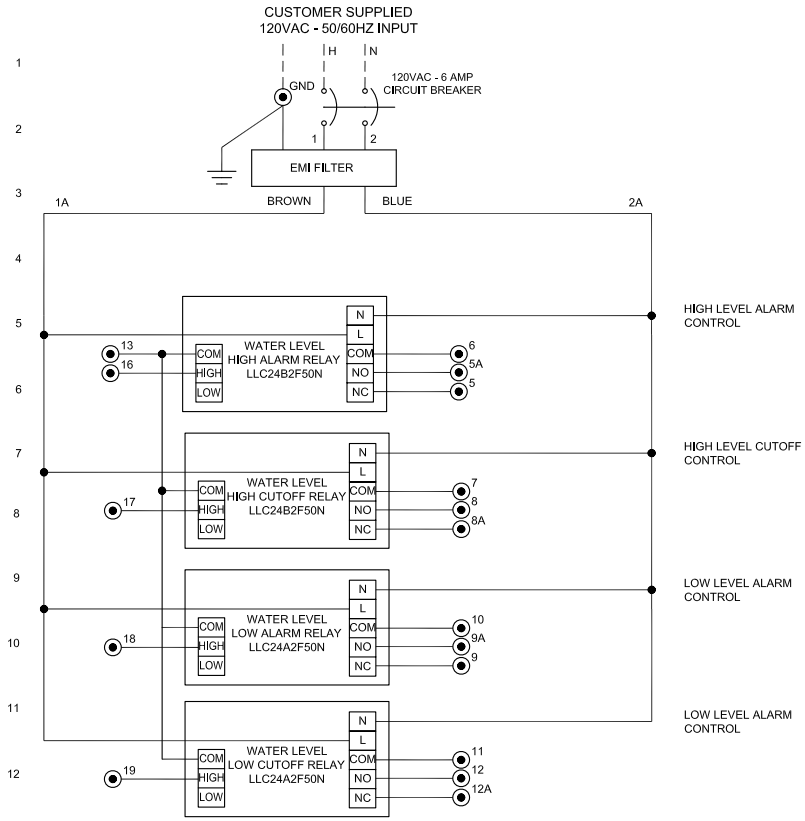
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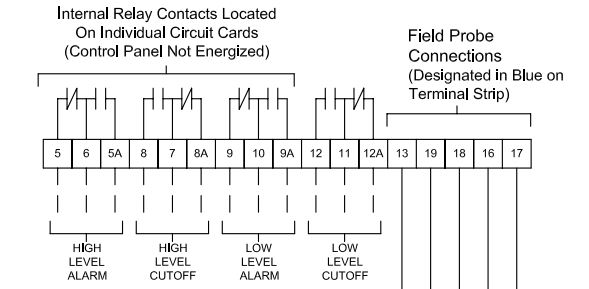
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MARLEY ITEM #:	E80328
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED	MAKE–UP + LA + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24246	





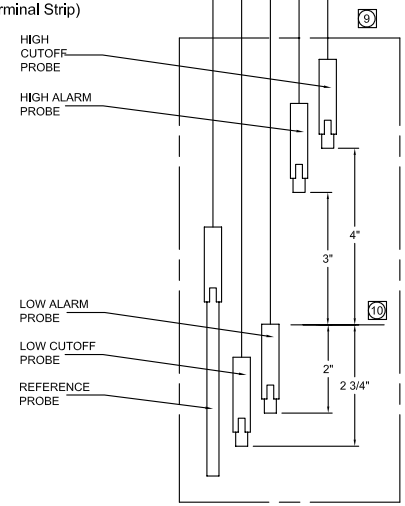


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PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

Notes:

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MARLEY ITEM #:	E80329
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

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REV. BY	CHECKED	HA + LA + HCO + LCO							
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
		DGWOOD	11/25/2008				1=5.2	08–24247	

SPX COOLING TECH, LLC
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OVERLAND PARK, KS 66213 USA
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spxcooling.com

Z0628617_C | ISSUED 8/2023
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MARLEY®

user manual

LLC+u ultrasonic water level control

INSTALLATION - OPERATION - MAINTENANCE

Z1079969 ISSUED 10/2018

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



contents

Note

This manual contains vital information for the proper installation and operation of the LLC+u controls. Carefully read the manual before installation or operation and follow all instructions. Save this manual for future reference.

System Diagram 4
Description 4
Programming 6
Operation 9
Water Makeup Function 9
HAND-OFF-AUTO Switch 9
Troubleshooting 10
Field Wiring - Parts List 11

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.

⚠ Warning

Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.

Note

Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.

introduction

These instructions are intended to assure that field connections are completed properly and the control system operates for the maximum time possible. Since product warranty may depend on your actions, please read these instructions thoroughly prior to operation.

If you have questions about the operation and/or maintenance of this control system and you do not find the answers in this manual, please contact your Marley sales representative.

⚠ Warning

Hazard of electrical shock or burn. Be sure to turn off power to the panel before servicing. If working on equipment out of site of panel disconnect, lockout using standard lockout procedure.

Safety First

The Marley control system uses UL listed components installed in accordance with the National Electric Code. The location of the cooling tower and field installation of the control system can affect the safety of those responsible for installing, operating or maintaining the tower and controls. However, since SPX Cooling Technologies does not control the tower location, or field installation, we cannot be responsible for addressing safety issues that are affected by these items.

⚠ Warning

The following safety issues should be addressed by those responsible for installation, maintenance or repair of the tower and controls:

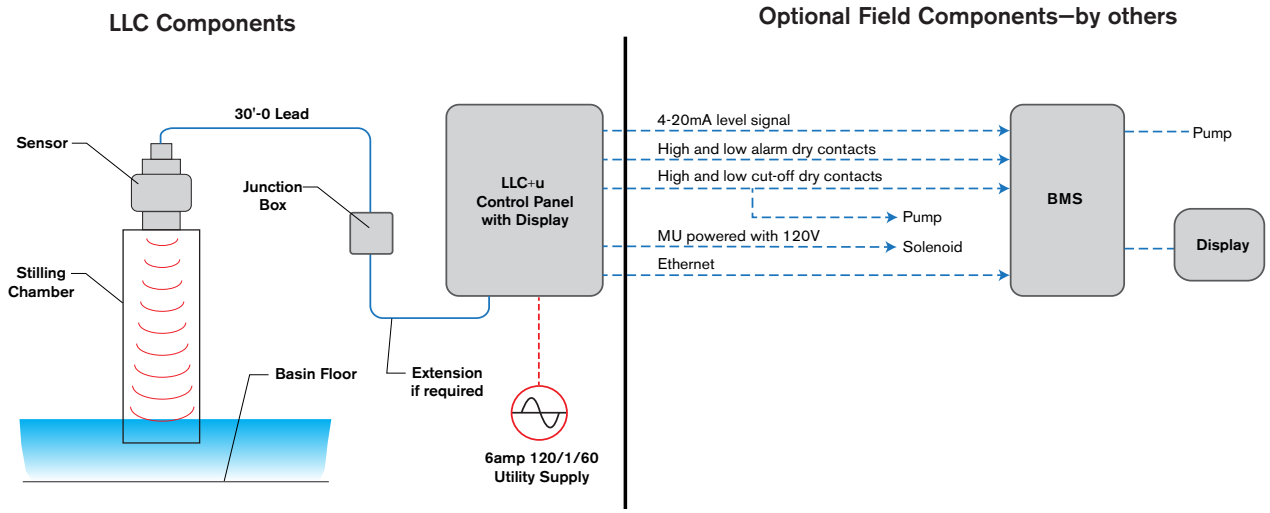
- Access to and from the control panel (including the customer supplied main disconnect/branch circuit protection.)
- Proper grounding of electrical control circuits.
- Sizing and protection of branch circuits feeding the control panel.
- Qualification of persons who will install, maintain and service the electrical equipment.

These are only some of the safety issues that may arise in the design and installation process. Marley strongly recommends that you consult a safety engineer to be sure that all safety considerations have been addressed.

Other safety issues are addressed in literature supplied with your tower. You should closely review the literature prior to installing, maintaining or repairing your tower.

description

SYSTEM DIAGRAM



The Liquid Level Control systems are used to accomplish five different functions:

- Water Makeup
- Low Water Alarm
- Low Water Cutoff
- High Water Alarm
- High Water Cutoff

The most common application of a water level control system is water makeup. The system regulates the amount of water in the tower basin and keeps it within normal operating levels. This makeup system is used to control a remotely installed water solenoid valve. When the water level drops below a prescribed, preset level, the solenoid valve is energized by the control system to fill the basin to its proper level.

High and low water alarms can be utilized to give warnings associated with abnormal operating water levels. To provide indication of these types of alerts, the control system provides dry contacts to interface with various digital control systems or can be connected to user supplied alarm indicators to signal when corrective action is required.

Low-water cutoffs are commonly used to protect pumps from operating without sufficient water. When used in unattended operating environments, the low-water cutoff is configured to shut the pump off, thus preventing costly repairs. Dry contacts can be wired directly in series with pilot duty controls or to digital control systems to initiate the shutdown of protected equipment during low-water situations.



Route incoming power cable from the bottom of the enclosure up into the top (line) side of the main circuit breaker.

Circuit breaker powers a remote solenoid.

H-O-A selector switch for makeup solenoid circuit.

If a makeup solenoid circuit is provided, connect the solenoid wires here at points 4A and 2A. This circuit provides 120 VAC power for the solenoid.

4-20mA output signal representing actual water level for remote BMS monitoring.

Connect alarm and/or cutoff control wiring to the grey terminal points.

Ultrasonic sensor wiring.

Seal field-added conduit holes with silicone or expanding foam to create a vapor barrier to prevent water vapor inside the enclosure.

Selector Switch Operation

HAND: position: Solenoid will energize. **OFF:** position: Solenoid is de-energized

AUTO: Solenoid will operate depending on water level in relation to water probe height.

SCREEN LAYOUT



Red indicates the relay inside the control panel has been energized.

LEVEL IN INCHES–actual water level in the cold water basin

GOTO SETUP–use to program sensor heights and setpoint levels. Default password is 1492

INFO–use to see programmed levels

Note

Requires field programming

1. Measure and program the distance between sensor and water basin floor

2 Program the water level setpoints



3. Operate WATER MAKE UP selector switch to operate solenoid valve circuit

The WATER MAKE UP selector switch controls the makeup solenoid circuit



HAND position–manually energizes remote makeup solenoid



OFF position–no power to remote makeup solenoid



AUTO position–ultrasonic makeup water level sensor activated

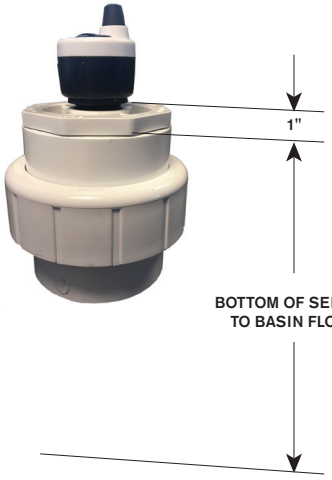
CIRCUIT PROTECTION



Main circuit breaker powers the control panel

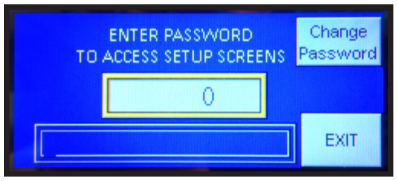
Feeder breaker powers the remote solenoid.

PROGRAMMING STEPS



Power ON the control panel circuits by moving the switches on the two circuit breakers to the up position.

Measure the distance from the bottom of the ultrasonic sensor to the basin floor.



Access the program by pressing GOTO SETUP



Press the light blue screen cell under ENTER PASSWORD bringing up a yellow keypad then enter password 1492 (factory default password) and press ENT to access the setup screens.

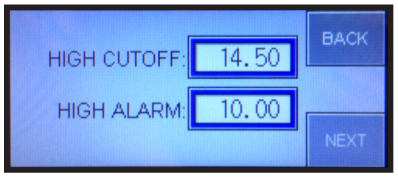
programming

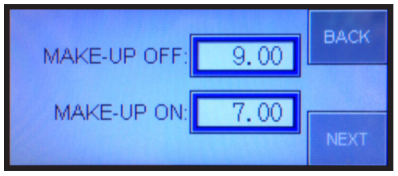


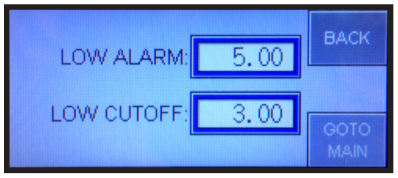


Press the light blue screen cell to right of SENSOR HEIGHT to bring up a yellow keypad then enter the sensor height in inches. Sensor height is from bottom of the sensor to basin floor (or bottom of PVC tubing in case of an external stilling chamber.

Press the NEXT button to enter additional programming screens.







On each screen, enter the water level setpoint values by pressing the light blue cell and entering a value on the yellow keypad then press ENT to save.

Recommended levels are unique for every cooling tower and are available from your Marley sales representative.

When finished press GO TO MAIN to return to main screen.

On the main screen are view actual water level and relay actions. The reaction time is purposely slow to allow time for the system to react and refresh the screens.



Operation

The LLC+u water level control system consists of an ultrasonic sensor placed to measure the water level in the cold water basin. The senor is typically located inside the cooling tower or on some cooling towers in an external chamber. A PLC with HMI touch screen is used to program water level heights and offers a visual indication of the water level. Internal relays with form "C" contacts are used as switches, one for each water setpoint.

Programming is accomplished in the field based on recommended cooling tower water level heights. Contact your Marley sales representative for recommended setpoint levels. The sensor is programmed with a height from sensor to bottom of the basin floor. Individual setpoint levels are programmed for high cutoff, high alarm, makeup, low alarm and low cut off.

Alarm set point may be used to complete a remote BMS alarm circuit. Cut off set point may be used to shut of a circulating pump.

A 4-20mA output is provided for BMS remote monitoring of water level

Water Makeup Function

The circuitry for water makeup in the LLC+u control panel provides an independent circuit breaker for direct connection to a 110-120VAC water solenoid valve. This added feature allows customer installation without having to provide an additional power circuit to energize the solenoid. The solenoid is connected to terminals 2A and 4A as represented on the control's specific wiring diagram.

Purpose and Function of the HAND-OFF-AUTO Switch



Located on the right side of the control's enclosure is a HAND-OFF-AUTO switch. This switch is used primarily at cooling tower startup and in maintenance procedures where the tower basin is empty or has been drained. When the tower's basin needs to be manually filled, the switch is placed in the HAND position. This selection bypasses the probe assembly's feedback and directly energizes the solenoid valve connected to the water supply. Once the cooling tower basin is filled, the switch is placed in the AUTO position to allow the adjusted ultrasonic sensor to monitor and sustain the proper operating level. Placing the switch in the OFF position completely interrupts any monitoring or fill action normally provided by the LLC+u control panel. Normal tower operation depends upon the HAND-OFF-AUTO switch being positioned in the AUTO mode at all times.

troubleshooting

The control panel has been factory tested before shipment and most issues lie outside of the control panel e.g. proper field wiring connections to the control panel.

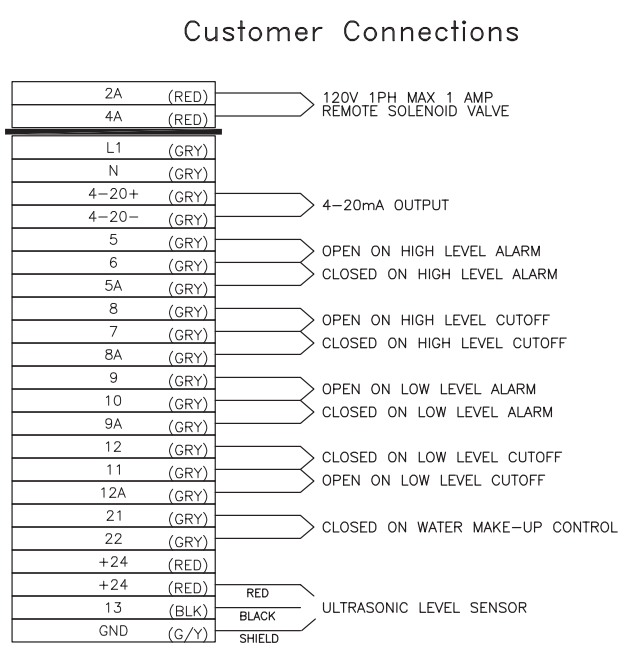
In an effort to troubleshoot the system, please check the following:

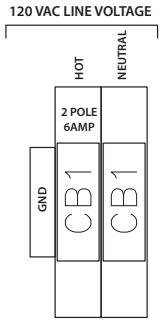
- The two circuit breakers must be energized with operating handles in the up position
- The unit requires programming in the field. See programming instructions in this manual. The ultrasonic sensor head does not require any field programming.
- Check water make up selector switch position.
- Confirm the two sensor wires are oriented and correctly connected at terminal points in the control panel assuring the terminal connection does not land on the insulation of the sensor wire. Strip back just enough wire insulation so you can see some copper wire exposed assuring a metal-to-metal connection.
- The sensor wire is a four wire plus shielded cord. The red and black wires connect to terminal points 24 and 13. The shield connects to ground. Always refer to the as-built wiring diagram on the inside door panel for current connection points. Tape back the white and green wires that are not used.
- If sensor wires were extended in the field, check to make sure the extension wires were numbered correctly and connections secure.
- Assure no external power wiring from other devices run in parallel with the sensor wiring. Follow best practice wiring for power and instrumentation wiring placements.

Checking the power circuit for the makeup solenoid

- Rotate the WATER MAKE UP selector switch to the HAND position. The solenoid should energize allowing makeup water to flow into the cooling loop. Inside the control panel is a single-pole circuit breaker, which must be in the ON position to power the circuit.

field wiring - parts list





MANF/FILE: E312361
SUPPLY VOLTAGE: 120VAC–60HZ
FLA: 6.0A
SCCR: 5KA
WIRING DIAGRAM: 2599336
ENCLOSURE: ..... TYPE 4X

TERMINALS

USE COPPER CONDUCTORS ONLY
60° C (140° F)
RECOMMENDED TORQUE = 4.4–7.1 lb.in
CLASS 1 WIRING ONLY

CONDUIT FITTINGS

USE TYPE 4X CONDUIT HUBS

Wiring diagram is typical. Refer to wiring diagram on inside of the enclosure door for actual as-built wiring diagram, which may include project specific options.

Wire 120 VAC incoming voltage supply to line side (top) of the main 2 pole circuit breaker CB1 and CB2

Wire 120 VAC remote makeup solenoid to terminal points 2A and 4A

Wire alarm and cutoff circuits to terminal points 5 through 22 as needed

Wire ultrasonic sensor:

- Red to terminal point +24
- Black to terminal point 13
- Shield to GND (Do not ground shield any other location, only at the LLC+u control panel)
- The white and green sensor wires are not used.

Wire 4-20mA output signal representing the water level in basin from points 4-20+ and 4-20- to customers BMS system.

Part Number	Description
2599336	120 VAC Ultrasonic LLC+u Control Panel
2588880	DL10 Ultrasonic sensor only with 30 ft cable (no junction box or fittings)
2586100	DL10 Ultrasonic sensor with 30 ft cable, junction box and 3" union slip fitting for round PVC stilling chamber located external to the cooling tower
2599330	DL10 Ultrasonic sensor with 30 ft cable, junction box and 3" threaded fitting for square metal stilling chamber located internal to the cooling tower
2586086	100 ft 4-18 AWG PVC cable
2586087	150 ft 4-18 AWG PVC cable
2586088	200 ft 4-18 AWG PVC cable

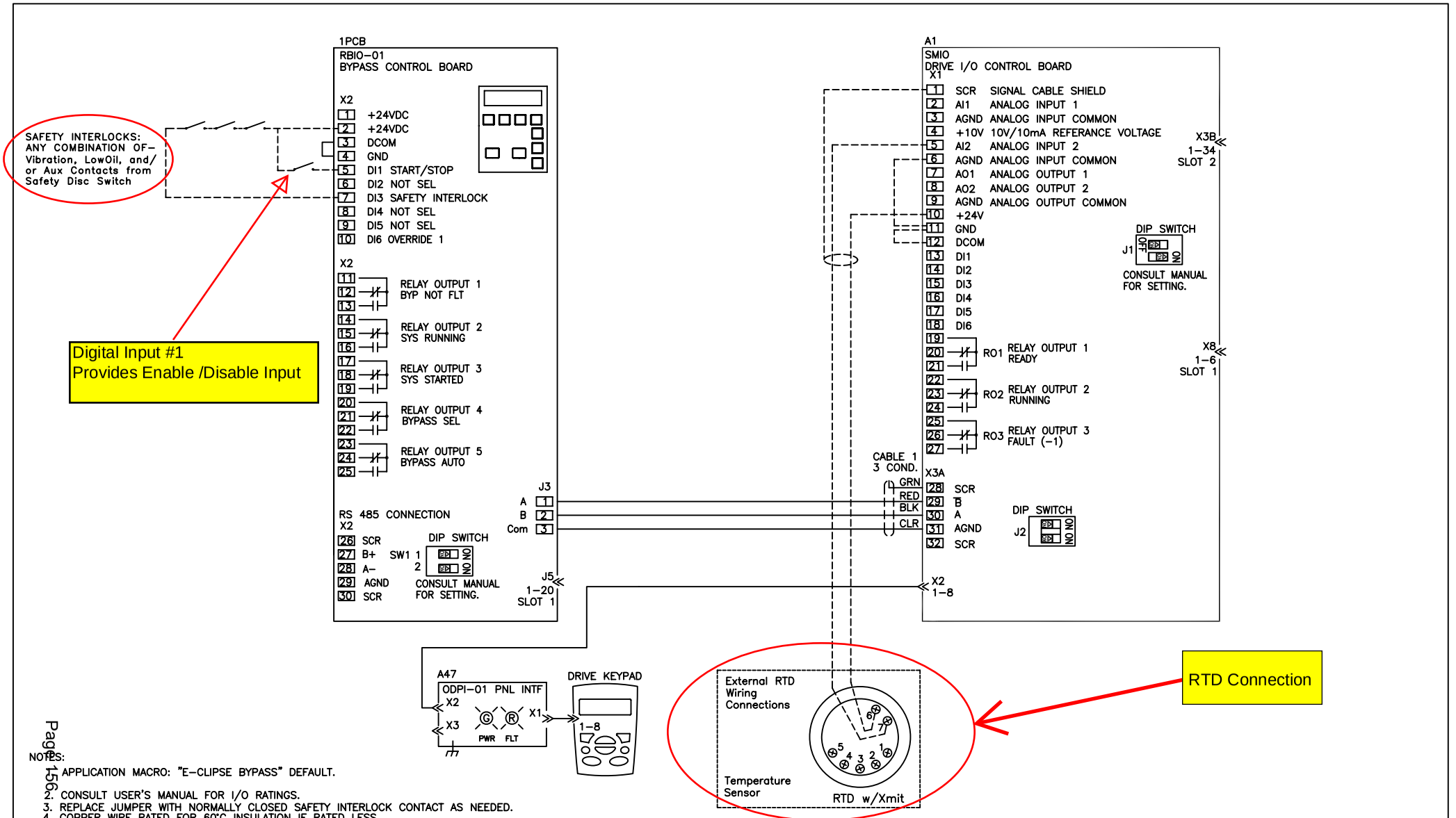
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In the interest of technological progress, all products are subject to design and/or material change without notice.

Controls Overview and Troubleshooting

Objective: Learn brief history of Marley panels that a service contractor may see in the field. Review and troubleshoot vibration switches, basin heaters, water level controllers, Control panels and VFD's. Gain a better understanding of the information included in the LLC User Manual and discuss tips and dos and don'ts.

Notes / Take Away Points:



NOTES:

1. APPLICATION MACRO: "E-CLIPSE BYPASS" DEFAULT.
2. CONSULT USER'S MANUAL FOR I/O RATINGS.
3. REPLACE JUMPER WITH NORMALLY CLOSED SAFETY INTERLOCK CONTACT AS NEEDED.
4. COPPER WIRE RATED FOR 60°C INSULATION IF RATED LESS THAN 100A OR 75°C IF RATED 100A OR MORE MUST BE USED.
5. REFER TO USER MANUAL FOR OPERATION, CONNECTIONS AND TIGHTENING TORQUE VALUES.
6. CUSTOMER REQUIRED TO PROVIDE BRANCH CIRCUIT PROTECTION AND DISCONNECT MEANS PER NEC AND LOCAL CODE.

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ECO NUMBER		ABB ACH550 with E-Clipse Bypass - Interconnection Diagram with RTD Temp Sensor -	SPX Cooling Technologies			
REV. BY	CHECKED		Baltcke | Hamon Dry Cooling | Marley			
REV. DATE	DRAWN BY	DATE 10-15-09	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER SUBMITTAL	REV.

MARLEY®

user manual

IMI 685A vibration switch

INSTALLATION - OPERATION - MAINTENANCE

Z0929039_D ISSUED 6/2020

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



contents

Overview

- General Features 3
- Warnings 3

Installation

- Field Wiring 5
- Internal Switch Rating 5

Operation

- Switch Setup 6
- Adjustment 7

Switches with Remote Reset 8

Commissioning 10

Specifications 11

Dimensions 11

overview

The IMI 685A mechanical switch is a shock sensitive mechanism for shutdown of the electric fan motor. This switch uses a patented linear adjustment magnetic latch technology to ensure reliable operation. Pushing the reset button moves the tripping latch into a magnetically held position. A shock/vibration will move the magnet beyond this holding position, thus freeing the spring loaded tripping latch to transfer the contacts and shut down the machinery.

General Features

- Designed to detect severe shock/vibration in three planes of motion
- Fully adjustable, with patented linear adjustment technology
- Includes magnetic latching feature
- Accommodates normally open (NO) and normally closed (NC) wiring schemes
- Manual reset button with red trip indicator
- NEMA 4X (IP66) rated enclosure
- Remote options
  - 24VDC Remote Reset
  - 120VAC 60Hz Remote Reset
  - 240VAC 50Hz Remote Reset
- Top cover is secured with socket head cap screws for easy access to wiring terminals

⚠ Warning

If using a VFD to control fan speed, identify and lock out system resonant frequencies during start up and commissioning. Prolonged operation at resonant frequencies may lead to excessive vibration, equipment damage and/or possible injury.

⚠ Warning

AC and DC input signals and power supply voltages could be hazardous.

- ***Do not connect live wires to screw terminal plugs***
- ***Do not insert, remove, or handle screw terminal plugs with live wires connected***
- ***Do not make any adjustments to the set-point with live wires present***
- ***Do not open the unit if fan motor is powered or running***
- ***Do not open the unit if the relays are energized***
- ***Do not open the unit if the reset coil is energized***
- ***Do not make any adjustments if fan motor is energized and/or power is present anywhere in the switch***

installation

Before Installation

- Stop the fan motor
- Disconnect all electrical power to the fan motor
- Make sure the machine cannot operate during installation by following proper lock-out tag-out procedures
- Follow all cooling tower safety warnings
- Read and follow all installation instructions

⚠ Warning

Remove power before opening the cooling tower access door. Stop the fan motor and disconnect all electrical power before beginning the wiring operation. It is your responsibility to have a qualified person install and wire the unit and make sure it conforms with NEC and applicable codes.

The vibration switch is sensitive to shock and vibration in all three planes of motion – up/down, front/back and side/side.

1. Firmly secure the unit to the equipment using the base foot mount.
2. Mount the enclosure with conduit port located downwards.
3. For retrofit installations, this switch may have a different footprint than an existing switch. Field drill four holes into the existing mounting plate or mechanical beam and mount switch with hardware based on mounting hole dimensions below. Replacement mounting plate and hardware can also be purchased through SPX, if desired.
4. Make the necessary electrical connections to the vibration switch. See **Figure 1** for electrical terminal locations and for typical wiring. ***Do not exceed voltage or current ratings of the contacts***. Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

Note

If the electrical cable crosses a pivot point such as at the pivot of the walking beam, be sure to allow enough slack in the cable so that no stress is placed on the cable when the beam moves.

If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc, or as otherwise required by applicable electrical codes. If conduit is not attached directly to the switch, use a strain relief bushing and a weatherproof cap on the exposed end of the conduit. A “drip loop” should be provided in the cable to prevent moisture from draining down the cable into the conduit should the weatherproof cap fail.

installation

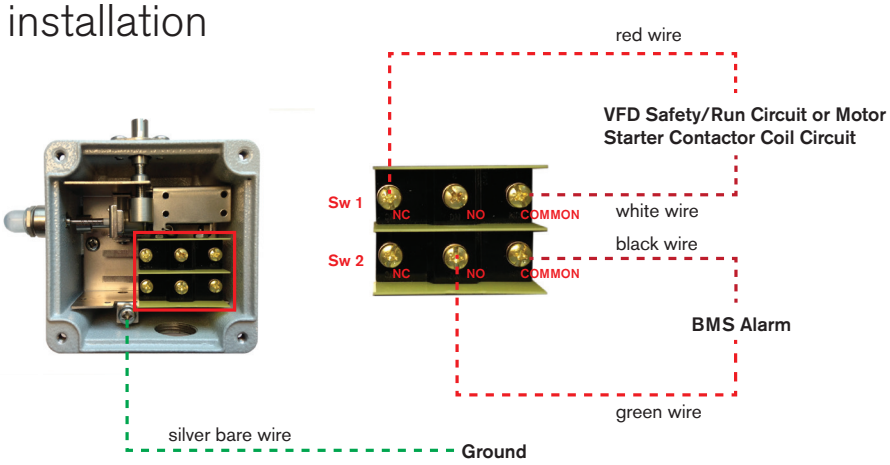


Figure 1

Field Wiring

Typically this switch is used to shut off the tower fan motor and provide an alarm. The switch has two SPDT (single pole double throw) contacts operating in unison providing a contact closure or contact opening in the event of a trip. The NC contact of Sw 1 may be used to complete a safety/start circuit of a VFD or motor starter. When the switch trips this contact will open and break the circuit. The NO contact of Sw 2 may be used to complete the alarm circuit. When the switch trips this contact will close and complete the alarm circuit.

⚠ Caution

The factory installed cord set is furnished with a water tight vapor barrier cord grip. If conduit is used, the inside of the conduit must be sealed to prevent water vapor from reaching the inside of the switch. A vapor barrier may be created in the field using expanding foam injected into the conduit after wiring connections have been made. Quality conduit fittings and proper installation of the switch lid is required to maintain product warranty.

Internal Switch Contact Ratings

The vibration switch uses two SPDT switch terminals with removable screws for all connections (see below). Wire the switch contacts depending on application, either Normally Open or Normally Closed. The Normally Open and Normally Closed are referenced to the Common screw terminal connector.

⚠ Caution

Do not exceed the maximum relay ratings as noted below.

Rated Voltage	Resistive Load	Inductive Load	Motor, Lamp Load	
			NC	NO
AC 125V	15A	10A	4A	2A
AC 250V	15A	10A	3A	1.5A
AC 480V	3A	2A	-	-
DC 8V	15A	15A	-	-
DC 14V	15A	10A	-	-
DC 30V	6A	5A	-	-
DC 125V	0.5A	0.05A	-	-
DC 250V	0.25A	0.03A	-	-

operation

Switch Setup

The IMI switch is factory set to trip in the event of excessive shock/vibration within its capability and should not require adjustment. If adjustment is required, either the trip point needs to be adjusted or the switch is being subjected to an abnormally high vibration or shock. Should adjustment be desired, reference the procedure below or contact your local Marley representative for assistance.

Adjustment Procedure

⚠ Warning

Resetting the vibration switch may cause the fan motor to operate. Follow lock out, tag out procedures.

Press the reset push-button to engage the magnetic latch, **Figure 2**. Be sure the reset button remains depressed. If it does not remain depressed, turn the sensitivity adjustment screw clockwise until it does, **Figure 3**. Turning the adjustment screw clockwise increases the set-point at which the switch will trip making it less sensitive to vibration. Turning the adjustment screw counter-clockwise reduces the set-point making it more sensitive to vibration. The

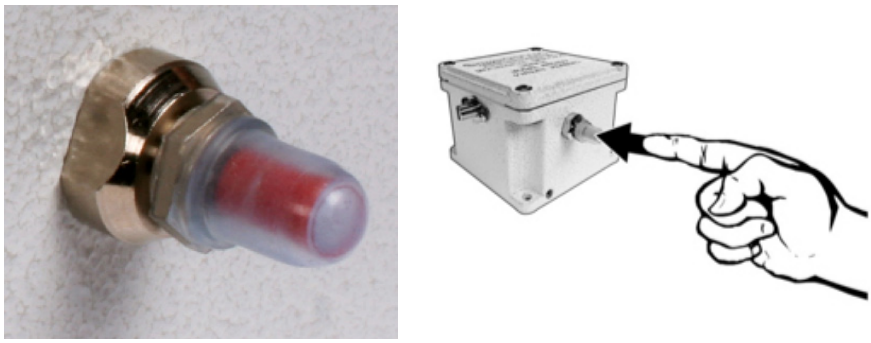


Figure 2

adjustment range is 0 to 7g. Refer to **Figure 4** for the factory default setting.

Factory Setting

The switch should be factory set. To confirm factory setting remove the lid and measure the gap distance between the edges of the cylinder and the square magnet, see **Figure 4**. If the gap setting is not 1/4" rotate the adjustment screw clockwise or counter clockwise until a 1/4" (6mm) gap is obtained, **Figure 3**. Using a 1/4" wide metal strip as a gauge works best.

Note

A slight difference of 1/16" either way creates a large change in the trip point setting.

Turning the adjustment screw clockwise increases the trip point making the switch less sensitive to shock. Turning the adjustment screw counter clockwise decreases the trip point making the switch more sensitive to shock.

Adjustment – If Required

Note

Make sure the switch is set per "Factory Setting" before making any adjustments.

Operate fan motor as follows:

Motor starter operation (full voltage or DOL start):

- Start the fan motor. If the switch trips rotate the adjustment screw clockwise 1/4 turn, reset the switch and restart the motor.

VFD operation:

- If the VFD has a bypass motor starter follow the above procedure first using the bypass motor starter.
- Using the VFD speed control, slowly ramp up the motor speed to full speed allowing 5 seconds for every 2 hertz of speed change. If the switch trips during the ramp up procedure, consider performing a vibration analysis on the tower operation.



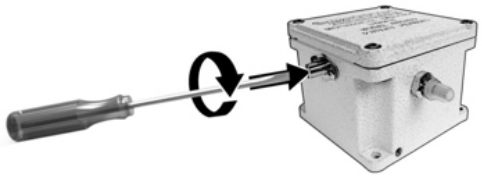


Figure 3

Note

Rotating the adjustment screw clockwise increases the trip point. Turning counter clockwise decreases the trip point

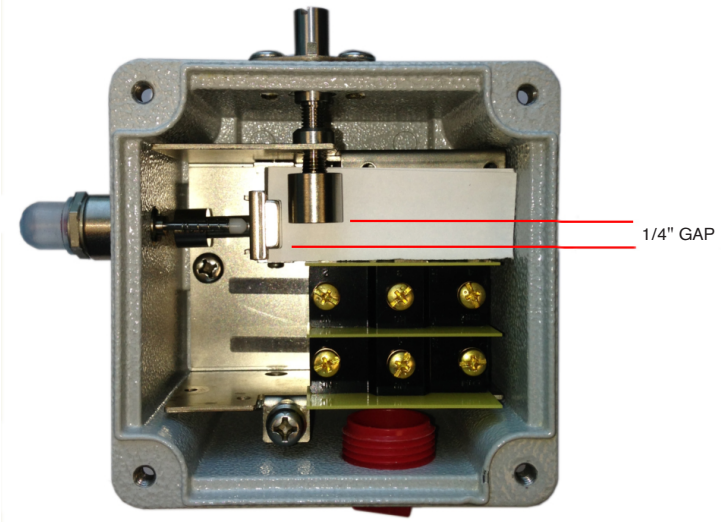


Figure 4

Gap Setting

The factory setting is determined by a 1/4" gap measurement illustrated in **Figure 4**. Adjust the sensitivity screw clockwise or counter-clockwise to achieve the dimension shown.

Switches with Remote Reset Option

A switch with the remote reset option uses an internal electrical solenoid with a plunger to remotely reset the internal trip mechanism. The solenoid requires electrical power to operate and is typically provided from the starter equipment in conjunction with a remote reset push-button station.

A mechanical switch is designed to sense a high shock or severe vibration event and cannot sense low vibration frequencies sometimes associated with cooling towers. When the switch trips it typically means a catastrophic event may have occurred. Upon a trip event, a thorough inspection of the tower, fan and drive train should be performed before restarting the fan motor. The operator should not simply reset the switch without an inspection being performed.

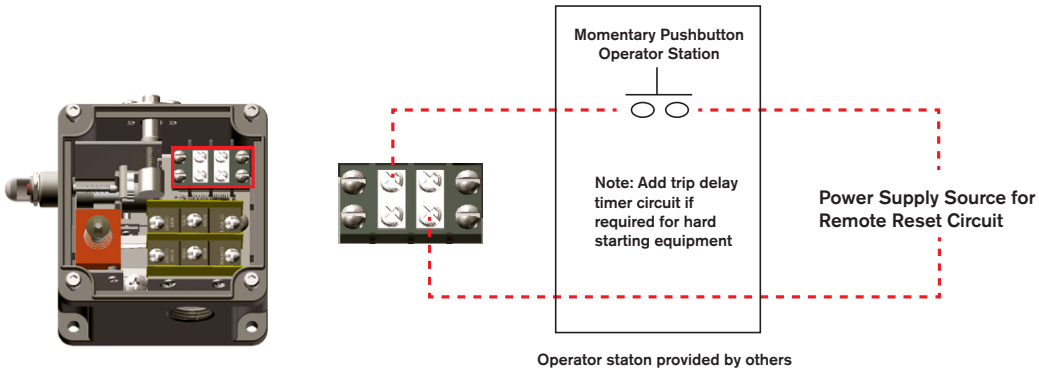


Figure 5

operation

The switch can be remotely reset after being tripped by applying the correct voltage across the reset terminal as shown below in **Figure 5**.

Note

There is no positive/negative polarity needed for the wiring. While the power is applied to the remote reset terminals, the switch cannot be tripped.

24 VDC Switch–A 24VDC power supply is needed to remotely reset the switch by energizing a solenoid. The 24VDC power source must be capable of supplying at least 2A of current. Upon power up, the unit will need the 2A to energize the remote reset coil. Depending on ambient temperature, this will decrease to approximately 0.4A after 5-10 seconds. After that time, the coil can be energized indefinitely.

To protect the remote reset solenoid from overheating, the unit has a built in thermistor that will limit the coil current after a certain amount of time. This time is dependent on ambient temperature and if the reset coil was recently energized. Since the coil needs the peak current only for a short period of time, the thermistor lowers the current but it is still strong enough to hold the switch in reset mode.

Note

The switch will start feeling warm to the touch if the remote reset coil is left energized for more than a few minutes.

120 VAC Switch–A 120VAC, 60Hz power supply is needed to remotely reset the switch by energizing a solenoid. Upon applying 120VAC to the solenoid, the unit will need 184mA to energize the remote reset coil. At standard ambient temperature, the solenoid has a 25% “on” 75% “off” cycle.

Maximum allowed On Time (remote reset energized) versus minimum Off Time (remote reset de-energized).

On Time (25%)	Off Time (75%)	Total Time (100%)
4 Minutes (Max)	12 Minutes	16 Minutes
2 Minutes	6 Minutes	8 Minutes
1 Minute	3 Minutes	4 Minutes
30 seconds	1.5 Minutes	2 Minutes

Note

If using the solenoid for a power on delay, do not exceed the “on” times listed. If the “on” time exceeds 4 minutes and/or the “off” time is shortened before energizing the solenoid again, the solenoid will be permanently damaged.

operation

240 VAC Switch–A 240VAC, 50 Hz power supply is needed to remotely reset the switch by energizing a solenoid. Upon applying 240VAC to the solenoid, the unit will need 92mA to energize the remote reset coil. At standard ambient temperature, the solenoid has a 25% “on” 75% “off” cycle.

Maximum allowed On Time (remote reset energized) versus minimum Off Time (remote reset de-energized).

On Time (25%)	Off Time (75%)	Total Time (100%)
4 Minutes (Max)	12 Minutes	16 Minutes
2 Minutes	6 Minutes	8 Minutes
1 Minute	3 Minutes	4 Minutes
30 seconds	1.5 Minutes	2 Minutes

Note

A power ON delay may be required when starting tower fan motor across the line (DOL). A 15 second delay is suggested to allow the fan to come up to full speed before allowing the switch to activate.

Commissioning

Before testing the switch make sure it is reset. If the red plunger protrudes outwards push the reset button inwards to reset the switch, **Figure 1**.

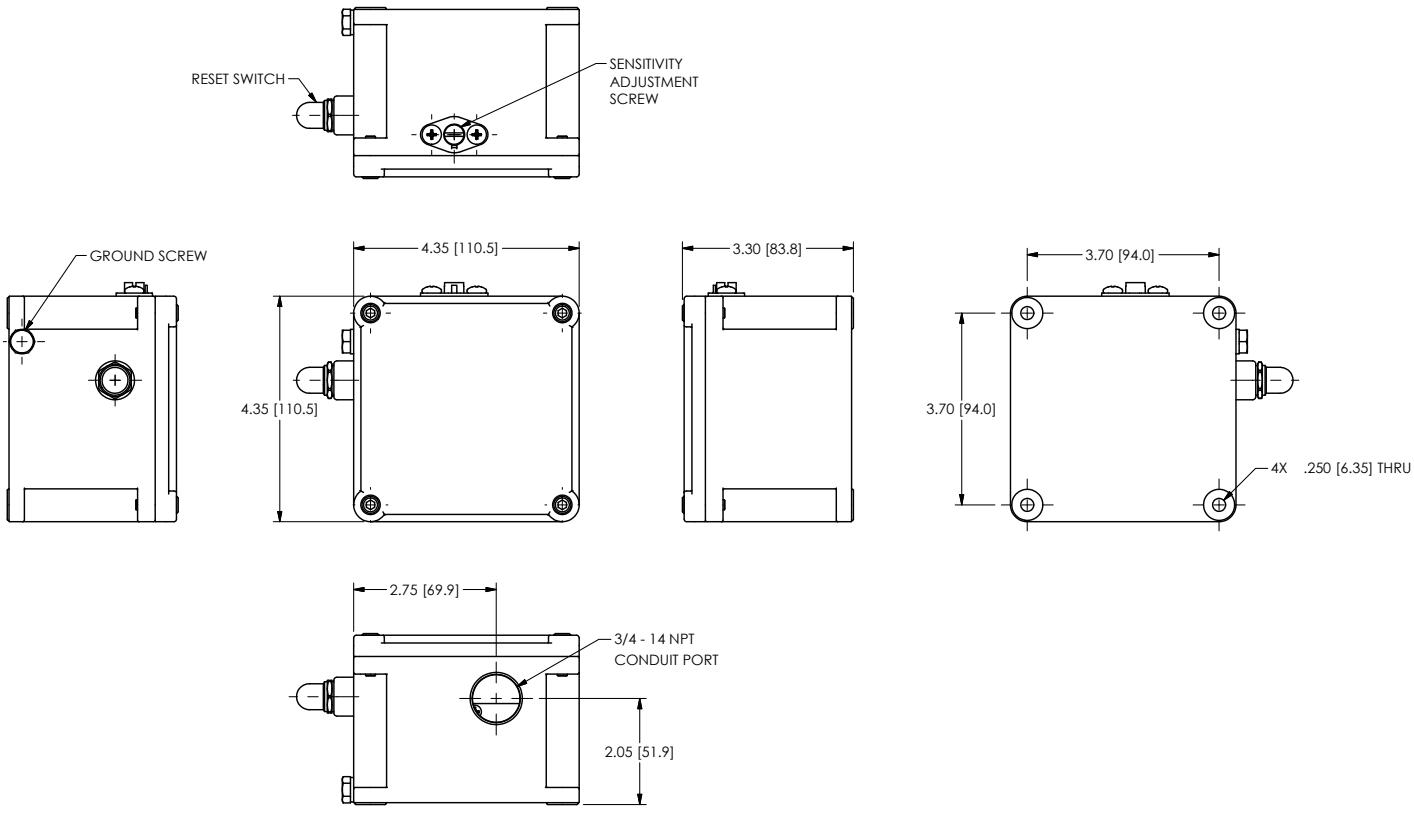
The switch is shock sensitive. Using a dead-blow hammer strike the lid or switch support beam to trip the switch. A trip is visually indicated by a protruding red stem shown in the reset button, **Figure 1**. Reset the switch for operation.

Specifications

Model	Reset	Relay Contact Output	Measurement Range	Frequency Range
2558910	Manual external reset button	One - DPDT form "C" 15 amp at 120 VAC	Inertial 1-7 g pk 0-68.7 m/s^2 pk adjustable	0 to 6000 cpm 0-100 Hz
2558911	Manual external reset button and 24 VDC remote reset solenoid			
2558912	Manual external reset button and 120 VAC 60 Hz remote reset solenoid			
2558914	Manual external reset button and 240 VAC 50 Hz remote reset solenoid			

Model	Startup Delay	Trip Indication	Enclosure Type	Conduit Fitting	Electrical Certification
2558910	No	External red indicator	NEMA 4X / IP66 epoxy painted aluminum	One - 3/4 inch NPT threaded female connection with liquid tight fitting and cord provided	c SP us CE
2558911	Timer required in customer's start circuit				
2558912					
2558914					

Dimensions



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MARLEY®

user manual

Basin Heater

INSTALLATION – OPERATION – MAINTENANCE

Z0238873_A ISSUED 03/2017

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



receiving and inspection

The heater package is shipped directly from the vendor.

1. Check all parts for any damage in transit. The carrier is responsible for the condition of the heater package upon arrival. If damage is apparent, note the freight bill accordingly. This will support your claim with the freight carrier.
2. Check the nameplate on the enclosure and verify that the heaters and the control panel are rated for the correct voltage.
3. Check the watt rating on each element and verify the sum of all elements is equal to the kW rating as ordered.
4. The control panel is nameplated for the maximum amperage that the panel can safely control and may be equal to or greater than the actual amperage required for your heater package. See **Installation Instructions** on page 5 to calculate amperage required.

introduction

The purpose of a basin heater is to prevent water freezing in the cooling tower basin during periods of shutdown or standby operation. The heater system is sized according to tower model and location to give maximum protection against water freezing in the cold water basin. This heating system is not intended to protect the tower fill and other components from icing. Refer to *Marley Technical Bulletin # H-003* **"Cooling Towers and Freezing Weather."** Contact your Marley Sales Representative for a copy or download at spxcooling.com.

The Marley basin heater system is manufactured by INDEECO, a leader in immersion heating equipment. The system is referred to as a "heater package" and consists of immersion heaters, a control panel and combination temperature / liquid level sensor with a 12'-0" cable length. The basic control panel contains a contactor(s) of sufficient capacity for the heater elements selected. In addition the panel contains a transformer to reduce line voltage to 24VAC for panel control power, and a solid state relay card to detect low temperature and low water conditions. The panel enclosure is rated NEMA 4X (liquid tight, noncorrosive) and the sensor cable is UL outdoor rated. The sensor probe is stainless steel with ½" NPT threads and a PVC bulkhead fitting for installation in the cold water basin.

The panel may control more than one heating element, up to its nameplate KW rating for the voltage and phase stated. In addition to the components of the basic panel described above, available options are fusing, circuit breakers or disconnect switches. The circuit diagram located on the inside of the panel cover will indicate the panel configuration.

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning the life of the product.

⚠ Warning

Indicates presence of a hazard which can cause severe personal injury, death or substantial property damage if ignored.

⚠ Caution

Indicates presence of a hazard which will or can cause personal injury or property damage if ignored.

Note

Indicates special instructions on installation, operation or maintenance which are important but not related to personal injury hazards.

Note

For detailed information concerning installation, refer to the heater installation drawing provided with the cooling tower.

Heater Element

Install the heater element(s) in the depressed area of the cold water basin near the outlet. Provide clearance of ⅞" or more above the floor.

A single centrally located heater can protect up to 300 square feet of basin surface area from ice damage. To protect larger surface areas, position several heaters so they protect equal areas. For multicell towers, no more than two cells may be protected by a single heater package. For three or more cells additional heater packages are necessary.

⚠ Caution

The heater should never operate out of the water. It would become extremely hot (1500°F) and destroy the heater element and/or ignite nearby combustible materials. As a precaution and to prevent fires when the clearance between any part of a heater element and combustible materials is less than 10", install a sheet metal shield to reflect and dissipate the heat. The shield must not contact the heater element and should extend beyond the heater element in all directions as shown in Table 1.

Table 1

Heater Clearance inches	1	2	4	6	8	10
Shield Extension inches	10	9	7	4	2	0

Heater Supports

Install metal supports for the heater element where necessary to keep the unsupported length under 30". The number of supports required is as shown in **Table 2**.

Table 2

Heater Kilowatts	1 - 9	12-18
Number of Supports	None	1

Control Panel

The control panel is suitable for outdoor mounting, and may be mounted on the tower, but not inside the tower. Wire the heaters to the panel. Wire the panel to the branch circuit supplying power to the heater.

The field supplied branch circuit disconnect switch and the branch circuit protective device (fusing or circuit breaker) shall be sized in accordance with the NEC/CEC rules for actual load. The total heater load can be calculated as shown below.

If the heater control panel is furnished with an optional disconnect, installation of the panel in relationship to the heater element shall be in accordance with the NEC/CEC rules.

The main incoming conduit hub and the main power termination points are sized for total nameplate KW and voltage. The actual load for a particular installation may be less. Either compute the actual load on the heater control panel to determine the sum total KW of all the heaters connected to it or use the nameplate rating to determine the wire size required. To calculate amp draw for a particular installation use the following formulas:

$$\frac{\textbf{kW} \times \textbf{1000}}{\textbf{Voltage}} = \textbf{Amperage for Single Phase Applications}$$

or

$$\frac{\textbf{kW} \times \textbf{1000}}{\textbf{1.7312} \times \textbf{Voltage}} = \textbf{Amperage for Three Phase Applications}$$

⚠ Caution

Should water be drained, either intentionally or accidentally, from the basin, the basin heater must be checked manually to insure the power source to the heating element is OFF. Although equipped with a low liquid level sensor probe, contaminants on or around the probe may cause false readings allowing the element to remain energized under low or no water conditions. Do not re-energize the unit until the sensor probe is fully submerged in water.

If the unit is energized while the sensor probe is not fully submerged in water, combustion/fire may result, which could damage or destroy the tower and may cause damage to persons or property nearby.

Temperature / Water Level Sensor Assembly

⚠ **Warning**

This basin heater package is equipped with a combination temperature/liquid level sensor and may have a thermal cutoff switch. Both are safety devices that must not be altered or changed in any manner. Disabling either safety feature may result in combustion and/or fire, which could cause damage or destroy the tower and may cause damage to persons or property nearby. Failure of one or both safety devices requires that the control panel be de-energize and tag circuit out for maintenance. Do not re-energize the unit until all safety devices are fully operational in accordance with manufacturer's specifications.

The sensor assembly is factory installed to the control panel. Do not attempt to lengthen or shorten the cord. Sensor assemblies with various lengths up to 99'-0" are available and may be specified at the time of purchase for additional cost.

Install the sensor probe in the cold water basin at least 1" above the highest point of the heater element and at least 6" away from the heater. The probe should be installed in the coldest part of the basin for maximum protection. It should extend into the open basin a minimum of 4". A ½" NPT PVC bulkhead fitting is provided on the sensor for mounting through the basin wall. Provide an 1⅝" clearance hole through the basin wall. Remove the nut from the bulkhead fitting and insert the sensor probe through the hole. Hand tighten the mounting nut onto the fitting, holding the bulkhead fitting to avoid twisting the cord. Lightly tighten the nut.

Operating Instructions

To operate the heater system, visually check that the water level is above the sensor probe before energizing the power supply. The temperature control is preset at 45°F. The system will not energize unless the water level is above the sensor probe and the temperature of the water is below the 45° set point. The solid state relay card located in the control panel has a green and a red LED–see **Figure 1**. In a "ready" condition, with water level above the sensor probe and temperature above 45°F both these LEDs will be off. If the red LED is illuminated this indicates a low water condition and the heaters will not operate. If the green LED is illuminated the heater elements are on.

Figure 1

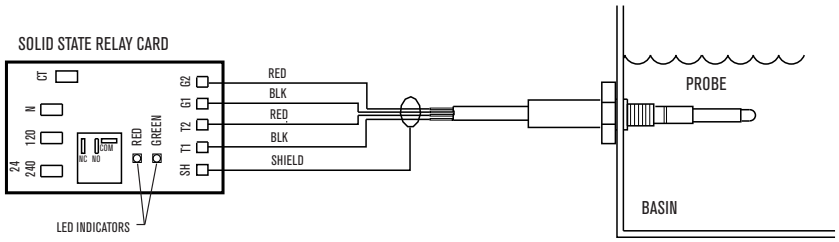


Table 3

Red	Green	
OFF	OFF	Ready, No Demand
ON	OFF	Low Water Level
OFF	ON	Heater On

⚠ Caution

Should water be drained, either intentionally or accidentally, from the basin, the basin heater must be checked manually to insure the power source to the heating element is OFF. Although equipped with a low liquid level sensor probe, contaminants on or around the probe may cause false readings allowing the element to remain energized under low or no water conditions. Do not re-energize the unit until the sensor probe is fully submerged in water.

If the unit is energized while the sensor probe is not fully submerged in water, combustion/fire may result, which could damage or destroy the tower and may cause damage to persons or property nearby.

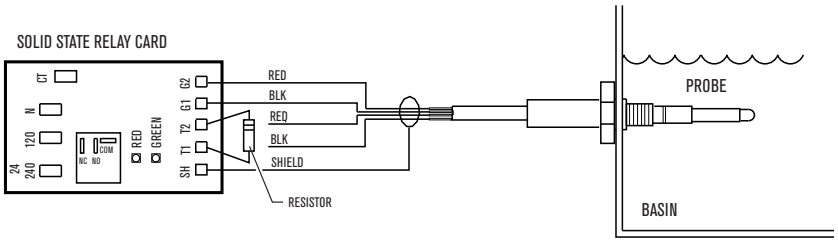
Testing above Freezing Temperatures

Under normal operating conditions the heaters will be turned on at a water temperature between 40° and 45°F, and turned off when the water temperature exceeds 45°F. For testing the system at temperatures above 45°F there are two methods as follows:

Method A

1. Disconnect power to the control panel using standard lockout procedure for safety.
2. Remove the panel cover
3. Remove the sensor wires connected to terminals T1 and T2 on the relay circuit board.

Figure 2



4. Connect a 1.5K ohm resistor (included in panel) across T1 and T2 terminals–see **Figure 2**.
5. Replace panel cover and verify probe is submerged in tower basin water.
6. With panel cover in place turn on power supply to the system. An audible CLICK should be heard as the contactor engages. If this does not happen, refer to the Troubleshooting section of this manual.
7. If the system tests OK turn off power, remove the panel cover and remove the resistor. Replace sensor wires T1 and T2 and replace the cover. Turn system on.

Method B

1. Disconnect power to the heater control panel using standard lockout procedures for safety.
2. Drain basin until the water level is below the probe allowing removal of the probe. Make sure water still covers the heater elements.
3. Place the probe in a container of ice water making sure both metal parts of the probe are submerged but not the cord.
4. Energize the heater control panel. Allow 5 min. for the probe temperature to stabilize.
5. An audible CLICK should be heard as the heater contactor engages. If this does not happen, refer to the **Troubleshooting** section.

Deicing

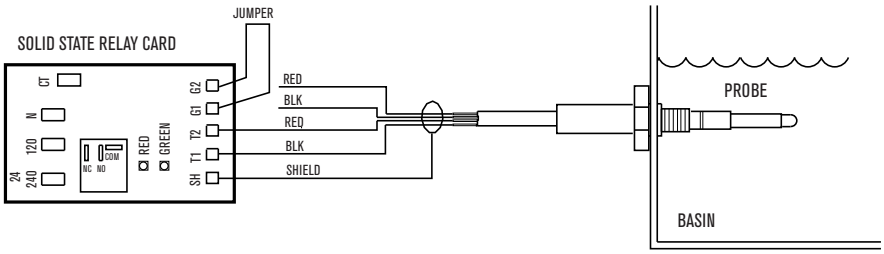
If the temperature/water level sensor assembly becomes encased in ice the heaters will not operate. Ice provides inadequate conductivity for the sensor probe to detect operational water level. To operate heaters in this situation and melt the ice follow these procedures.

1. Disconnect power to the control panel using standard lockout procedures for safety.

2. Remove the panel cover.

3. Install a jumper wire between relay terminals G1 and G2–see **Figure 3**.

Figure 3



4. Replace panel cover.

5. Energize the system and listen for contactor closing.

6. Operate the system until ice is melted around the sensor probe.

7. After ice is melted, de-energize the system, remove the jumper, check all connections and place the system back in operation.

⚠ Caution

Do not leave the heating system unattended during this procedure. There is no low water protection with this jumper in place.

troubleshooting

⚠ Caution

Please refer to the Caution statement on page 6 and the Warning statement on page 7 of this manual before performing the following Troubleshooting procedures.

If the system fails to operate, check the following:

1. Check water temperature. Systems will turn on between 40° and 45°F and turn off above 45°F.

2. Check water level. Water must completely cover the sensor probe.

3. Make sure the sensor is not encased in ice. See Deicing procedure.

⚠ Caution

The following checks should be made by a qualified electrician.

4. Remove panel cover and check incoming electrical power for proper voltage. Make sure all phases are present. Correct as required.

5. If water level is adequate, temperature is 40°F or lower and power is present, observe the LEDs on the relay circuit board. The red LED indicates low water level or ice around the probe and the green LED indicates the heaters are energized.

   A. If the red LED is on and the sensor probe is submerged in water–no ice–this indicates the sensor probe is defective. Confirm by disconnecting power and placing a jumper across terminals G1 and G2–see Figure 3. Reconnect power. If the red LED is now off and the green LED is on, the system is now operating. Replace sensor probe.

   B. If the green LED is on and the heaters are not operating, the problem is either the contactor, the relay circuit board or the heater elements. To determine which, observe the panel while power is disconnected and reconnected.

   – If the contactor operates with an audible CLICK and no heat results the heater element is defective. Check voltage at the heater side of the contactor to confirm voltage is present. Check each line with a clamp-on amp meter. If voltage is present and no current is flowing, this indicates the element is defective and must be replaced. As an additional check, disconnect power, remove wires from the contactor and check the element with an ohm meter for measurable resistance.

– If the contactor does not operate, check voltage across terminal N on the circuit board and NO on the relay mounted on the circuit board –21-29 volt required. If voltage is present across the coil–N to NO– the contactor coil is defective and the contactor must be replaced. If voltage is not present, the circuit board relay is defective and the circuit board must be replaced.

C. If the green LED is off and the red LED is also off the problem is either the circuit board, the sensor probe, or the transformer. To determine which check as follows:

– Disconnect power and remove wires T1 and T2 from the circuit board. Replace with the 1.5K ohm resistor provided. See **Figure 2**. If the system now works, the sensor probe is defective and must be replaced. If the system does not work, go to step 2.

– Reconnect power and take a voltage reading across N and 24/240 on the circuit board–21-29 volts required. If proper voltage is not present the transformer is defective and must be replaced. If proper voltage is present go to step 3.

– Take a voltage reading across N and NO–21-29 volts required. If proper voltage is not present, replace circuit board.

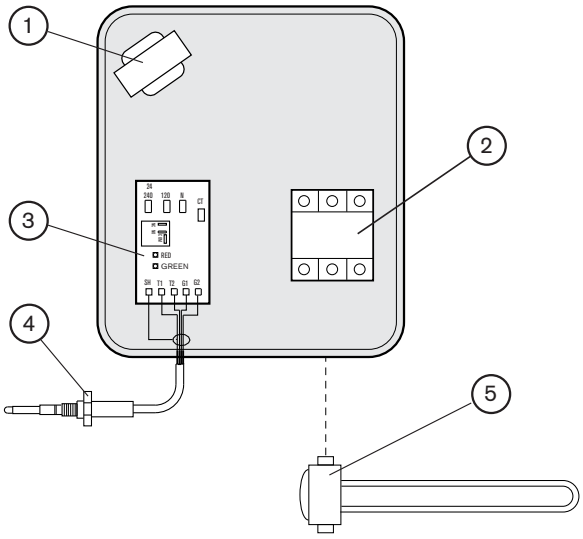
6. The sensor assembly can be checked for accuracy in the following manner.

Remove wires T1 and T2 from the circuit board and measure ohm readings across these wires. Measure the water temperature that the probe is being exposed to. Compare with the following values.

Table 4

Temp °F	**ohms**
0	4273
10	3126
20	2312
32	1633
40	1305
45	1138
60	765
75	525
85	412

parts list



Replacement Parts

1	Transformer 120V/24V	B52465D
	Transformer 208V/24V	A79270D
	Transformer 240V/24V	B91566D
	Transformer 480V/24V	B09608D
	Transformer 600V/24V	B62553D
2	Contactor 50 amp, 600V, 24 volt coil	C32328D
3	Solid State Relay Card	A79269D
4	Sensor Probe with 12' cord	A81137D
	Sensor Probe with 22' cord	B07688D
	–contact Marley Sales Rep for other cord lengths	
5	Heater Element–contact SPX Cooling Technologies for specific heater elements	

Call your Marley Sales Representative for replacement parts. For the location of your Marley Sales Representative call 913 664 7400 or check the web at spxcooling.com

SPX

Date:

From: SPX / Marley Controls department
Subject: Electrical Control drawings for customer approval
Job name:
Marley job #:

Thank you for your order.

Production of electrical control items are on hold pending your approval of the attached drawings.

____ Approved as submitted, hold release
____ Approved as submitted, release for production
____ Approved as noted, release for production
____ Not approved, revise and resubmit as noted

Signed by approver_____ Date_____

Marley item # E58146 Oil level switch bill of material including:

1 - Item # E46874 Oil level switch head unit

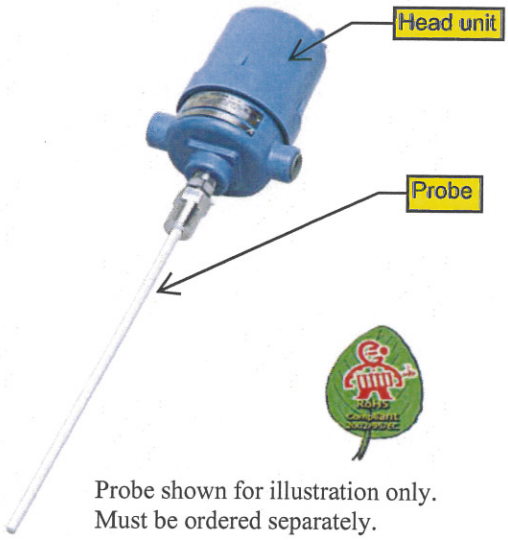
1 - Item # D62900 Probe

Marley

Marley item # E46874 Head unit only
Robertshaw item # 5318B-B1-A

Note: Requires a probe for complete assembly

LEVEL-TEK MODEL 5318B



Probe shown for illustration only.
Must be ordered separately.

GENERAL DESCRIPTION

The Robertshaw Model 5318B Level-Tek is a RF capacitance point (On/Off) level switch, which employs all solid state electronics for detecting predetermined product level changes in tanks, sumps, silos and other vessels or containers. The Model 5318B is capable of detecting a wide variety of products, including liquids, powders, granular, lump and flake materials. The product can be either conductive or non-conductive.

The Model 5318B is self-contained and uses microprocessor based digital circuits to ensure long-term stability, reliability and reduced maintenance. Control signals are provided through the contacts of a DPDT relay. The instrument features adjustable time-delays that are individually adjustable for both "Alarm" and "Return-to-Normal". There are either fixed or adjustable differential settings available. The unit is available for either AC or DC supply voltages.

PRICIPLE OF OPERATION

The standard Model 5318B Level-Tek mounts directly on a Robertshaw Probe Assembly, which is installed in the tank or other container. A remote mount capability (maximum 15 feet) exists. The Level-Tek unit senses changes in product level as a function of the "true" capacitance change between the probe element and the wall of the container.

Instrument setup and calibration are done using integral pushbuttons and a 2-line by 8-character LCD display. Setpoint calibration can be done without requiring level changes in the vessel.

The primary measuring circuit employs Robertshaw's patented Pulse Frequency Modulation, PFM, technology. The 12 VDC and 24 VDC rated units accept voltages from 9 to 18V and 18 to 36V, respectively, while the universal input AC powered unit accepts 100 to 240V. No jumper, or switch, changes are required.

FEATURES AND BENEFITS

- **Versatile - *Suits Many Applications-***
  Enclosure meets explosion-proof and weather-tight requirements. Choice of supply voltages. Adjustable time delays are standard.
- **All Solid-State Construction -**
  Use of digital solid-state circuits insures long-term stability, reliability, and reduced maintenance.
- **Simplified Installation -**
  Self-contained unit may be oriented in any position. Mounts directly on installed Robertshaw Probe Assembly, connected to probe element by rugged, and convenient, disconnect pin.
- **Field Selectable Operational Modes -**
  High Level Fail-Safe, HLFS, or Low Level Fail-Safe, LLFS, is user field selectable.
- **Ease of Calibration and Adjustment -**
  Built-in LCD display aids in calibration (no external meter required).
- **Convenient Design for Wiring and Maintenance -**
  Plug-in chassis assembly provides easy access to wiring and terminal board. Heavy-duty relay.
- **Remote Mount Capability-**
  (Up to 15 feet from the probe.)
- **$_{c}$ETL$_{us}$ Approvals**
- **RoHS Compliant**

SPECIFICATIONS

ENVIRONMENTAL:

Storage Temperature Limits ..... -55° F to +225° F (-48° C to +107° C)

Operating Temperature Limits..... -40° F to +160° F (-40° C to +70° C)

Vibration Limits .....2 g's to 100 Hz

Operating Humidity Limits.....0 to 95% RH

Weight ..... 3.5 lbs. (1.6 kg)

Shipping Weight ..... 5 lbs. (2.3 kg)

PERFORMANCE:

Temperature Coefficient..... Control point, 0.01 pF/°C

Time Delay:

On ALARM.....Adjustable, 0 to 60 seconds

On RETURN.....Adjustable, 0 to 60 seconds

ELECTRICAL:

Supply Voltage:

Standard .....100 to 240 VAC, 50/60 Hz

Optional ..... 18 to 36 VDC

..... 9 to 18 VDC

Supply Power.....5 watts, 5 VA maximum

Control Ranges .....250, 500 & 1,000 pF max

Differential (dead-band):

ON/OFF (Adjustable)... 0.2Pf to 100% of Control Range

ALARM++ (Fixed) ..... 1.0 pF

ALARM+ (Fixed) ..... 0.2 pF

ALARM- (Fixed) ..... 0.2 pF

ALARM- - (Fixed) ..... 1.0 pF

CONTROL (Fixed)..... 0.2 pF

Control Relay:

Form ..... DPDT

Contact Rating .....5 A @ 28 VDC; 5 A @ 120/240 VAC, non-inductive:

ENCLOSURE:

Standard .....Explosion proof, cast aluminum, painted with blue polyurethane enamel. Suitable for Class I, Division 1, Group C & D; Class II, Division 1, Group E, F & G hazardous areas. Dust tight CSA Enclosure 5. Meets Enclosure 4.

Optional .....Same as above, except painted with gray epoxy enamel. Also meets Enclosure 4X.

APPROVAL (Standards):

UL.....STD 61010-1

CAN/CSA.....C22.1 No. 61010-1

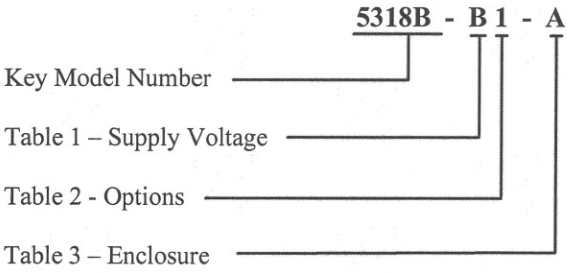
RoHS Compliance..... EU Directive 2002/95/EC

ORDERING INFORMATION

STANDARD MODEL* 5318B-B1-A

OPTIONAL MODELS

Select from Tables.



Key Model Number

Designation	Description
*5318B	Capacitance-actuated On-Off Level Control. DPDT relay, fixed & adjustable differential (dead-band) and adjustable time delays. Explosion proof, weather tight enclosure. Unit mounts directly on sensing probe. Probe not included.

Table 1 - Supply Voltage

Designation	Description
A	18 to 36 VDC
*B	100 to 240VAC, 47 to 440 Hz, 50/ 60 Hz Nominal
C	9 to 18 VDC

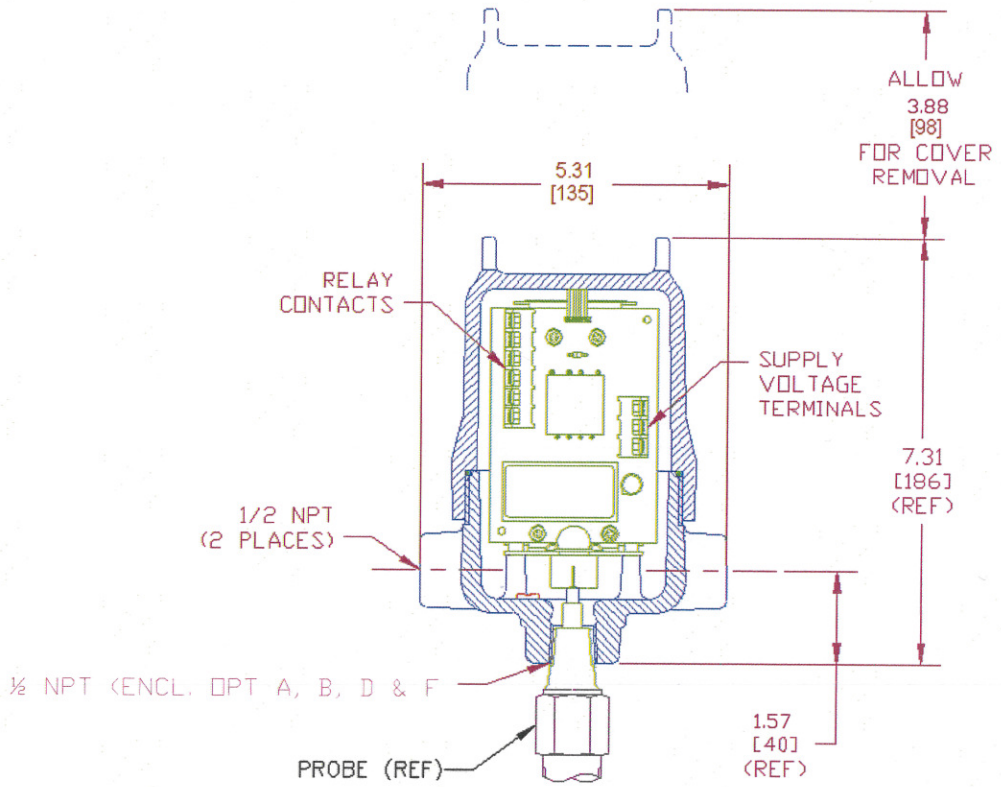
Table 2 – Options

Designation	Description
*1	No options.
2	Special, Lower Measurement Frequency (Consult factory)
3	Special, Custom Calibration (Consult factory)

Table 3 – Enclosure

Designation	Description
*A	½" NPT Probe Hub, Nitro Blue
B	¾" NPT Probe Hub, Nitro Blue
D	½" NPT Probe Hub, Gray Epoxy
E	3/4" NPT Probe Hub, Gray Epoxy

DIMENSIONS



CUSTOMER CONNECTIONS

RELAY CONTACTS*	
TERMINAL	**DESCRIPTION**
N.C. 1	Normally Closed No. 1
C 1	Common No. 1
N.O. 1	Normally Open No. 1
N.C. 2	Normally Closed No. 2
C 2	Common No. 2
N.O. 2	Normally Open No. 2

* Control relay contact designations are shown with relay in the de-energized condition. The relay is normally energized and becomes de-energized when level or process reaches the control point.

SUPPLY VOLTAGE (See Rating Plate)	
TERMINAL	**DESCRIPTION**
GND	Ground
NEU (+)	Power Input (supply voltage)
HOT (–)	

ACCESSORIES

COOLING EXTENSIONS (not shown)

If the temperature within a vessel can cause the electronics in the Model 5318B to be subjected to a temperature greater than its rating, consideration should be given to using a cooling extension. Refer to the Product Specification sheet for Cooling Extensions for more information.

REMOTE MOUNTING CABLES

If a lack of head room above the model 5318B may prevent cover removal, or if a high ambient temperature at the vessel will subject the Model 5318B to a temperature greater than its rating, the Model 5318B may be remote mounted with the use of a special cable.

The remote mounting cable consists of a stainless steel gland which screws into the Model 5318B, a Teflon insulated cable rated for 350° F (177° C), and an aluminum conduit outlet box for cable termination of the cable at the probe. Cable length should be kept as short as possible. Maximum recommended length is 15 feet (4.5 m). Consult the factory before using longer lengths. The remote mounting cables are not Agency certified and their use may void the explosion proof rating of the instrument enclosure.

CABLES FOR REMOTE MOUNTING THE 5318B

PART NUMBER	DESCRIPTION
032KX050-XX*	Coaxial cable with conduit outlet box. Meets NEMA 4.
032KX080-XX*	Coaxial cable with conduit outlet box painted with a gray epoxy enamel. Meets NEMA 4X.

* Replace XX with length in feet.
Maximum length 15 feet (4.5 m)

Robertshaw
INDUSTRIAL PRODUCTS

Robertshaw Industrial Products
1602 Mustang Drive
Maryville, Tennessee 37801
Phone: (865) 981-3100 Fax: (865) 981-3168
http://www.robertshawindustrial.com

Q-4178 (7/07) **Printed in the U.S.A.**

Marley item # D62900 Probe only
Robertshaw part # 741A-B38N
Note: Requires a head unit

Robertshaw
INDUSTRIAL PRODUCTS DIVISION

Model 741A & 741C Probe



GENERAL DESCRIPTION

The Model 741A is a general purpose high gain rigid probe for use with Robertshaw capacitance instruments. It is used for level measuring applications involving liquids or dry materials. Available either bare (non-insulated) or Teflon insulated for use in conductive solutions. The Teflon electrode insulation has a Teflon wall thickness of 1/32" over a 7/16" 316 stainless steel sensing rod. The Teflon insulated probe is recommended for use on low viscosity liquids and low density granular materials. (For abrasive or agitated products, see Robertshaw Model 728B Heavy Duty probes.)

The Model 741A Probe has been designed to ensure long, trouble-free life. Extra tight fitting Teflon insulation has been incorporated into the design of the Model 741A Probe series. This insulation is continuous through the total length of the probe including the gland with an internal stainless steel sheath over the Teflon inside the gland. If a seal should break down and allow leakage into the gland, this internal construction is such that the measurement will not be affected and reliable readings will continue.

The Model 741A Probe, except as noted, conforms to the requirements of the National Association Of Corrosion Engineers (NACE) specification MR0175-88 (Material requirements For Resistance To Sulfide Stress Cracking For Oilfield Equipment).

The Model 741C Probe is a Model 741A Probe that has been registered in Canada as a pressure containing fitting and bears the Canadian Registration Number (CRN). All specifications for the Model 741C, except as noted are identical to the specifications for the Model 741A Probe.

APPLICATION DATA

When a probe is used with on-off (point level) instruments, it may be installed in the vessel either horizontally or vertically. For extremely small differential (deadband), the probe should be mounted in a horizontal position at the desired level point.

If the probe is to be used on a continuous level measurement application, the probe must be mounted in the vessel in a vertical position.

For low dielectric liquid applications, the Model 741A probe offers a concentric shield option over the sensing electrode.

Various gland materials and/or optional flanges are readily available to meet particular requirements.

- **Non-shortable Gland Assembly**
- **Extra tight Fitting Teflon Insulation**
- **Many Options Available to Tailor Probe to Customers' Needs**
- **Available in Lengths to 20 Feet**
- **No Moving Parts**
- **Canadian Registration Number (CRN Model 741C)**
- **Conformance to NACE MR0175-88 (Certain Models)**
- **High Gain for Low Dielectric Materials**

Invensys
An Invensys company

SPECIFICATIONS

Temperature/Pressure Ratings

Non-Insulated Probes ..... -30" Hg to 600 psi
Up to 100°F.
Derated to 0 psi @ 350°F.

Insulated Probes ..... -30" Hg to 600 psi
Up to 100°F.
Derated to 0 psi @ 350°F.

Gland Capacitance 56pf

Probe Gain (insulated probe in conductive liquid) 250 pf/ft.

Sheath Capacitance .....250 pf/ft.

ENGINEERING DATA

Probe Rod Material (standard) .....316 stainless steel

Probe Length (maximum) .....20 feet

Gland Connection Size ..... 3/4" NPT

Probe Diameter, Non-Insulated ..... 7/16" O.D.
Insulated ..... 1/2" O.D.

Gland Materials:
Standard .....316 stainless steel
Optional (741A Only) ..... Monel, Hastelloy C
Sheath Material .....316 stainless steel
Optional (741A Only) ..... Monel, Hastelloy C

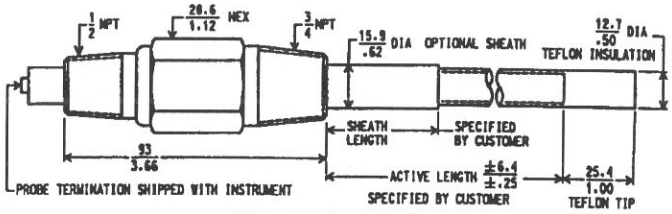
Canadian Registration Number (CRN) OH0461.9

BEND DIMENSIONS

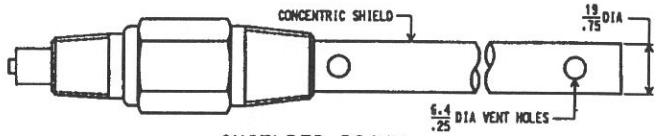
Probe Style	Minimum Lengths		
	L1	L2	L3
Basic Probe	3.50"	3.50"	-
With Straight Sheath	4.50"	3.50"	-
With Bent Sheath	3.50"	4.50"	3.50"
With Welded Flange	4.75"	3.50"	-
With Welded Flange and Straight Sheath	4.75"	3.50"	-
With Welded Flange and Bent Sheath	4.75"	4.50"	3.50"

DIMENSIONAL DATA

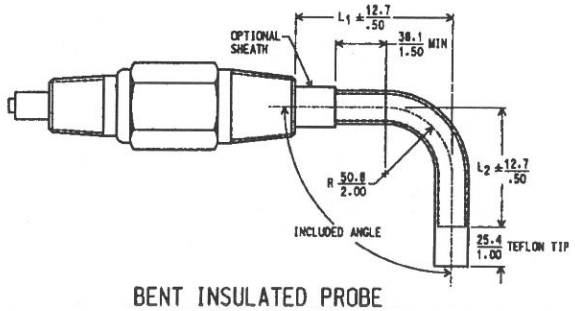
MM
INCH



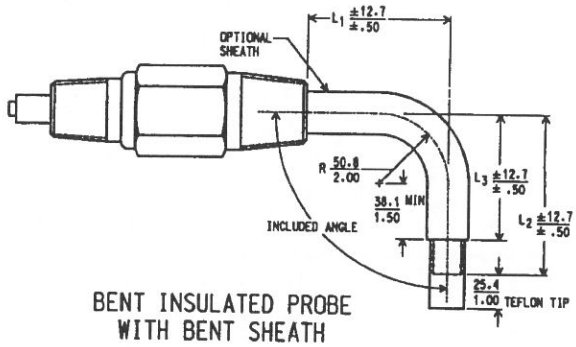
INSULATED PROBE



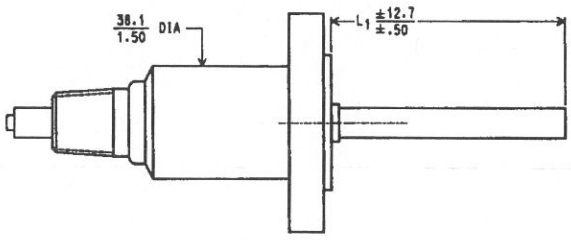
SHIELDED PROBE



BENT INSULATED PROBE
WITH STRAIGHT SHEATH



BENT INSULATED PROBE
WITH BENT SHEATH



BARE PROBE WITH WELDED FLANGE

ORDERING INFORMATION

Specify complete model number according to the tables below.

741A – A xxx - N 0

- Key Model Number
- Table 1 - Gland and Rod Material
- Table 2 - Probe Active Length
- Table 3 - Flange Option
- Table 4 - Additional Options

KEY MODEL NUMBER

Model No.	Description
741A	High gain rigid capacitance probe. The probe utilizes the patented, non-shorting gland assembly.
741 C	Same as 741 A except registered in Canada and bears the CRN.

Table 1- GLAND AND ROD MATERIAL

Desig.	Description
A	316 St. St. gland and 7/16" bare rod
B	316 St. St. gland with 1/2" O.D. Teflon over 7/16" rod
C*	Monel gland with 1/2" O.D. Teflon over 7/16" St. St. rod
D*	Hastelloy C gland with 1/2" O.D. Teflon over 7/16" St. St. rod

*** Not available with Model 741C.**
Does not conform to NACE MR0175.

Table 2 - PROBE ACTIVE LENGTH

Desig.	Description
xxx 38 inches	Specify active length in inches. Maximum length is 240". For insulated probes the insertion length is 1" longer than the active length due to the Teflon Tip.

Table 3 - FLANGE OPTION

Desig.	Description
N	None
A*	Flange Screwed onto probe gland. **Specify size and material.**
B	Flange welded to probe gland. **Specify size and material.**

*** Not available with Model 741C.**

Table 4 - ADDITIONAL OPTIONS

Desig.	Description
0	None
1	Bent Probe. **Specify Bending Dimensions.** See Bending Dimension table and drawings.
2	Sheath, same material as gland. **Specify Sheath Length.**
3	Combination of 1 & 2 above.
4	Ground Wire Probe. **Specify Material.**
5*	Concentric shield, same material as gland.

*** Does not conform to NACE MR0175.**

Standard Flange Sizes
1" Class 150 Raised Face
1-1/2" Class 150 Raised Face
2" Class 150 Raised Face
3" Class 150 Raised Face
4" Class 150 Raised Face
1" Class 300 Raised Face
1-1/2" Class 300 Raised Face
2" Class 300 Raised Face
3" Class 300 Raised Face
4" Class 300 Raised Face

Standard Flange Materials
* Carbon Steel
* * 316 Stainless Steel
316L Stainless Steel

*** Does not conform to NACE MR0175.**
**** Does not conform to NACE MR0175. Not available with 741C.**

Ground Wire Materials
* 316 Stainless Steel
316L Stainless Steel
* Monel
* Hastelloy B
* Hastelloy C
* Tantalum

*** Does not conform to NACE MR0175.**

NOTES:

1. The insertion length for insulated probes is 1" longer than the active length due to the Teflon Tip which is required for sealing the probe. For bare probes the insertion length is the same as the active length.

2. For simple bent probes, specify dimensions L_1, L_2, the included angle and, if the sheath is bent, L_3 as shown in the drawings. For more complicated bending submit a sketch with the order.

3. Probes may be supplied with flanges of different sizes, styles and materials than listed above by special order.

FILE NO.

NO MANUAL REVISIONS PERMITTED		909HB918		
REV.	CHANGE NO.	DESCRIPTION	REVISED DATE	BY
A	96284	RELEASE FOR PRODUCTION	19APR06 20APR06 17MAY06	PDK PDK PAJ
B	96435	ADD POWER SUPPLY DESIGNATION C, ADD OPTIONS DESIGNATION 2 REMOVE ENCLOSURE OPTIONS B, C, E, F. ADD "* DENOTES STANDARD CONFIGURATION" REMOVE FLANGE MOUNT VIEW FORM PAGE 2	27MAY07 28FEB07 20APR07	PDK PDK JOE

ELECTRICAL CONNECTIONS

TB101 - SUPPLY POWER	
GND	EARTH GROUND
NEU(-)	SUPPLY POWER
HOT(+)	(SEE RATING PLATE)

TB102 - CONTACTS	
N.C. 1	NORMALLY CLOSED #1
C 1	COMMON #1
N.O. 1	NORMALLY OPEN #1
N.O. 2	NORMALLY OPEN #2
C 2	COMMON #2
N.C. 2	NORMALLY CLOSED #2

CONTROL RELAY CONTACT DESIGNATIONS ARE SHOWN WITH THE RELAY IN THE DE-ENERGIZED CONDITION. THE RELAY IS NORMALLY ENERGIZED AND BECOMES DE-ENERGISED WHEN THE LEVEL REACHES THE CONTROL POINT.

MODEL NUMBER IDENTIFICATION

5318B - B1 - A

- KEY MODEL NUMBER
- SUPPLY POWER
- OPTIONS
- ENCLOSURE

KEY MODEL NUMBER

DESIGNATION	DESCRIPTION
5318B	CAPACITANCE INPUT POINT LEVEL SWITCH.

SUPPLY POWER

DESIGNATION	DESCRIPTION
A	18 - 36 VDC
B✳	100 - 240 VAC, 50/60 Hz
C	9 - 18 VDC

OPTIONS

DESIGNATION	DESCRIPTION
1✳	STANDARD
2	SPECIAL, LOWER MEASUREMENT FREQUENCY

ENCLOSURE

DESIGNATION	DESCRIPTION
A✳	TYPE 4, NITRO BLUE
D	TYPE 4X, GRAY EPOXY

✳ DENOTES STANDARD CONFIGURATION

THIS CERTIFICATION APPLIES ONLY TO YOUR

ORDER: _____

ITEM OR TAG: _____

ROBERTSHAW ORDER NO: _____

APPROVED: _____ DATE: _____

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DR. PDK
DATE 13JAN06
DES. APPD. PDK
DWG. CHKD. PAJ
REQUIRED CERTIFICATIONS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES UNLESS SPECIFIED
DECIMALS ±.005
ANGLES ± 1°
CAST SURFACES ±.032
REMOVE BURRS-BREAK CORNERS .015 MAX.

SPECIFICATIONS: ANSI Y14.5M-1982 Ø6-70.0150

SCALE _____ EXP. DRAWING NUMBER

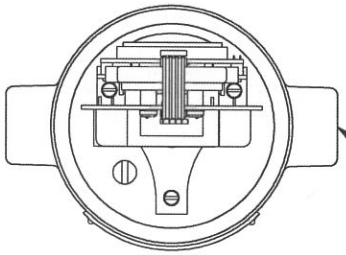
invensys Robertshaw
INDUSTRIAL PRODUCTS
MARYVILLE, TENNESSEE

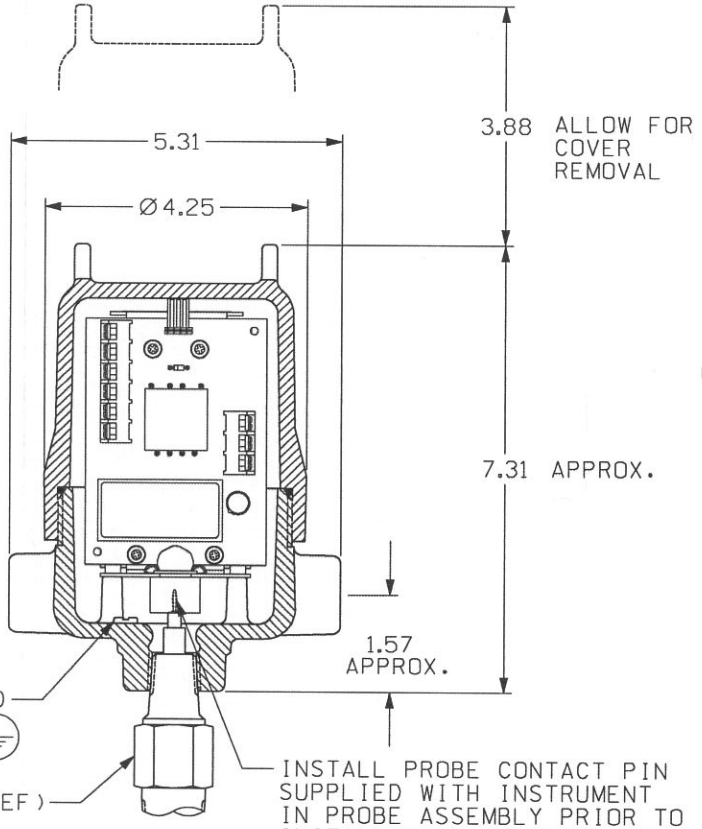
CERTIFIED PRINT
INSTALLATION DRAWING
MODEL 5318B

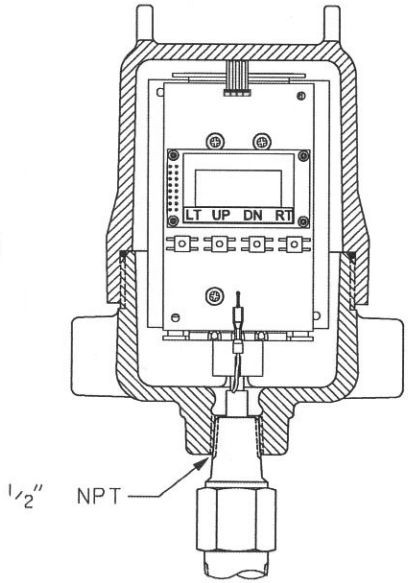
PROD. DWG. NO. 909HB918 REV. B

FILE NO.

NO MANUAL REVISIONS PERMITTED		909HB918		
REV.	CHANGE NO.	DESCRIPTION	REVISED DATE	BY
B	96435	SEE SHEET 1		







DISPLAY SIDE

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DR. PDK	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DATE 13JAN06	TOLERANCES UNLESS SPECIFIED
DES. APPD. PDK	DECIMALS ±.005
DWG. CHKD. PAJ	ANGLES ± 1°
REQUIRED CERTIFICATIONS	CAST SURFACES ±.032
	REMOVE BURRS-BREAK CORNERS .015 MAX.
SPECIFICATIONS: ANSI Y14.5M-1982 06-70.0150	
SCALE	EXP. DRAWING NUMBER

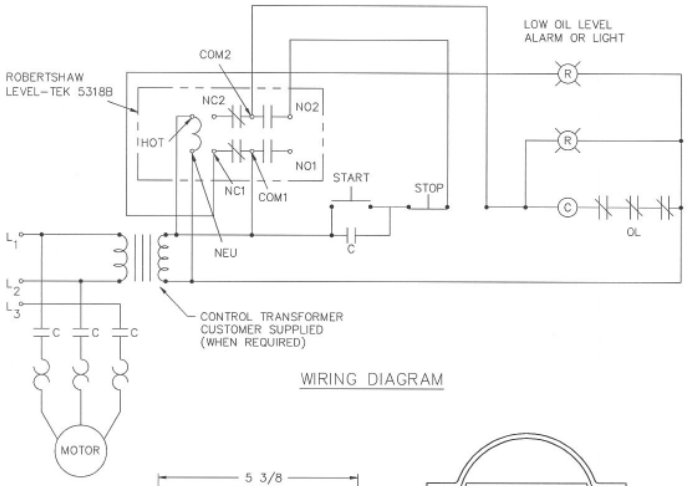
invensys

Robertshaw

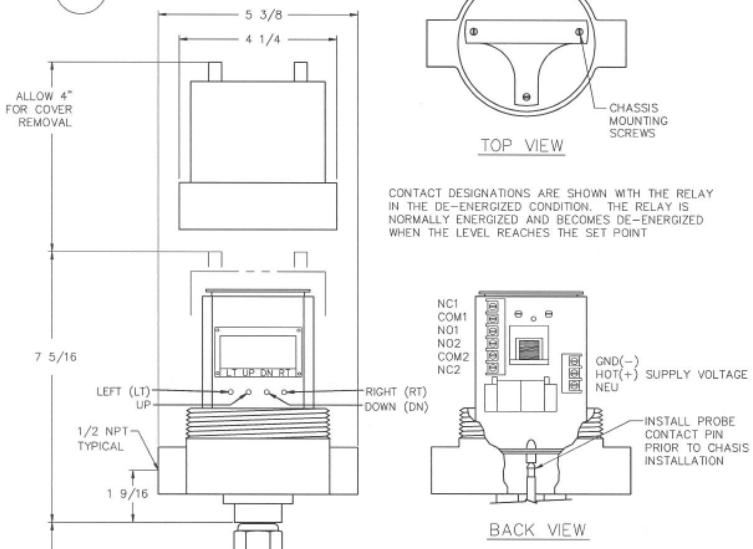
INDUSTRIAL PRODUCTS
MARYVILLE, TENNESSEE

CERTIFIED PRINT
INSTALLATION DRAWING
MODEL 5318B

PROD. DWG. NO. 909HB918 REV. B



WIRING DIAGRAM



TYPICAL INSTALLATION

TOP VIEW

CONTACT DESIGNATIONS ARE SHOWN WITH THE RELAY IN THE DE-ENERGIZED CONDITION. THE RELAY IS NORMALLY ENERGIZED AND BECOMES DE-ENERGIZED WHEN THE LEVEL REACHES THE SET POINT

BACK VIEW

GENERAL INSTALLATION & CALIBRATION DETAILS; REFER TO MANUFACTURER'S INSTRUCTIONS SUPPLIED WITH SWITCH FOR OTHER DETAILS.

1. ASSEMBLY OF INSTRUMENT & PROBE.
The probe electrical connection pin (included w/ instrument) should be installed in the end of the probe so as to make a connection with the instrument chassis when installed (See Detail in Backview)

2. ELECTRICAL CONNECTIONS.
The instrument chassis assembly may be removed from the housing for wiring installation by loosening the three chassis mounting screws (captive screws) and withdrawing the chassis straight out of the housing. Care should be exercised in re-installing the chassis to engage the probe connection pin in the chassis receptacle. All electrical connections should be made in accordance with the Wiring Diagram.

3. SELECTING THE OPERATING MODE.
The model 5318B is designed to be field configurable. This includes the selection of the fail-safe mode so that the relay contact opens upon the loss of electrical power. IMPORTANT: All power to the relay connections should be removed when making adjustments and calibrating to safeguard against electrical shock.

4. CALIBRATION ADJUSTMENTS.
Low level alarm/control – in this mode of operation the alarm will be sounded when the oil level drops below the control point or power to the instrument is lost. NO OIL IS DRAINED from the geareducer to perform this calibration. Check to make sure oil level is at the full mark before starting this calibration procedure.

a. Initial Setup.
The Model 5318B is configured through entries made in the setup table. The current values are displayed on the integral LCD display and adjusted using the four pushbuttons located below the LCD display.

i. Enter the setup mode by pressing the [DN] button once followed by pressing the [RT] button once. This will enter the SETUP mode and will display the current High SP value.

ii. Press the [DN] button three times to access the FAILSAFE mode. Push [RT] twice to change the mode. Use the [UP] or [DN] buttons to adjust the displayed value to "LLFS". When the proper value is displayed press the [RT] button to select this value.

iii. Press the [DN] button once to access the AlarmDly setting. This is the time delay when an alarm condition is detected. Press the [RT] button to allow the time delay to be adjusted. Use the [DN] button to adjust the display value to "00", then press [RT].

iv. Press the [DN] button once to access the RetDly setting. This is the time delay when an alarm condition is reset. Press the [RT] button twice to allow the time delay to be adjusted. Use the [UP] and [DN] buttons to adjust the display value to "00", then press [RT].

v. Press the [LT] button twice to exit the SETUP mode.

b. Start the motor and run for 15 minutes to allow the oil level and temperatures to stabilize.

c. Set Point Calibration:

i. Press the [DN] button twice to enter the calibration mode.

ii. Press the [RT] button twice to begin the process of selecting the operating mode.

iii. Press the [DN] button six (6) times to access the "Control" mode.

iv. Press the [RT] button to select the "Control" mode.

v. Since the operating oil level should now be at the normal draw down amount, Press the [RT] button twice to save this set point. The 5318B will now return to its normal operating mode.

vi. The set point will now be adjusted from the normal operating point to the Alarm Set Point. Start by pressing the [DN] button once.

vii. Press the [RT] button three (3) times. Screen should say "High SP DN 0.0%"

viii. Press the [DN] button until the % on the readout is 1.2% when used with a 3/4 inch diameter standpipe, this percentage is equivalent to 1 inch below the Alarm Set Point.

ix. Press the [RT] button to select.

x. Press the [LT] button twice to return to normal operation.

d. Time Delay Adjustment:

i. Press the [DN] button once. Press the [RT] button once. Press the [DN] button four (4) times to display the "AlarmDly" setting. Push [RT] twice to change the "AlarmDly" setting.

ii. Use the [UP] button to adjust the displayed time delay value to 15 seconds, then press the [RT] button to accept this value.

iii. Press the [LT] button to return the 5318B to normal operation.

e. Shut down the motor and allow the oil level to stabilize. Check the gearbox to be sure the oil level has returned to the "Full" mark with the motor off.

SWITCH AND PROBE ARE ORDERED SEPERATELY. PROBE LENGTH IS DETERMINED BY APPLICATION. THE ROBERTSHAW LEVEL-TEK SWITCH USES ROBERTSHAW GENERAL PUPOSE RIGID PROBE 741A-B12-"LENGTH IN INCHES"

APPROXIMATE WEIGHT 5 LBS

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LTR	DATE	REVISION	BY	CHKD
C	12/26/2012	16881	RWS	GLS
B	8/11/2009	12309	RWS	RLL
A	2/11/2009	11673	GLS	RLL

LOW OIL LEVEL SWITCH INSTALLATION AND CALIBRATION DETAILS
ROBERTSHAW LEVEL TEK 5318B

PLOT	DATE	DRAWN	CHECKED	APPROVED	CAD
NONE	05-07-2007	GLS	RL	RL	

ORDER NUMBER | DRAWING NUMBER 07-22070 | REV C

Cooling Tower Performance

FAN MOTOR OVERAMPING

Overamping

Overamping occurs when the amperage drawn by the fan motor exceeds the fan motor nameplate amperage. In other words, more horsepower is required than the recommended maximum for the motor. Overamping is often thought to be caused by incorrect fan pitch, but it is likely the result of other issues that are not inherently related to the fan. Before attempting to repitch the fan blades, please refer to the Troubleshooting list on page 2.

If following the troubleshooting list does not solve the problem, the issue may lie with the fan pitch. The blades are pitched to draw approximately the same volume of air year-round while consuming power that is less than the motor nameplate. However, the air density is higher in winter, and the fan will draw more horsepower than in the summer to move the same volume of air. In addition, the initial trial pitch is calculated using theoretical models, meaning it may need adjustment after taking into account deviations in the system. If incorrectly pitched, the fan can draw more than the nameplate horsepower of the motor, leading to overamping. When full nameplate amps are drawn at design conditions, the cold water temperature will be in alignment with the contractual guarantee. Please follow the fan user manual for the correlation between air density and motor amperage.

Finally, it is important to note that overamping can be acceptable in certain situations. Particularly, if the ambient conditions are much colder and/or the range is much lower than design, the increased air density may cause overamping. All fan motors are selected with a 1.15 safety factor for operation at the maximum ambient temperature, so a small amount of overamping at or below the design ambient conditions will not cause the motor to overheat.

The relationship between power draw and amperage for 3-phase power is shown by the following equation:

$$hp = V \times I \times \sqrt{3} \times f_p \times \frac{\eta}{746} \qquad kW = V \times I \times \sqrt{3} \times f_p \times \eta$$

Where V *= voltage*
I *= currents (amps)*
f_p *= power factor*
η *= efficiency*

For example, assume an 1800 rpm motor has a nameplate of 40 hp, with a voltage of 460 V, and nameplate amperage of about 49 A. Efficiency is normally about 95% while the power factor usually has a value of about 0.85. If the fan is overamping by 5%, it is drawing about 51.6 A, or 42 hp. This assumes the voltage is relatively constant. It is important to note that the power factor is not constant for any particular system. Therefore, a calibrated wattmeter is preferred when measuring power because it automatically measures the motor power factor.

Possible Cause of Overamping	Solution
Air density variation due to insufficient heat load or colder ambient temperature than design	- Ensure cooling tower is operating at full design duty at design ambient conditions
Inaccurate instrumentation used in measuring power/ current draw	- Calibrate wattmeter/voltmeter/ammeter - Measure after cooling tower has been operating continuously for 15 minutes (high current during motor startup)
Low voltage	- Check system wiring (connections, length of wires, etc.)
Power loss from point of measurement to motor	- Measure power as close to motor as possible
Overload heater tripping	- Measure voltage (low voltage causes trips, particularly during start-up) - Ensure heater is in correct location
VFD operating incorrectly	- Run the system in bypass mode; if overamping ceases, the VFD should be inspected
Incorrect wiring	- Rewire system if it does not match the wiring diagram
Incorrect motor speed	- Replace motor if speed is incorrect
Incorrect gearbox ratio	- Ensure the gear ratio is the same as the engineering record - Rotate fan by hand to manually count reduction ratio
Incorrect number of fan blades	- Compare fan blade count to that of the engineering record; fan replacement is necessary if different
Incorrect blade pitch measurement procedure	- Ensure the proper measurement procedure is followed (reference fan user manual for specific fan model)
Oil in gearbox is viscous due to temperature	- Ensure adequate warm-up time for the gearbox (typically 15 minutes minimum)

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Hands on Training – Marley MC Coupling Replacement

Objective: Learn how to install the Marley MC Series Close Coupling. Gain a better understanding of the information that is included in the Coupling User Manual. Learn what steps it takes to check and verify the alignment, and gain a better understanding of what it takes to make a correction if the alignment is out.

Scenario: Customer has had their cooling tower(s) operating for several years. They have recently noticed that the flex element on their close coupling is showing signs of wear. They have ordered a complete coupling replacement.

Provided Items and Tools:

Close Coupling	ratchet Wrench
User Manual	Sockets
Box Wrenches	Straight Edge
Torque Wrench	Tape Measure

Step 1: Remove old coupling. Refer to user manual for Reference.
Loosen bolts on clamp rings, to a point where you can remove the flexible element.

Step 2: Loosen motor from support.

Step 3: Remove Coupling Hubs from motor and geareducer.

Step 4: Clean motor and geareducer shafts, verify keys are in good condition to be re-used if not replace with new.
Step 5: Install new hubs onto shafts.
Step 6: Re-mount motor into place
Step 7: Set proper distance and alignment.
Step 8: Verify the coupling spacing and angular alignment.
Use the information found in the user manual to verify if your settings are correct.

What is the measured coupling spacing “C” at four places?

1. _____	3. _____
2. _____	4. _____

Is the angular alignment within tolerance? Be sure and check in at least 4 places. If it is not, what is your measurement?

1. _____	3. _____
2. _____	4. _____

Based on the checks and measurement taken, does this mechanical equipment need adjusted? If it does, correct, and recheck. Repeat as until within tolerance.

Step 9: Re-install the flex element. Be sure to use the torque wrench, to tighten the clamp ring bolts to _____ Ft-lbs. (found in the manual).

MARLEY®

user manual

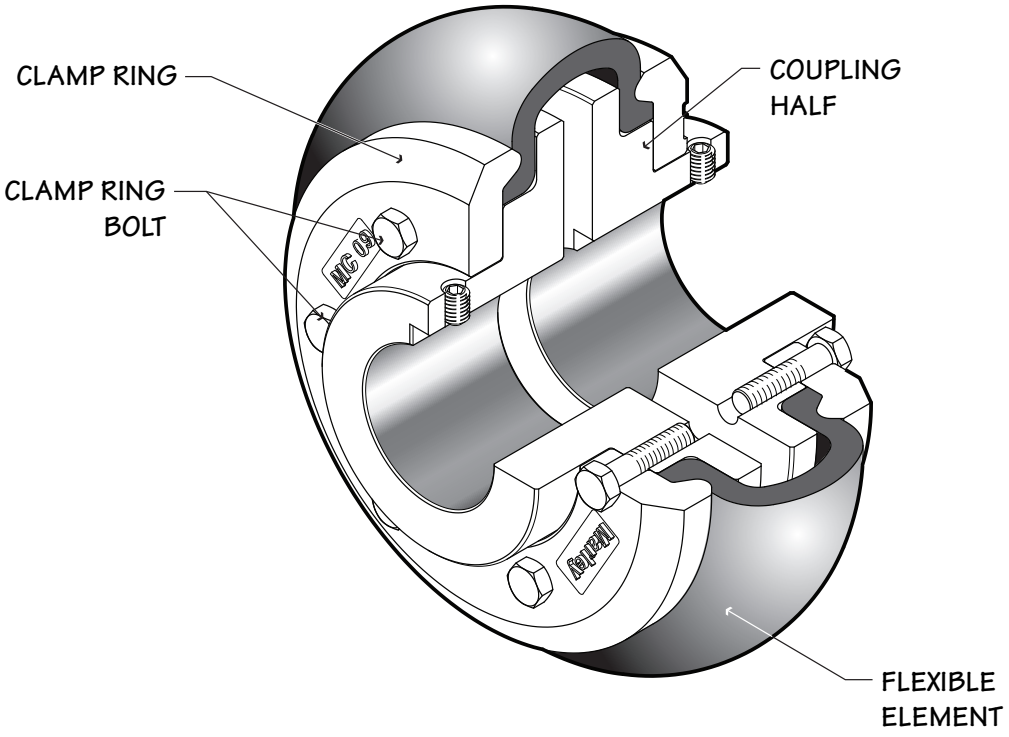
Softork™ MC coupling

INSTALLATION - OPERATION - MAINTENANCE

Z0592740_B ISSUED 02/2019

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



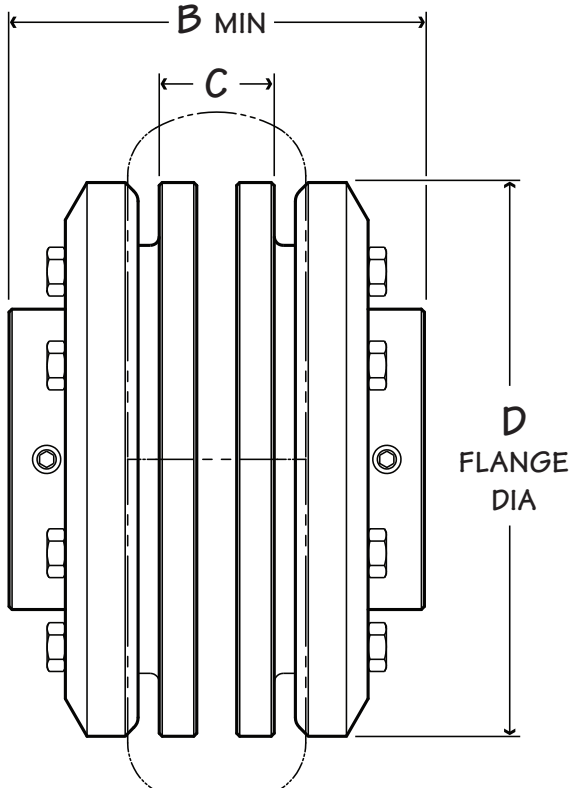


Assembly and Alignment

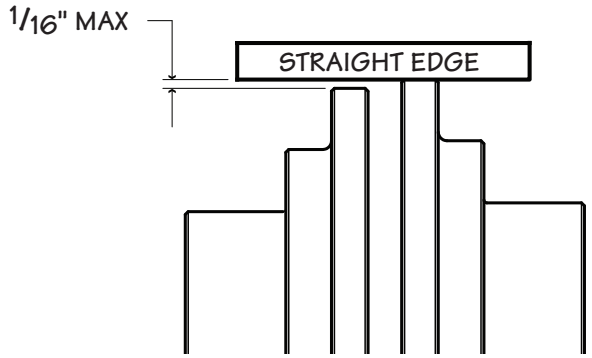
1. Inspect and clean motor and Geareducer® shafts. Remove any burrs on shafts with emery cloth or a fine file. Remove all lubricants from coupling bores and mating surfaces. Install keys in motor and Geareducer shaft keyways.
2. Install a clamp ring on each coupling half using the bolts provided.

   Note: Leave this attachment loose for now, only engaging a few threads of each bolt–it may be necessary to reposition the clamp rings for parallel alignment–Step 7.
   Caution: Do not lubricate bolt threads.
3. Slip each coupling half onto its mating shaft. Move the motor and Geareducer into place.

   Note: Clamp ring must be mounted to coupling half before the motor and Geareducer are positioned.
4. Check coupling spacing by measuring dimension "C" at the top of the coupling only. Refer to Table and Detail 1. Slide the coupling halves along the shafts to obtain spacing. The maximum distance between shaft ends is 2". The shafts may protrude through the coupling halves if necessary.
5. Tighten each set screw on its key–24 ft·lb$_f$.



Detail 1



Detail 2

6. Check angular alignment by measuring the “C” dimension at 90° intervals (take at least four measurements). The total difference between any two measurements, C max – C min, must not exceed 1/16". See Detail 1.
7. Check parallel alignment by laying a straight edge across the outside of the coupling halves at several places around its circumference. Parallel misalignment may not exceed 1/16". See Detail 2.

   Tip: If the clamp rings are larger in diameter than the coupling halves, remove enough clamp ring bolts to rotate the clamp rings so the straight edge bears directly on the coupling halves.

   If measured misalignment is greater than 1/16", shim the motor and/or Geareducer mounting feet to obtain proper alignment. After adjusting shims, tighten the hold-down hardware and check alignment. Repeat the procedure until proper alignment is achieved. The best alignment is achieved when the straight edge is in contact with the coupling halves at four points as shown in Detail 2.
8. With clamp ring bolts holding the clamp ring(s) in place, wrap the flexible element around the clamp rings as shown. Make sure the beads of the element are fully worked down into the seats.
9. Hold the split of the flexible element closed. An 1/8" maximum gap is allowable. Tighten one or two bolts directly opposite the split—enough to hold the flexible element in place. Using both hands, knead the rubber element toward the split. Hold split closed and tighten the next two bolts farthest from split—enough to hold the flexible element in place. Repeat this procedure on all remaining flange bolts. Retighten each bolt in the order shown in Detail 3 using a torque specified in table.

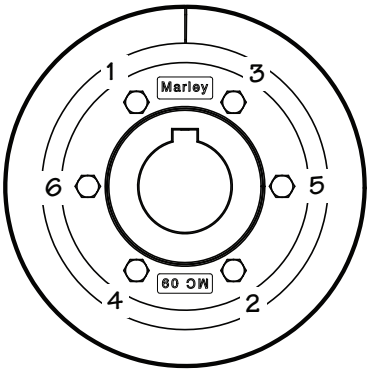
   Note: MC07 couplings have 5 bolts/half, use a similar cross pattern.

   Tighten all bolts a second time to the specified torque.

   Caution: Do not over-torque bolts or you may damage the clamp ring.

Maintenance

1. Marley SofTork couplings do not require lubrication.
2. Thoroughly inspect the coupling at least every six months. Check for looseness of set screws and coupling halves on shafts, and for wear of the flexible element.
3. Contact your Marley sales representative if you need replacement parts. Call 913 664 7400 or check the web at spxcooling.com to locate your nearest rep.



Detail 3

Coupling	B	C	D	Torque ft · lb_f	Cap Screw
MC07	5 1/8"	1 1/2"	5 5/8"	24	5/16" x 1 1/2"
MC09	5 9/16"	1 17/32"	7 3/8"	40	3/8" x 1 1/2"
MC11	6 3/8"	1 9/16"	9 3/16"	40	3/8" x 1 1/2"
MC12	6 7/8"	1 3/4"	10 1/8"	90	1/2" x 1 1/2"

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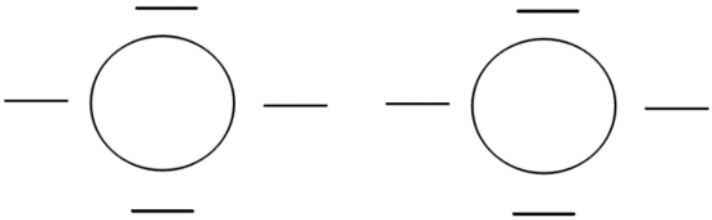
Hands on Training – Marley 6Q Driveshaft Replacement and Alignment Check

Objective: Learn how to replace and align a Marley Driveshaft. Gain a better understanding of the information that is included in the Marley Driveshaft Manual, and the Dial Indicator Kit User Manual. Learn what steps it takes to check and verify the alignment. Gain a better understanding of what it takes to make a correction, if the alignment is out.

Scenario: Customer has just purchased a new driveshaft for their NC8400 cooling tower(s), with the MOA (motor outside airstream) option. The old drive shaft has to be removed and the new one installed and properly aligned. The alignment readings have to be checked and reported. With the use of the Marley Dial Indicator Kit, take the readings and verify that the alignment is correct, if not make the proper adjustments.

Provided Items and Tools:
6-Q driveshaft assembly
Marley 6-Q, 175, 250 User Manual
Wrenches
Sockets
Torque Wrench
Marley Dial Indicator Kit User Manual
2- Marley Dial Indicator Kits
Shim Kit
Replacement Hubs
New Flex Elements

Step 1: Remove existing driveshaft Tube and Flange and Couplings. Reference user manual as needed.
Step 2: Clean motor and geareducer shafts, verify keys are in good condition to be re-used if not replace with new.
Step 3: Install new driveshaft. Follow steps in the user manual found on pages
Step 4: Install Dial Indicator(s) to the coupling flange. Refer to the Marley Dial Indicator Kit User Manual for step-by-step instructions.
Step 5: Take measurements and determine if driveshaft alignment is within tolerance.
Step 6: Record Readings - use the below chart to record your data at the 12, 3, 6, and 9 o'clock locations for both the motor and driveshaft ends:



Motor Geareducer

Step 7: Based on the charts above correct alignment if needed by shimming or making the adjustment side to side to obtain a proper alignment?

Step 8: Retake alignment readings if adjustments were made. Repeat until correct.

Bonus Instruction: Replace Flex Elements in drive shaft yoke. Best method with an arbor press. Field option using C-clamp.

Take Away Points:

- Understand steps for installation of driveshaft assembly.
- Understand how to zero your indicator.
- How much travel does the indictor have?
- What tolerance does the alignment have to meet, or where can I find this information?

MARLEY®

user manual

6Q - 175 - 250 Series driveshaft

INSTALLATION - OPERATION - MAINTENANCE

Z0239004_A ISSUED 06/2017

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



driveshaft parts list

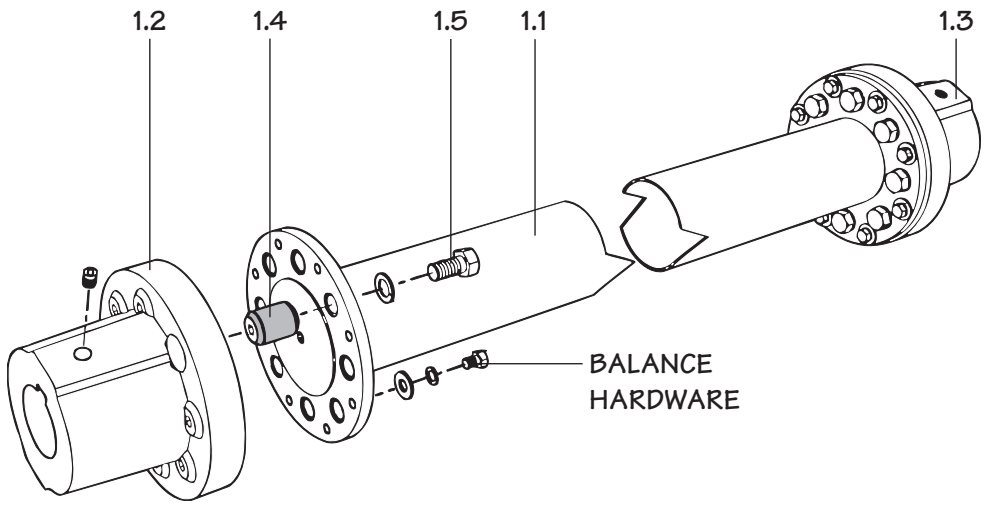


Figure 1 *250 Series shown*

1.0 Complete driveshaft assembly

1.1 Tube and flange assembly

1.2 Geareducer yoke assembly with set screw

1.3 Motor yoke assembly with set screw

1.4 Bonded rubber bushing. 8 required for 6Q and 175 Series and 16 required for 250 Series.

1.5 Machine bolt or cap screw with lock washer. 8 required for 6Q and 175 Series and 16 required for 250 Series. The 175 Series also requires 8 nuts.

Note

Complete driveshaft assemblies are dynamically balanced at the factory. When replacement parts are installed, driveshaft may need to be rebalanced.

When ordering parts, always provide cooling tower serial number. Contact the Marley sales office or representative in your area for assistance.

installation

General

Marley driveshafts consist of a motor and Geareducer yoke with rubber bushings and a tube and flange assembly. Driveshafts are balanced dynamically and tube and yoke flanges are match-marked. See Figure 3. Do not change position or relation of match-marked components during installation.

Driveshafts must be rebalanced whenever yokes or tube and flange assemblies are replaced. The driveshaft may be rebalanced on the tower. See instructions on page 6.

Installation

Before installing the driveshaft, be sure the motor and Geareducer are on level bases and that their shafts are in reasonable alignment.

Note match numbers on the driveshaft flanges and remove the yokes. Coat the motor shaft and Geareducer shaft with “Thred-Gard” (Crane Packing Co.) or similar lubricant. Place the key halfway in motor and Geareducer shafts, then install yokes as shown in Figure 4. Use a rubber mallet or wood block when tapping yokes to prevent damage. Tighten each yoke set screw against key.

Align match numbers on tube and yoke flanges and bolt the tube and flange assembly to the Geareducer yoke while supporting the motor end of the tube and flange assembly. Progressively tighten bolts to 60 ft·lb*f* (82 N·m) torque. Slide the motor so that motor yoke can be bolted to the tube and flange assembly without pushing or pulling on the bushings. Align match numbers and bolt the motor yoke to the tube and flange assembly. Progressively tighten bolts to 60 ft·lb*f* (82 N·m) torque. The distance between tube and yoke flanges should be as shown in Figure 4.

Alignment

Check the alignment of motor shaft, driveshaft and Geareducer shaft by measuring between the tube and yoke flanges. Alignment requires the distance between adjacent points on the two flanges not vary more than .005" as the points make one complete revolution. A preliminary check of alignment can

be made by measuring between the flanges at four points: top, bottom and two sides. Alignment requires measurement with a dial indicator as described in the following section. A ***Marley Dial Indicator Alignment Kit*** is available from SPX Cooling Technologies.

Checking Alignment with Marley Dial Indicator Kit

1. Screw adapter bushing into one of the balancing holes on the tube flange. If necessary, remove any balance hardware. Reinstall balance hardware in original location before running the drive shaft.
2. Insert the dial indicator into the adapter until indicator point contacts the face of the yoke.

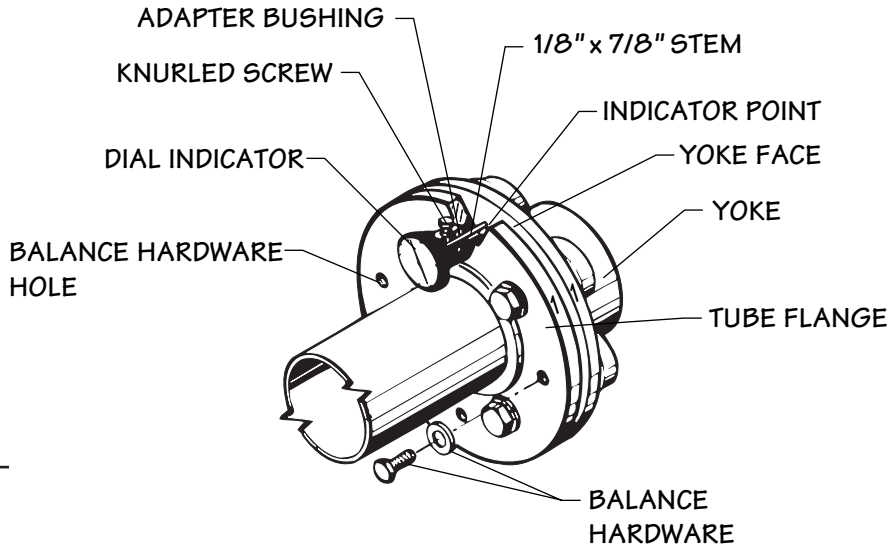


Figure 2 *6Q Series shown*

3. The indicator point must remain in contact with the yoke face during one complete revolution, it must not at any time be pushed in so far that it bottoms out reaching the limit of the stem movement. The total travel of the indicator point is 0.100".
4. When the dial indicator has been positioned, tighten the knurled screw in the adapter enough to hold the indicator stem in contact with yoke face.
5. Check alignment at each end of the driveshaft by rotating the shaft 360° noting the total change in the reading on the dial indicator. Total indicator reading must not exceed .005". Move the motor and/or Geareducer vertically by shimming, or horizontally by shifting on support. Align driveshaft

until the total indicator reading at each end is within .005". Tighten all mounting bolts on the motor and Geareducer, and recheck alignment. Maintain gap between face of flange and face of yoke as shown in Figure 4.

Vibration

Forced vibration is a condition where a mechanical system is caused to vibrate at other than a natural frequency. A forced vibration can result from driveshaft imbalance. Vibration at the driveshaft or motor shaft, rotating frequency as measured on the motor suggests driveshaft or motor rotor imbalance. The severity of imbalance is measured in terms of mils, or thousands of an inch, displacement is usually read in peak-to-peak or double amplitude. For example, a vibration at .002" peak-to-peak at 29.3 CPS (1760 RPM ÷ 60 seconds = 29.3 cycles per second) could indicate a motor rotor or driveshaft imbalance.

Note

Drive shaft vibration resulting from imbalance can generally be reduced to .002" peak-to-peak, but in no case should it exceed .005".

If vibration is considered excessive and driveshaft imbalance is suspected on a fan-cell of a multicell tower, measure and record vibration amplitude and frequency in horizontal and vertical planes at the motor and at the Geareducer with all fans, except the one being tested, in operation. These readings will show the vibration introduced from outside sources. Do not attempt to compensate for this vibration within the fan-cell under test.

Start the motor on the test cell. Measure and record vibration amplitude and frequency at the same points and attitudes as above. Three sets of readings should be obtained and the average compared with vibration measured as described in the previous paragraph with the test cell not in operation. The differences in amplitude are the vibration characteristics of the test cell.

If operating conditions permit, stop all motors on the tower except in the test cell and measure vibration as before. This will verify test cell vibration characteristics as calculated above.

Balancing

Note

When balancing a driveshaft on the cooling tower, do not exceed 30 seconds/hour total motor starting time. The motor may become overheated.

Add or remove washer weight or weights on one of the ⅜" balancing bolts in the driveshaft tube flange at the motor end. Figures 1 and 2. If improvement is made, continue to add or remove more washer weights at the same point.

Note

Adding weights at one point has the same effect as removing similar weights directly opposite (180°) . This can be used to keep the total weights to a minimum.

If vibration increases, restore original condition and repeat the same operation on a bolt 90° from starting point.

After the motor end is adjusted, repeat the same operation on the Geareducer end. Recheck the motor end to determine if the Geareducer end balance operation has increased motor end vibration reading. If so, repeat balancing of each end until no change in the opposite end is affected.

If a satisfactory balance cannot be obtained, turn the drive shaft tube and flange assembly end for end and repeat the balancing operation. Vibration readings can be taken on the motor with the motor yoke installed and the driveshaft disconnected to determine motor and yoke roughness. If vibration readings still indicate roughness, remove the yoke from the motor shaft and repeat the test to determine motor roughness.

Note

Marley driveshafts do not require lubrication.

Inspection of the complete driveshaft should be made at least every six (6) months. Look for corrosion, checking or cracking of rubber bushings, looseness of hardware, and alignment of the driveshaft. Accurate drive shaft alignment is required to insure maximum service life. Check alignment as outlined in the preceding section on page 4. Repair or replace drive shaft parts as necessary.

Replacing Bonded Rubber Bushings

1. Remove the tube and flange assembly by removing the ⅝" machine bolts or cap screws at each end of the driveshaft. It may be necessary to loosen the motor mounting bolts and slide the motor back slightly to provide clearance for the tube and flange assembly to be removed.
2. Remove bushings by driving or pulling out of yoke sockets in the direction of the yoke face.
3. Clean yoke sockets but do not polish.
4. Lubricate bushing with rubber lubricant before inserting into the socket from the yoke face.
5. Using a C-clamp, press the bushing into the socket letting the sleeve end extend ¼" ± 1/32" beyond the 6Q and 175 Series yoke face and 3/16" ± 1/32" beyond the 250 Series yoke face. Bushing bore must be perpendicular to the yoke face.
6. Care must be exercised to insure equal projection of all the bushings. Should it be necessary to straighten the bushing in the socket, insert a ⅝" bolt into the bushing and drive the bushing lightly from the side to attain perpendicularity between the bore of the bushing and the yoke face.
7. Replace the driveshaft tube and flange assembly. Be sure to match the numbers on the tube flanges with their respective numbers on the motor and Geareducer yokes. Install ⅝" machine bolts or cap screws in each end of driveshaft. Tighten to 60 ft·lb*f* (82 N·m) torque. See Figures 3 and 4.

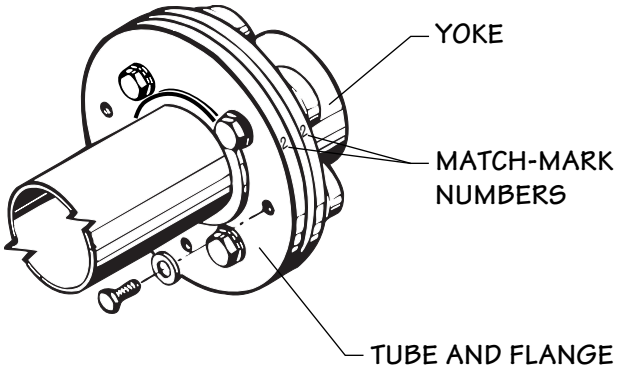


Figure 3 *6Q Series shown*

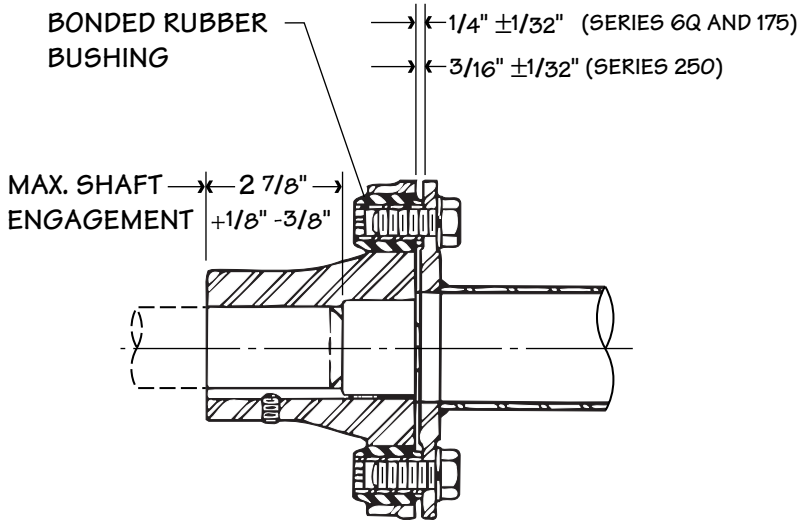


Figure 4 *250 Series shown*

8. If the motor has been moved back to permit removal of the tube and flange assembly, reposition the motor, being sure that flange spacing is maintained. See Figure 4. Tighten the ⅝" machine bolts or cap screws to 60 ft·lb*f* (82 N·m) torque. For the 6Q and 175 Series driveshaft, use an Allen wrench to prevent bushing from rotating in its socket. Recheck driveshaft alignment and tighten motor mounting bolts.
9. Rebalance driveshaft if necessary.

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Hands on Training – Marley X7 Series Fan – Blade Pitch

Objective: Learn how to disassemble/assemble fan blades to the fan hub. and check/measure/set blade pitch, on the Marley X7 Fan. Gain a better understanding of the information included in the User's Manual, for example needed torque specifications.

Scenario: Customer has recently replaced their fan on their older cooling tower. The tower now is showing signs of vibration that it wasn't before. Knowing that the fan assemblies are statically balance at the factory before shipping, you should investigate by checking blade pitch measurements and record pitch value for each blade. You may not always have the necessary tools with you to correct a problem if found. In this case if a problem is found use the tools provided to correct.

Provided Items and Tools:
X7 Fan User Manual
New Fan Blade Hardware
Wrenches
Digital Level
Torque Wrench and Socket.

Step 1: Pick one fan blade and remove it. This is done by loosening up the nuts on the U-bolt holding it in place. These nuts should be lock nuts and can be difficult to remove.

Step 2: Inspect fan blade and blade socket.

Step 3: Find new hardware items.
Step 4: Install the blade per instructions on page 3 of the X7 Fan User Manual.
Step 5: To determine blade pitch find where the correct location on blade to take the pitch measurement is by referring to the fan user manual on page 5.
Step 6: Measure the Blade Pitch Values of the remaining blades to see what pitch to set the blade you removed to. Note the tolerance of ±_____°.

Blade A: _____ Blade D: _____
Blade B: _____ Blade E: _____
Blade C: _____ Blade F: _____

Step 7: Pitch Blade. Tighten/Loosen the nuts on the u-bolt(s) for the blade that needs to have the pitch set. Make sure the nuts just loose enough that the blade will move when applying pressure to the blade. If too loose the blade will move freely on its own.

Step 8: Once the pitch is set, tighten the nuts on the U-bolts. Be sure that you torque the nuts to the proper setting. This can be found in the Fan User's Manual on page 6. Recommended that everyone in the group takes a pull on the torque wrench once the bolt is tight, to feel what the torque setting feels like.
Step 9: Re-check the pitch to make sure all blades are within a ±1/4° of the desired fan pitch.

Take Away Points:

- Where do you check the pitch on this type of fan blade?
- What is the allowable tolerance of the pitch?
- Proper torque is needed to keep fan blade from de-pitching.

Additional Topics of Discussion:

Types of towers these fans are used in:

- Package single and double crossflow towers
- Package counterflow towers
- Closed circuit fluid coolers

Steps for complete fan removal:

- Remove fan retention bolt.
- Use Hub Puller

Points to look for when inspecting this type of fan

- Hardware corrosion
- Look for cracked/broken plastic tips.
- Look at leading edge of fan blades

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user manual

X7 fan

INSTALLATION - OPERATION - MAINTENANCE

Z0331480_A ISSUED 06/2016

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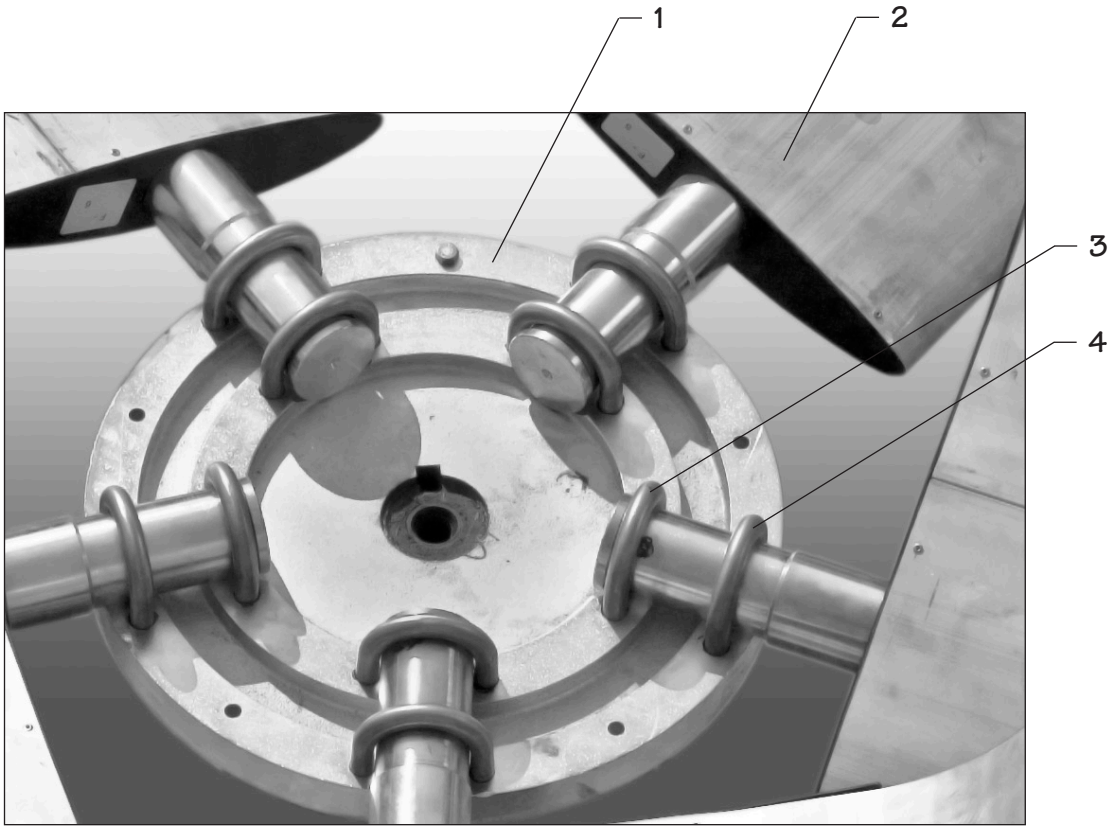


Figure 1–Typical Fan Assembly

Order No. _____

Trial Pitch Angle _____

Final Pitch Angle _____

Speed-rpm _____

Contract hp _____

fan assembly

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 X7 fans are statically balanced as a complete assembly. If fan is shipped unassembled, blades and hubs are match-marked to insure proper re-assembly.

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

2–Position the fan hub **1** in the center of the work area with the blade sockets up.

3–Place a blade **2** in a blade socket on the hub. On fans where the blades overlap at the hub be sure to have the leading edge under the trailing edge of the forward blade. Refer to **Figure 2**.

4–Ensure the blade shank safety collar is inboard of the inner hub rim. Refer to **Figure 3**.

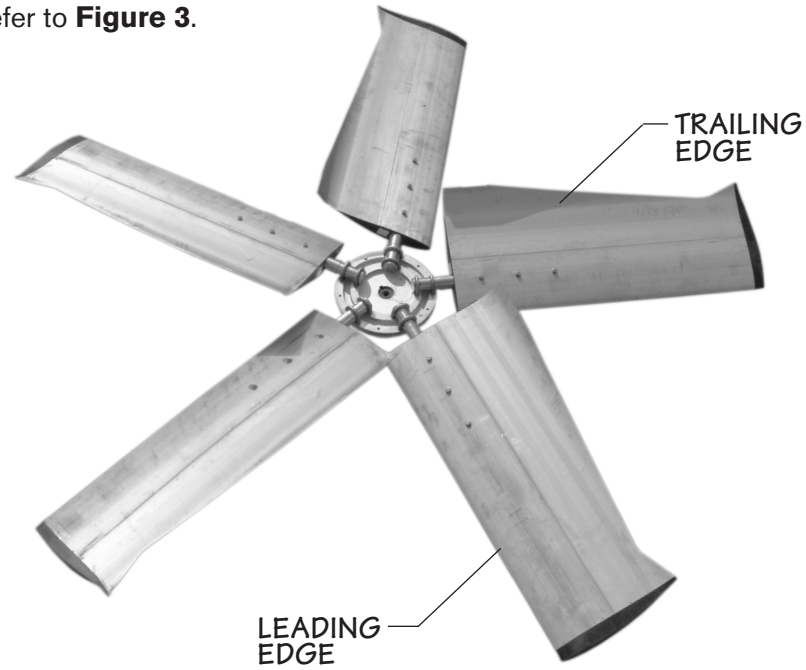


Figure 2

5–Lubricate U-bolt threads and bearing surface of self-locking nuts. Install U-bolt through inner row of holes in the hub. Finger tighten the self-locking nut with flat washer onto U-bolt threads. Progressively tighten each leg of the U-bolt until blade is held in place.

6–Pull blade radially outward to be certain the shank safety collar is in contact with hub inner ring. Refer to **Figure 3**.

7–Repeat steps 5 and 6 as required with the outer U-bolt **4**.

8–Repeat steps 3 through 7 for all blades.

9–Progressively tighten each side of the U-bolt until the blades are barely able to move when twisting the blade.

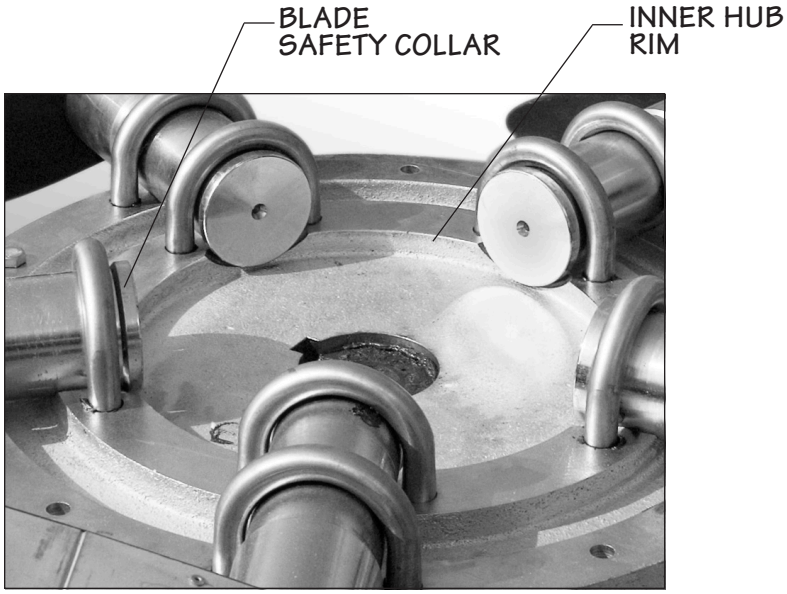


Figure 3

Fan Installation Instructions

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″ (3 mm) . 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–Install the Hub Retention Cap Screw with Lock Washer. Torque hub retention cap screw to 40 ft·lb$_f$ (54 N·m).

adjusting blade pitch

Note

The trial pitch is the calculated setting for design conditions *(water rate , heat load, air density, and brake horsepower)**. The trial pitch is provided by SPX*** *(see page 2).*

1–Select a position on the fan circumference and rotate each blade to this common location when setting or checking blade pitch. Support the blade tip to maintain a common rotation plane while setting the fan pitch. The pitch is set by placing a protractor on top of a straight edge or with a digital level that extends across blade near the tip. For flare-tip blades, the pitch is measured across the end cap as shown in **Figure 4**. For full chord blades, the pitch is measured across the aluminum airfoil about 1" inboard of the end cap as shown in **Figure 5**.

2–Be sure all blades are positioned correctly on hub, then set the pitch. Blades should be within ± 1/4° of the desired pitch angle. After the desired setting is obtained, progressively tighten the U-bolt nuts according to **Table 6**. Recheck the pitch angle. If required, loosen the hex nuts and reset the pitch as necessary until the proper pitch angle is obtained.

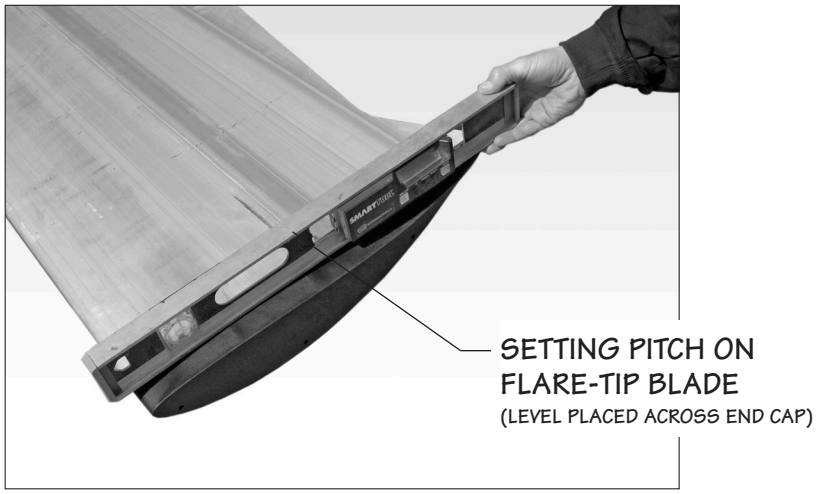


Figure 4

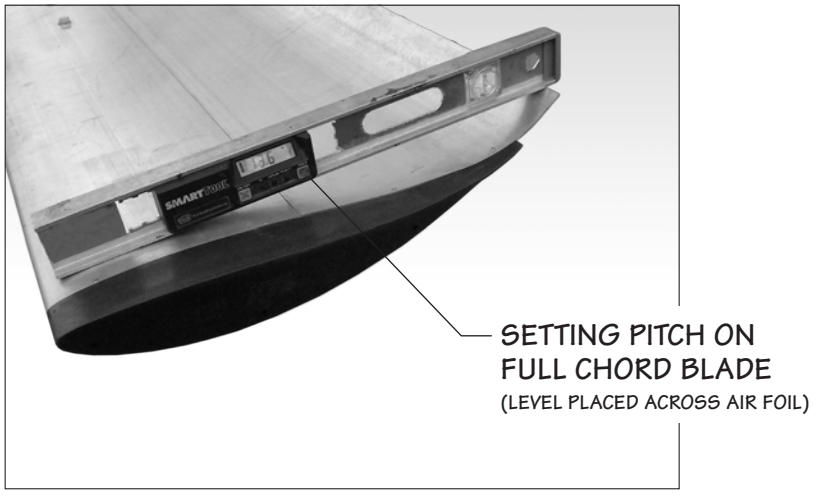


Figure 5

Table 6

Fan Model	Bolt Diameter mm	Torque Wrench Setting	
		$ft{\cdot}lb_f$	N·m
X71	12	40	54
X72	16	70	95

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 insure 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. 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 Geareducer 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 V	$AMPS_N$	=	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).

Hands on Training – Marley H3 Series Fan – Blade Pitch

Objective: Learn how to disassemble/assemble fan blades to the fan hub. and check/measure/set blade pitch, on the Marley H3 Fan. Gain a better understanding of the information included in the User's Manual, for example needed torque specifications.

Scenario: Customer has recently replaced their fan on their older cooling tower. The tower now is showing signs of vibration that it wasn't before. Knowing that the fan assemblies are statically balance at the factory before shipping, you should investigate by checking blade pitch measurements and record pitch value for each blade. You may not always have the necessary tools with you to correct a problem if found. In this case if a problem is found use the tools provided to correct.

Provided Items and Tools:
H3 Fan User Manual
New Fan Blade Hardware
Wrenches
Digital Level
Torque Wrench and Socket.

Step 1: Pick one fan blade and remove it. This is done by loosening up the nuts on the U-bolt holding it in place. These nuts should be lock nuts and can be difficult to remove.

Step 2: Inspect fan blade and blade socket.

Step 3: Find new hardware items.
Step 4: Install the blade per instructions on page 3 of the H3 Fan User Manual.
Step 5: To determine blade pitch find where the correct location on blade to take the pitch measurement is by referring to the fan user manual on page 2.
Step 6: Measure the Blade Pitch Values of the remaining blades to see what pitch to set the blade you removed to. Note the tolerance of ±_____°.

Blade A: _____ Blade D: _____
Blade B: _____ Blade E: _____
Blade C: _____ Blade F: _____

Step 7: Pitch Blade. Tighten/Loosen the nuts on the U-bolt(s) for the blade that needs to have the pitch set. Make sure the nuts just loose enough that the blade will move when applying pressure to the blade. If too loose the blade will move freely on its own.

Step 8: Once the pitch is set, tighten the nuts on the U-bolts. Be sure that you torque the nuts to the proper setting. This can be found in the Fan User's Manual on page 3. Recommended that everyone in the group takes a pull on the torque wrench once the bolt is tight, to feel what the torque setting feels like.
Step 9: Re-check the pitch to make sure all blades are within tolerance of the desired fan pitch.

Take Away Points:

- Where do you check the pitch on this type of fan blade?
- What is the allowable tolerance of the pitch?
- Proper torque is needed to keep fan blade from de-pitching.

Additional Topics of Discussion:

Types of towers these fans are used in:

- Package single and double crossflow towers
- Package counterflow towers
- Closed circuit fluid coolers

Steps for complete fan removal:

- Remove fan retention bolt.
- Use Hub Puller

Points to look for when inspecting this type of fan

- Hardware corrosion
- Look for cracks around U-bolt holes in aluminum hub plate
- Look at leading edge of fan blades.

Hands on Training

Notes / Take away Points:

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H3 fan

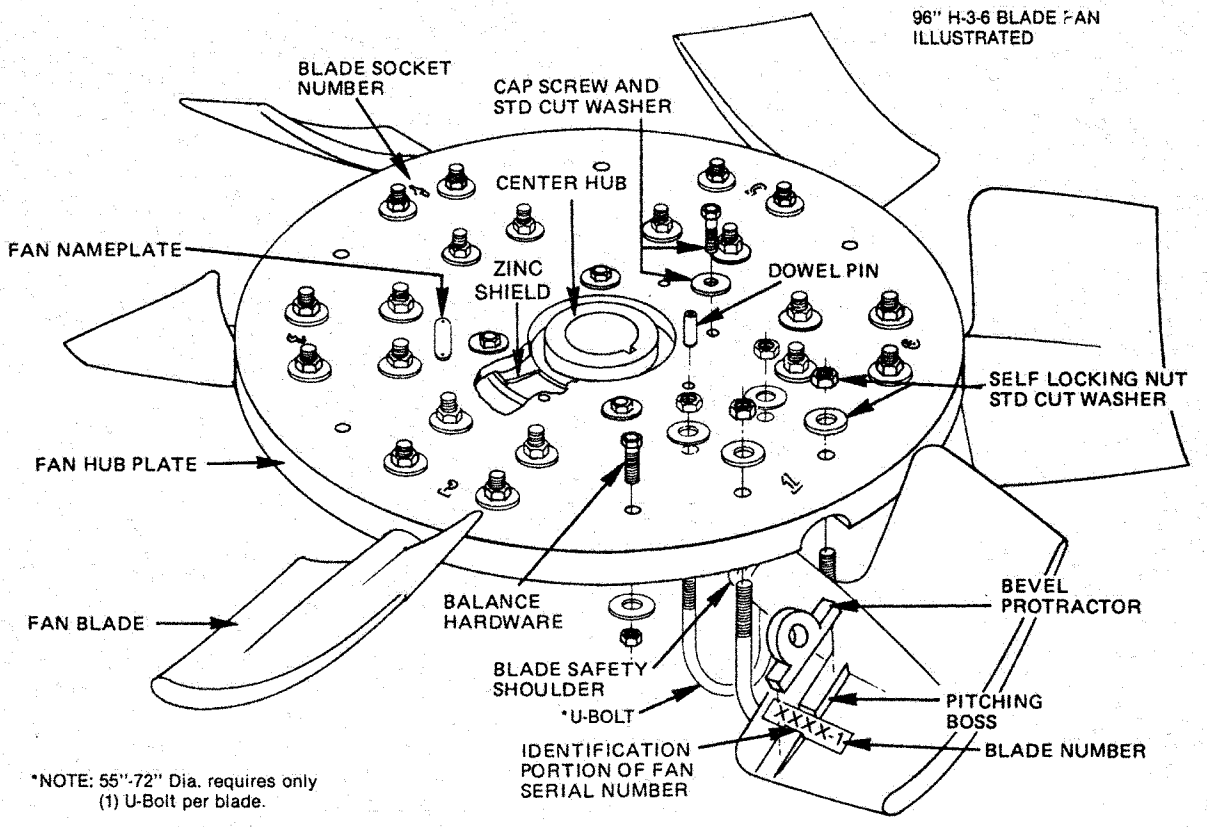
INSTALLATION - OPERATION - MAINTENANCE

Z0239018_A ISSUED 06/2017

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



TYPE H-3 ALUMINUM BLADE FANS
55" THROUGH 168" DIAMETER 6, 8, 9, 10 AND 12 BLADE FANS
WITH ALUMINUM PLATE HUB



SPX COOLING TECHNOLOGIES, INC. OVERLAND PARK, KS.
FAN SERIAL NO. 96 H3 6 — XXXX
FAN BLADE CLAMP FASTENER TIGHTENING INSTRUCTIONS
GENEROUSLY COAT CLAMP BOLT THREADS AND NUT BEARING SURFACE WITH MARLEY THREAD LUBRICANT
TIGHTEN TO 55 FT LB TORQUE 71-81-2 PW

TYPICAL FAN NAMEPLATE

(NOTE: Refer to Table for Prescribed Torque)

Marley Order No. _____

Fan Diameter _____

Order No. _____

Final Pitch Angle _____

Speed, rpm _____

Contract hp _____

NOTE

A. Each fan is statically balanced at the factory as an assembly. The fan hub is identified with the complete serial number and each blade socket is identified by number. Each fan blade is marked with the identification portion of the fan serial number and a sequential number indicating position of the fan blade in the fan hub.

B. Check and, if necessary, retighten blade clamping hardware to prescribed torque prior to startup and subsequently at 6 month intervals.

C. When writing the Marley sales office or representative for repair or replacement parts, please refer to the tower order number and fan serial number. Contact your Marley sales representative for assistance on order placement.

ASSEMBLY

Fan hubs are shipped with center hub and zinc shield assembled to the hub plate. If components of the hub assembly are to be replaced in the field, refer to paragraphs 1,2 and 3 for reassembly instructions.

1. Position the protective zinc shield and the fan hub plate on the center hub with the keyway and socket No. 1 lined up. One of the bolt hole patterns will be aligned properly in only one position.

2. Drive the dowel pins flush into the four smaller holes to accurately position the hub plate.

3. Apply a thread sealant/adhesive to the cap screws, install and tighten. See Table 1 for correct center hub torque.

4. Make certain that the identification number on each blade corresponds to the identification number in the fan assembly serial number on the nameplate.

5. U-bolt threads and bearing surface of self-locking nuts are lubricated at the factory prior to shipment. **Touch up all threads and nut bearing surfaces with a generous coating of the lubricant supplied with the fan.**

6. Install blade marked No. 1 in hub socket No. 1. Install blade No. 2 in hub socket No. 2, and so on around the fan. Install blades with pitching boss and fan direction arrow on air discharge side of fan.

7. **Be certain that each blade is as far from the center of the fan as the shoulder on the shank end of the blade will permit after the locking nuts are tightened.** This is necessary in order to maintain proper balance.

8. Support blade tips in a horizontal plane when U-bolts are tightened. Hold each blade at the proper pitch angle when tightening.

9. Total vertical tip track variation should not exceed tolerances specified in Table 1. Excessive tip track will cause dynamic imbalance.

SETTING FAN BLADE PITCH

1. The trial pitch angle is the calculated setting for design conditions (water rate, heat load, air density and contract horsepower). Set the bevel protractor at the trail pitch angle supplied and pitch all the blades to the same angle. All blades must be pitched to the same angle when each blade is pointing in the same direction in the fan cylinder.

2. Progressively tighten the self-locking U-bolt nuts to specified torque. Stainless steel fasteners are prone to galling. Be alert to a sudden rise in nut turning resistance before parts are properly clamped. This signifies galling. Remove nuts and U-bolt and replace with new ones until satisfactory joint is made. See Table 1 for correct U-bolt torque.

3. Recheck the pitch of each blade, as the pitch might change while tightening the nuts.

Table 1 - Specified Torque and Tip Track Variation

Diameter	55"-72"	73"-84"	85"-96"	97"-144"	145"-168"
Center Hub Torque	40-50 ft/lb	40-50 ft/lb	40-50 ft/lb	40 ft/lb	100 ft/lb
U-Bolt Torque	40 ft/lb	40 ft/lb	55 ft/lb	40 ft/lb	70 ft/lb
Vertical Tip Track Variation	¾" (± ⅜")	¾" (± ⅜")	¾" (± ⅜")	1" (± ½")	1½" (± ¾")

CAUTION: When checking and/or changing blade pitch or when cycling fan in normal operation, do not exceed 30 sec./hr. total motor starting time as motor may become overheated.

CHECKING LOAD AT MOTOR

1. Operate the fan until motor and Geareducer have reached operation temperature. Take operating voltage and amperage measurements* for use in calculating motor hp by the following equation:

$$hp = \frac{\text{actual volts x actual amps}}{\text{nameplate volts x nameplate amps}} \text{ x nameplate hp}$$

2. The calculated horsepower should equal but not exceed the specified contract horsepower. Measurements used in above calculations must be made with hot water flowing through the tower. Repitch blades as required to obtain contract horsepower. Reading taken with no water or cold circulating water will result in an erroneous calculate horsepower. Degrees change in pitch required to change motor load one hp: see Table 2.

Table 2 - Pitch vs hp

No. of Blades:	6	8	9	10	12
Diameter	**Pitch Change Per hp**				
60"	3	2.5			
72"	2.5	2			
84"	1	.8		.6	
96"	.8	.7		.6	.5
108"			1		
120"			.8		
132"			.6		
144"			.4		
168"	A one degree change in pitch will vary the power required by approximately 3 hp.				

3. If blades are repitched, self-locking U-bolt nut must be retightened to specified torque. See Table 1. Touch up U-bolt threads and nut bearing surface with lubricant consisting of 50% petrolatum and 50% graphite by weight.

FAN REBALANCE

1. If the fan hub plate, center hub, or one or more blades are replaced, the complete fan assembly may require rebalancing. Other components can be replaced without significantly affecting balance.

2. If rebalance is required, trail and error attachment of balance weights at various locations on the hub may produce a satisfactory dynamic balance with the fan operating on the tower. If this is not satisfactory, the fan assembly can be rebalanced as follows:

   A. Fan assembly should be mounted on a suitable mandrel matching the hub bore, and the mandrel placed on knife wheels or level, parallel bars with the fan blades in a vertical plane. This must be done in a draft free area.

   B. Apply balance washers to hub, on same side as blade sockets, until all tendency for fan to rotate is overcome. This is accomplished by allowing the fan assembly to rotate freely on the knives until it comes to rest with the heaviest portion at the bottom. Manually rotate the fan 90° so that the heaviest portion is at either side of the fan centerline. Add weights to the light side of the hub plate. Holes are provided in the plate between each blade socket for attachment of weights.

   C. If one or more blades are replaced, relocating some of the blades in other sockets might simplify balance and result in fewer balance weights being required.

MAINTENANCE

A monthly inspection of the fan should be made to assure continued trouble-free operation. Remove carefully and completely any accumulation of dirt or scale deposits, if balance is affected.

Hands on Training – Marley Ultra Quiet Series Fan – Blade Pitch

Objective: Learn how to check/measure blade pitch on the Marley Ultra Quiet Fan. Gain a better understanding of the information included in the User's Manual. Learn how to adjust the blade pitch and gain an understanding of what it takes to make this happen.

Scenario: Customer has complained that the fan is vibrating on their new tower at any operating speed, and also says all of the blades don't appear to be tracking at the same angle or height. Investigate by checking blade pitch measurements and record pitch value for each blade. You may not always have the necessary tools with you to correct a problem if found. In this case if a problem is found use the tools provided to correct.

Provided Items and Tools:

Ultra Quiet Fan User Manual
Digital Level
Box Wrench
Torque Wrench and Socket

Step 1: Pick one fan blade and remove it.
Step 2: Inspect fan blade and blade socket.
Step 3: Find new hardware items.
Step 4: Install the blade per instructions on page 5 of the Ultra Quiet Fan User Manual.
Step 5: Measure Blade Pitch

Please refer to the Ultra Quiet Fan Users to determine correct location on blade to take the measurement.

Blade Pitch Values

Blade A: _____ Blade C: _____
Blade B: _____ Blade D: _____

Step 6: Re-pitch Blade (if necessary) - loosen the collar for the blade that needs to have the pitch corrected. Loosen up the bolt just enough that the blade will move when applying pressure to the blade. If too loose the blade will move freely on its own.
Step 7: Adjust Pitch to match other blades
Step 8: Re-tighten the bolt on the collar. Be sure that you torque the bolt to the proper setting. This can be found in the Fan User's Manual. Recommended that everyone in the group takes a pull on the torque wrench once the bolt is tight, to feel what the torque setting feels like.
Step 9: Re-check the pitch to make sure all blades are within a 1/2°

Take Away Points:

- Where do you check the pitch on this type of fan blade?
- What is the allowable tolerance of the pitch?
- Proper torque is needed to keep fan blade from de-pitching.

MARLEY®

user manual

Ultra Quiet fan

INSTALLATION - MAINTENANCE

Z0414808_C ISSUED 03/2021

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



introduction

Safety

⚠ **Warning**

Because of the potential for property damage and/or danger to personnel, 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 and 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 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.

components

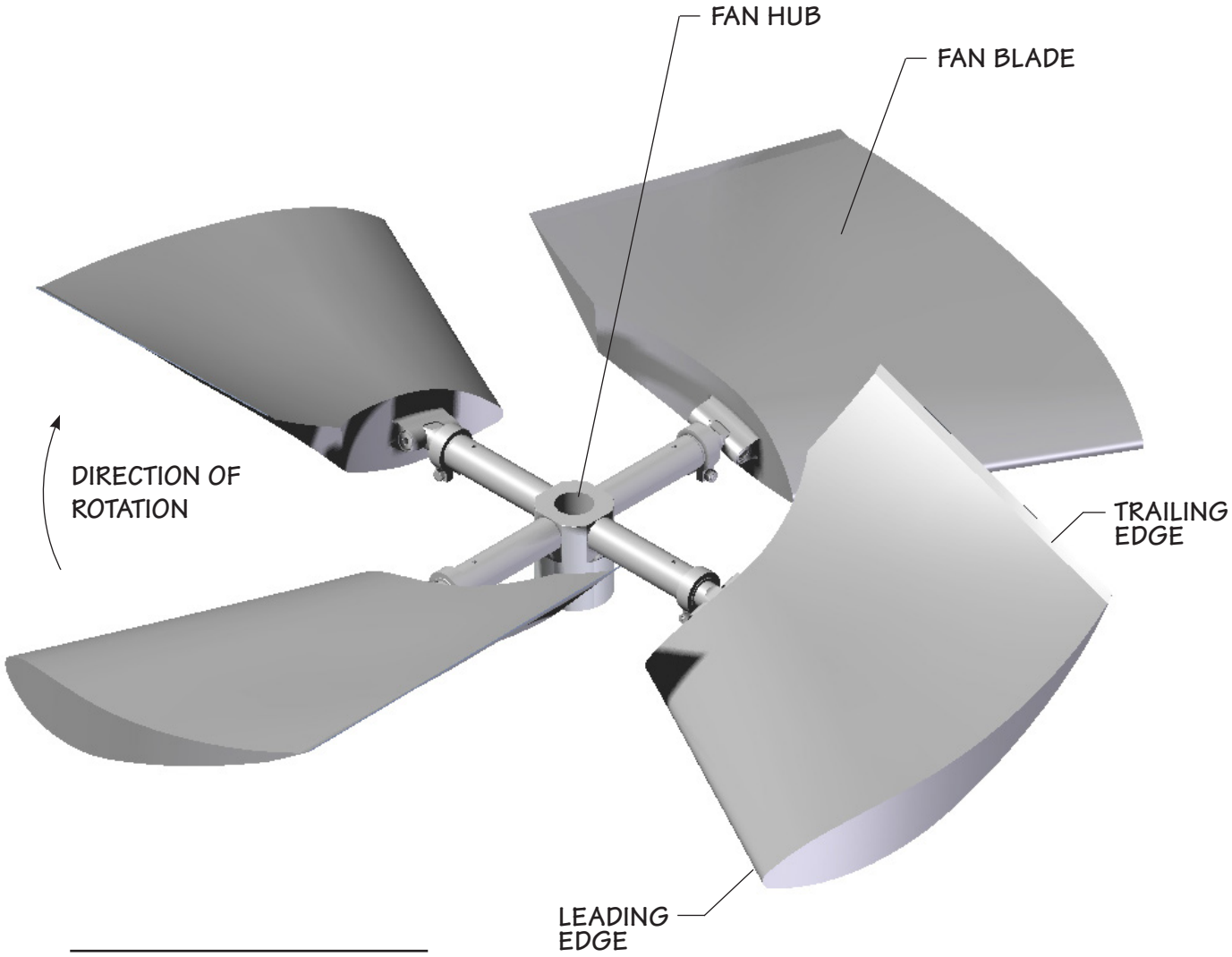


Figure 1

Order No. _____

Trial Pitch Angle _____

Final Pitch Angle _____

Speed-rpm _____

Contract hp _____

assembly

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.

Ultra Quiet fans are statically balanced as a complete assembly and shipped unassembled. To ensure proper reassembly, 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** on page 3.

Note

Proper assembly, with particular attention to tightening hardware to the specified torque is essential to maintain the design integrity of the fan.

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**. Screw the bolt into the second resilient mount lightly. A ¾" drive torque wrench with a short extension may be useful. The blade-mounting bolt is supplied from the factory with grease on the threads and conical face. ***Do not remove the grease from the bolt.***

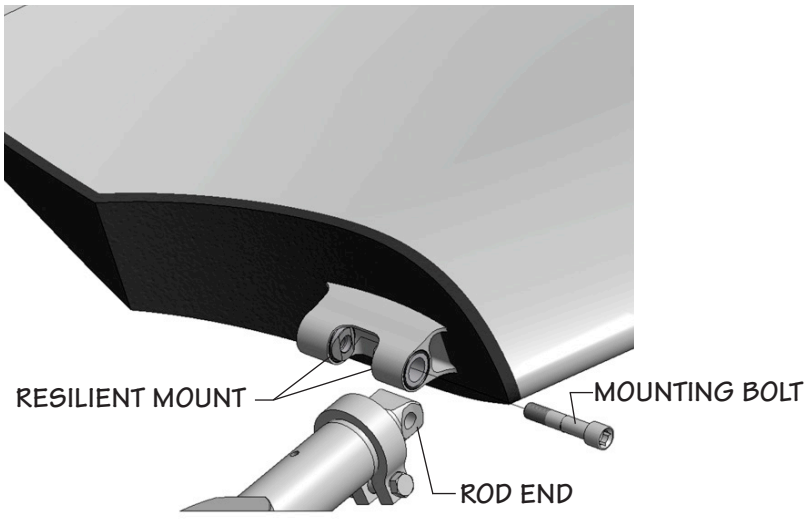


Figure 2

assembly

4–Complete the installation by holding the blade so that it extends straight out from the hub tube. While holding the blade in this position, tighten the bolt to values provided in **Table 1** making sure the rod end and the resilient mounts seat.

5–Install the other blades. See **Figure 3** for completed blade connection. All bolts should be tightened to values provided in **Table 1**. 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).

Figure 3

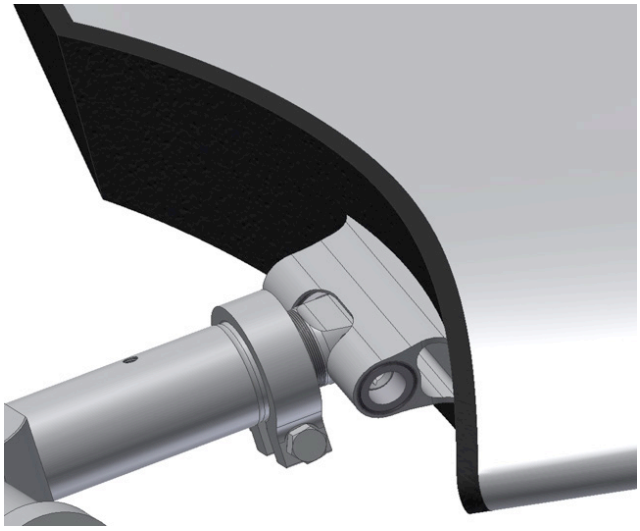


Table 1

Fan Diameter	Bolt Torque
Up to 12 ft	200 ft-lb$_f$ (271 N·m)
Over 12 ft	500 ft-lb$_f$ (675 N·m)

One and Two Piece Fan Hub

1–Be sure the fan motor is locked out.

2–Clean the hub bore and drive fan 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 ⅛" (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–Install the hub retention bolt(s) with the lock washer(s) and torque to 50 ft-lb (68 N·m). If the standard hub retention bolt is too short, locate a longer one in the fan retention hardware kit.

Note

Installation is applicable to the fan being installed on a gear drive or belt drive fan shaft

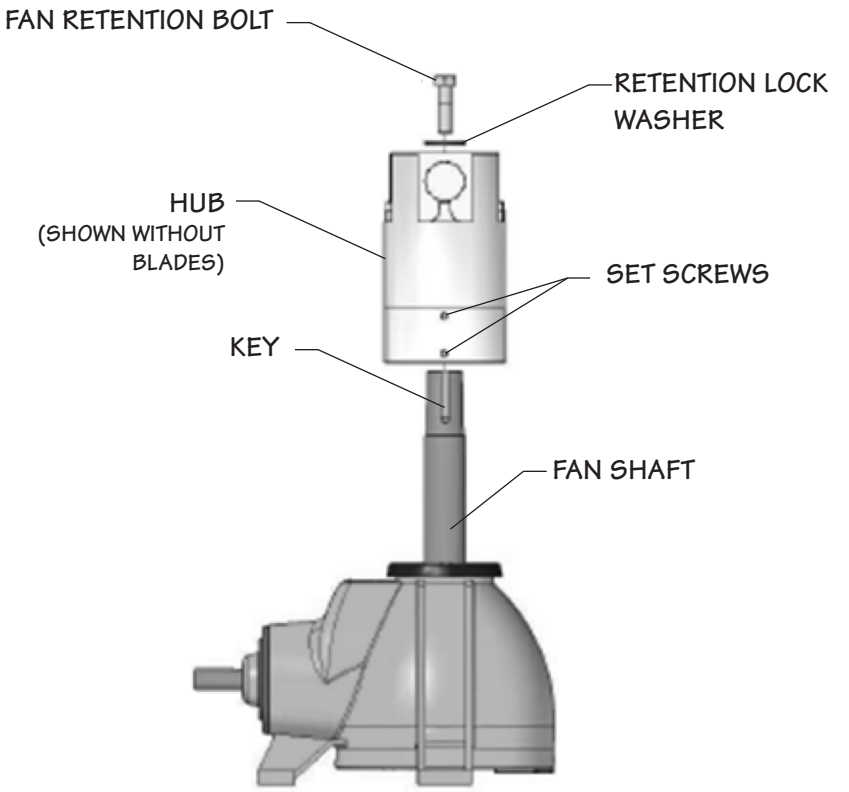


Figure 4

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

8–After installing the fan, manually rotate it while moving the blade tips up and down to be sure they clear the cylinder ring or throat at all points. When a blade is held in alignment with the blade tube – i.e. straight outward from the hub – it should clear the fan cylinder by a distance adequate to provide for any relative motion between the fan and the cylinder. Excess clearance between the blade tips and the cylinder should be avoided to prevent backflow, which seriously reduces fan efficiency. Correct blade tip clearance dimensions are shown in **Table 2** on page 11.

9–Install the air seal.

Three Piece Fan Hub

1–Be sure the fan motor is locked out.

2–Clean the hub bore and drive fan 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 ⅛" (3mm). The key is a tight fit across the width and must never be altered.

4–Install threaded rod for fan retention as shown in **Figure 5** or **Figure 6** on page 8.

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

6–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.

7–Install top retention plate, flat washer and lock washer as shown in **Figure 7** on page 8. Apply threaded lubricant to stainless threads and tighten retention nut to 60 ft-lb (81 N·m) torque.

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

9–After installing the fan, manually rotate it while moving the blade tips up and down to be sure they clear the cylinder ring or throat at all points. When a blade is held in alignment with the blade tube – i.e. straight outward from the hub – it should clear the fan cylinder by a distance adequate to provide for any relative motion between the fan and the cylinder. Excess

clearance between the blade tips and the cylinder should be avoided to prevent backflow, which seriously reduces fan efficiency. Correct blade tip clearance dimensions are shown in **Table 2** on page 11.

10–Install the air seal.

Note

Installation is applicable to the fan being installed on a gear drive or belt drive fan shaft

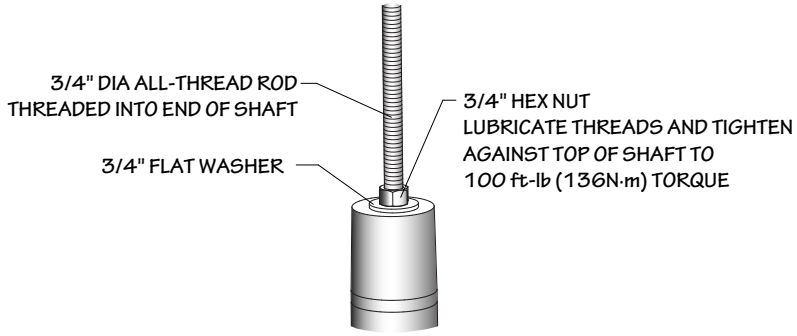


Figure 5

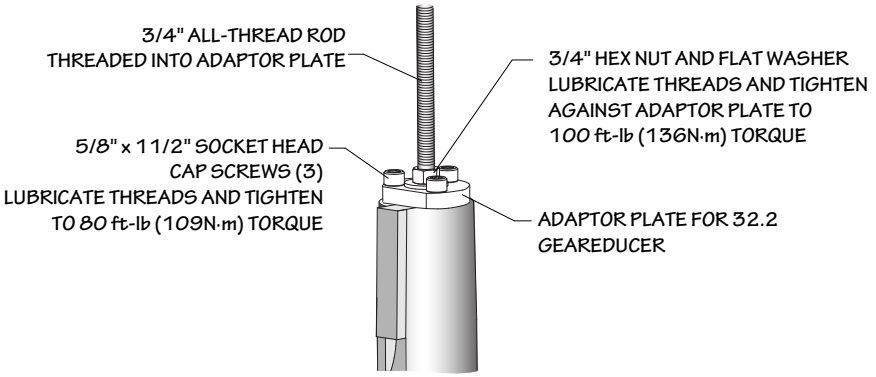


Figure 6

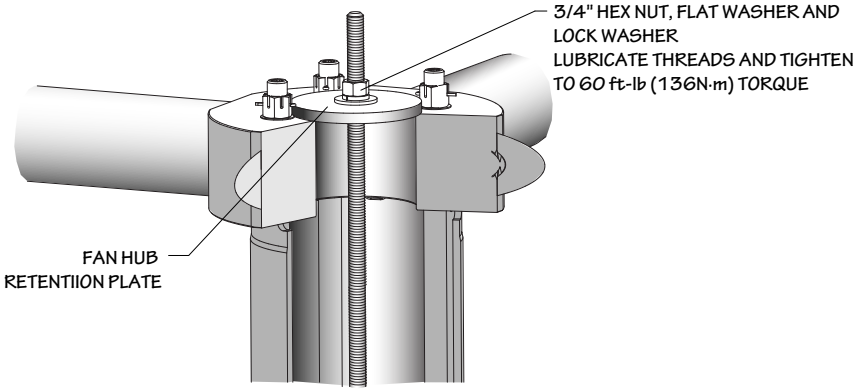


Figure 7

Air Seal Installation

The air seal is a thin sheet metal disc that is required to prevent the back flow of air through the center of the fan to maximize the fan's efficiency. See **Figure 8**.

1–Locate the air seal installation hardware.

2–Install the air seal studs on the hub tube – finger tighten.

3–Place one resilient washer on each stud as shown in **Figure 9**.

4–Place the air seal onto the studs and install the remaining hardware following the sequence shown. Do not lubricate 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.



Figure 8

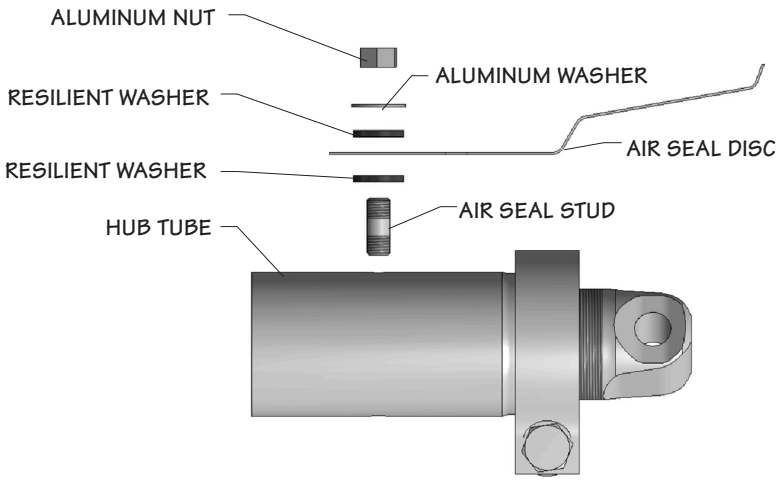


Figure 9

Blade Pitch Adjustment

Hubs are shipped from the factory with the rod end set for the blade angle (pitch) required for design performance. A change in blade angle is sometimes necessary 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 blade as shown in **Figure 10**. Turn the blade until the desired angle is achieved. Make a permanent record of the final angle selected and make sure that all blades 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 compromised.

The maximum recommended blade angle is 30°. Retighten the clamp nut to 100 ft-lb (136 N·m) for fan diameters 8'-0" (244cm) and smaller or 200 ft-lb (271 N·m) for fan diameters 9'-0" (274cm) and larger. Recheck blade angles after tightening.

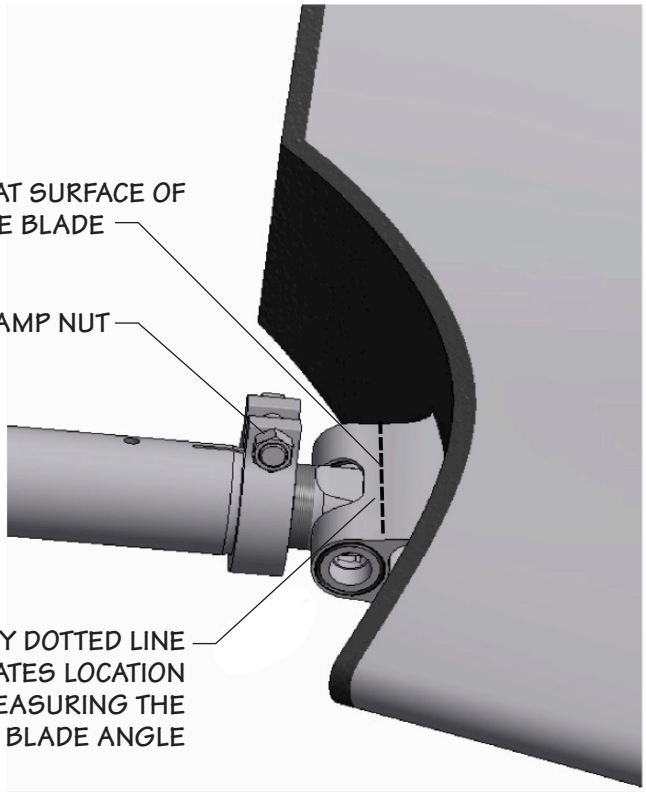


Figure 10

Blade Tip Adjustment

It may be necessary to adjust the fan diameter to suit a particular fan cylinder ring. See **Figure 11.** The tip clearance of the blades should be in the range of the fan diameter listed in **Table 2**. If the tip clearance is found to be outside of this range the fan diameter can be adjusted.

First remove the fan blade and 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 pitch 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 100 ft-lb (136 N·m) for fan diameters 8'-0" (244cm) and smaller or 200 ft-lb (271 N·m) for fan diameters 9'-0" (274cm) and larger. Maximum adjustment possible is about ± 0.75" (19mm) radially (1½" on diameter). At least 1½" (38mm) of rod end threads must remain in the tube (rod end threads must fully engage tube threads). Repeat for all fan blades so that the tip clearance is within the listed range.

Table 2

Fan Diameter	Blade Tip Clearance
5'-0"	⅜" (10mm)
5'-6"	⅜" (10mm)
6'-0"	⅜" (10mm)
7'-0"	7⁄16" (11mm)
9'-0"	½" (13mm)
10'-0"	⅝" (16mm)
11'-0"	⅝" (16mm)
12'-0"	11⁄16" (17mm)
19'-0"	1" (25mm)

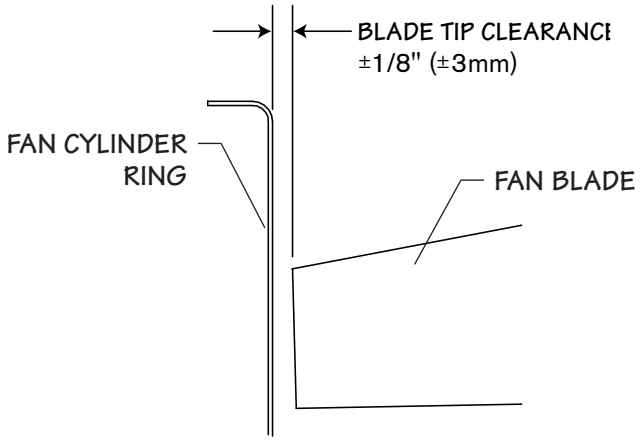


Figure 11

maintenance

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

- Check all hardware torque 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 the fan operation.
- Remove any accumulated scale or dirt.
- Clear the blade drain holes at the 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. 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).

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

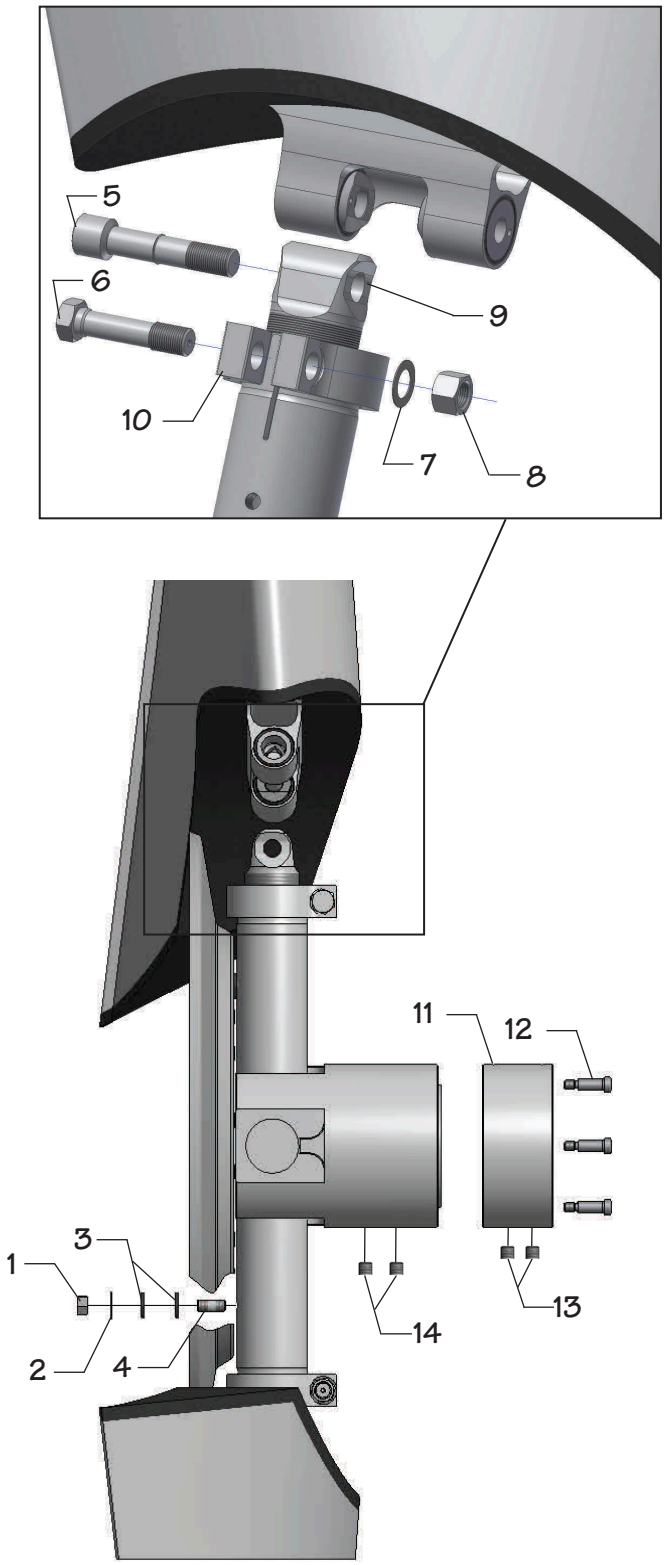
HP_C	=	Corrected Horsepower	$VOLTS_N$	=	Nameplate Volts
$VOLTS_A$	=	Actual Volts	$AMPS_N$	=	Nameplate Amperage
$AMPS_A$	=	Actual Amperage	HP_N	=	Nameplate Horsepower
$DENSITY_A$	=	Actual Air Density	$DENSITY_D$	=	Design Air Density

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



1	Aluminum Nut
2	Aluminum Flat Washer
3	Resilient Washer
4	Air Seal Stud
5	Aluminum Blade Bolt
6	Clevis Clamp Bolt
7	Stainless Steel Flat Washer
8	Clevis Clamp Nut
9	Magnesium Rod End
10	Magnesium Clevis Clamp
11	Shaft Adaptor **
12	1½" Stainless Steel Shoulder Bolt (6) **
13	Stainless Steel Set Screw (2) **
14	Stainless Steel Set Screw (2) *

* Used in single-piece hubs only

** Used in two-piece hubs only

Note: When ordering parts always provide the cooling tower serial number and if possible, the fan serial number located on the fan hub.

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Hands on Training – Geareducer Oil Seal Replacement

Objective: Learn about Marley Geareducer design and maintenance, including how to replace a pinion shaft seal.

- Marley Geareducer operation, design features, components, and optional accessories
- Common maintenance and maintenance intervals
- Pinion shaft seal replacement
    - Removing the pinion cap
    - Seal identification
    - Lip seal removal
    - Lip seal installation
    - Pinion shaft preparation

Scenario: A customer has called you stating that their gearbox has been in operation for around three years and during a routine maintenance check the oil level is low. Upon inspection you see there is a small puddle under the pinion shaft and the seal needs to be replaced.

Tools Required:

- New pinion shaft seal
- Marley Gearlube
- Small flat file
- Fine grit Emory cloth, sandpaper, or Scotch Brite pad
- Torque Wrench
- Wrench and/or socket set
- Ball peen hammer
- Deal blow hammer, chisel, pry bars, and/or 3-point puller
- Flat head screwdriver
- Allen wrenches
- Oil bucket and rags

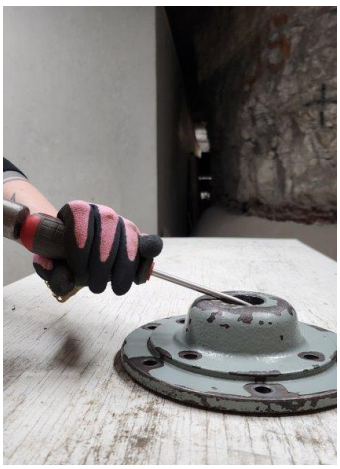
Process:

Pinion Cap Removal:

1. Lock out motor control and follow all safety criteria.
2. Drain enough oil from the gearbox to lower the oil level below the bottom of the pinion cage – approximately 5 quarts.
3. Disconnect the gearbox from the motor:
    a. For driveshaft applications, disconnect and move the spacer tube out of the way.
    b. For close coupled applications, remove the flexible element and unbolt 3 of the motor mounting connections. Move/swivel the motor to allow for the gearbox coupling half removal.
4. Remove the driveshaft yoke or coupling half from the pinion shaft.
5. Remove the key from the pinion shaft, being mindful not to damage the shaft/keyway.
6. Using a socket wrench, remove the hex head cap screws and lock washers from the pinion cage cap. Set aside in a safe place.
7. Carefully remove pinion cage cap without damaging pinion cap-to-pinion cage sealing surface. A chisel may be needed to drive the cap loose. Place a bucket or several rags under the cap prior to removal to catch residual oil behind the cap.
8. Remove shims and place in a safe location. Keep all shims!

Old Seal Removal:

1. Take pinion cap to a work bench or other work surface.
2. Orient the cap so the exterior is facing up, then using the screwdriver as a wedge, place it in between the lip seal and the pinion cap through the shaft hole, keeping the screwdriver as parallel to the cap as possible. Rotate the cap as necessary to knock the seal loose. This ensures that the seal does not tear.



Install New Seal in Pinion Cap:

1. Inspect the interior of the pinion cap to ensure a clean area for the new seal to seat.
2. Place the new seal (and the spacer ring, if necessary) in the pinion cap. The spacer ring should easily fall into place behind the seal. The seal must be inserted with the green side down.
3. To seat the seal, you will need a way to press it flush into the pinion cap. We typically use a PVC plug that fits inside the inner ring of the seal and a hammer. Other common options include an arbor press or PVC pipe and woodblock.
4. Once inserted, check from the opposite side to ensure the seal is seated against the cap or spacer ring.

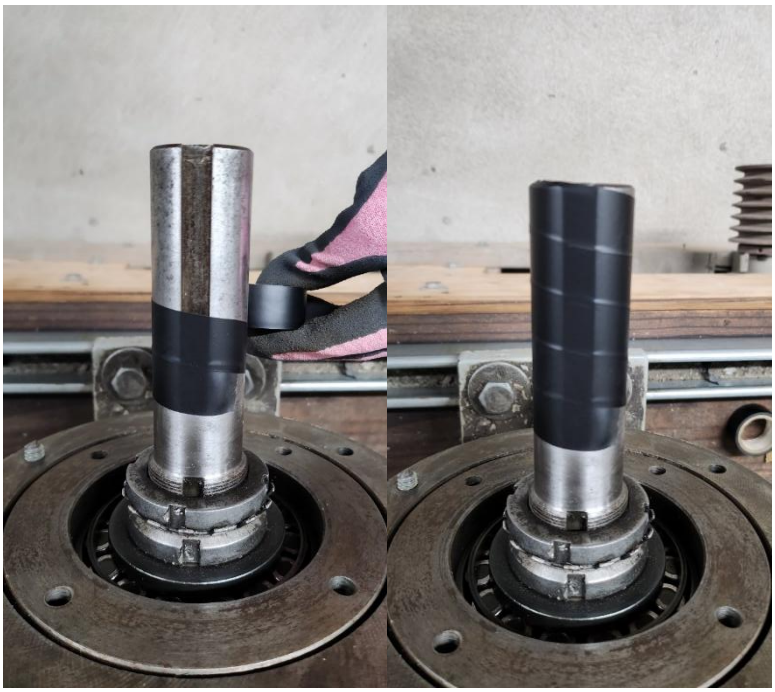






Replace the Pinion Cap:

1. Before replacing the pinion cap on the Geareducer, the pinion shaft must be properly prepared. Any damage on the shaft may damage the sealing face.
    a. Inspect for any roughness along the shaft diameter.
    b. Using fine-grit sandpaper/emery cloth/scotch pad, sand along the shaft to ensure a smooth surface, paying close attention to the edges of the key slot.
2. As an extra precaution and to help keep the pinion cap properly aligned during replacement, we typically use electrical tape to cover the key slot. Starting at the end of the slot closest to the Geareducer, wrap the tape, overlapping as little as possible, to the front of the shaft.



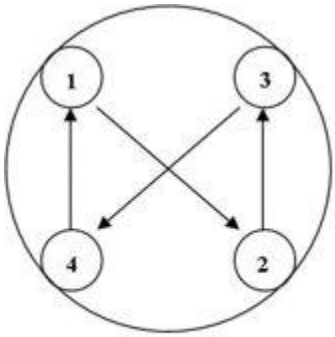
3. To help the cap slide on easily and protect the new seal, use a couple drops of Marley Gearlube on the tape and spread to coat the taped area.

4. Keeping the pinion cap AND METAL SHIMS parallel to the Geareducer, slowly slide it into place.

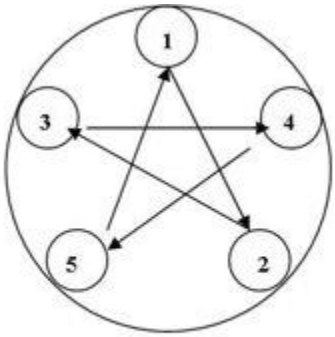




   a. NOTE: due to the two rings of bolts on the pinion cap, there are only two orientations where the cap can line up properly with the casing. Make sure to have the bolt holes aligned prior to moving the cap onto the shaft.
   b. Proper alignment has the exterior bolt circle with holes at center top and bottom AND the interior bolt circle forming a standard square
5. The shims can be challenging to keep in place while replacing the pinion cap, one easier way to manage them is to insert one or two of the outer bolts through the holes in the cap to keep everything aligned or to use.
6. Once the cap is in place, insert the cap screws and finger tighten to hold all components in place.
7. Remove the electrical tape by pulling the loose end away from the Geareducer.
8. Tighten the bolts on pinion cap using a star pattern with a torque wrench per the standard in the IOM.
9. Replace the motor and coupling then check for proper alignment.



Four-Bolt



Five-Bolt

MARLEY®

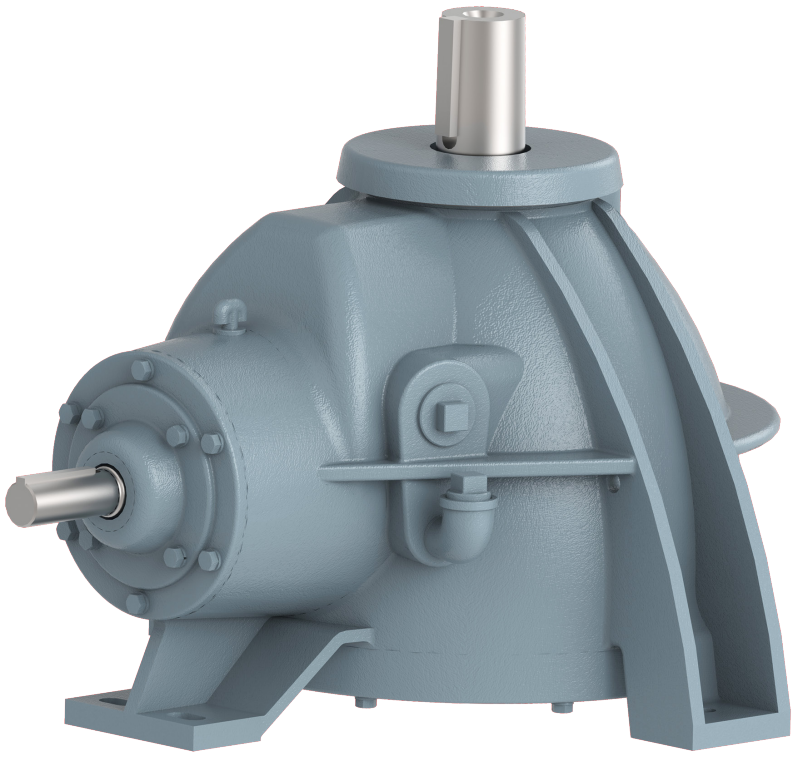
user manual

Geareducer® models 2200 - 2250 - 2250S - 2400 - 2450

OPERATION - MAINTENANCE – REPAIR

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



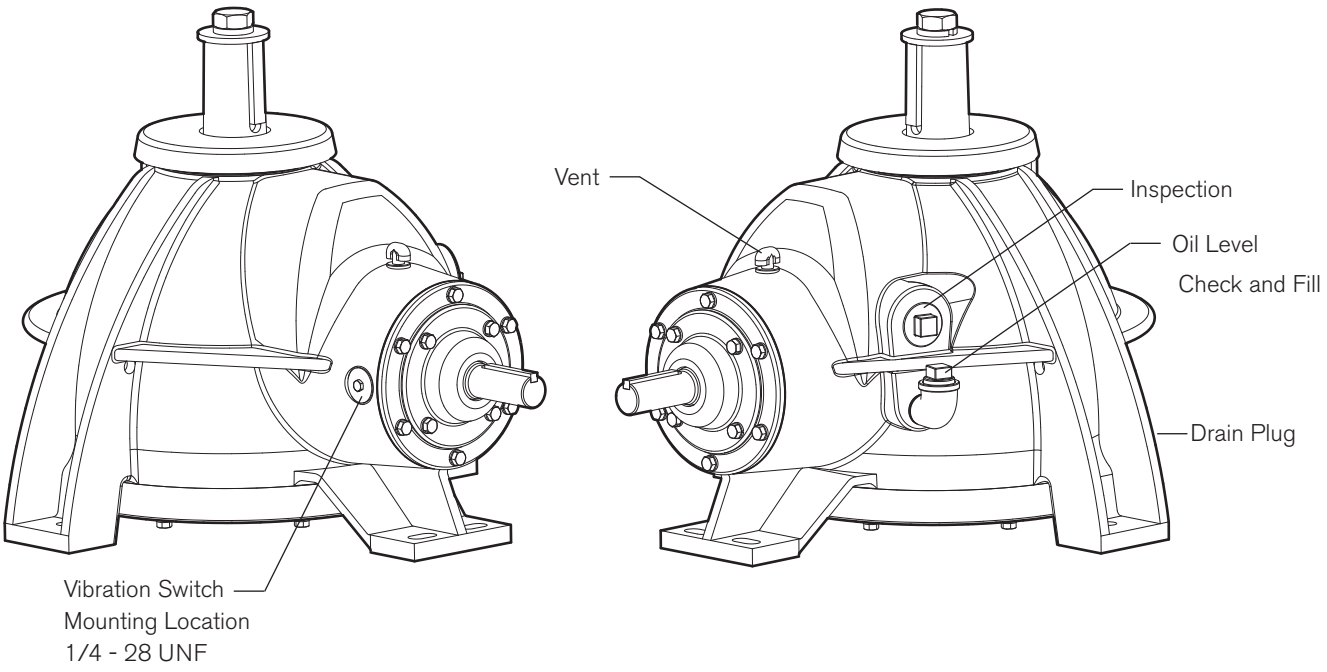


Figure 1 Service Fittings

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 of maintenance—or during any situation of possible endangerment to personnel. If your electrical system contains a disconnect switch, lock it out until the period of exposure to injury is over.

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— If using turbine-type mineral oil, change oil—see **Changing Geareducer Oil** for instructions. 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. Intermittent operation and extended periods of downtime can cause condensation of water in the oil. If using synthetic Marley Gearlube, the oil condition must be inspected every six months—see **Changing Geareducer Oil** for maximizing service life.

Annually—Check mechanical equipment anchor bolts, drive shaft coupling bolts, and coupling set screws. Tighten as required. Check Geareducer exterior yearly and touch up with epoxy paint, if required. Coat all exposed threads at pipe joints to prevent corrosion.

Every 5 Years—If using synthetic Marley Gearlube, change oil. To maintain five-year change intervals, use only synthetic Marley Gearlube. It is recommended to monitor the oil condition every six months throughout the five-year period per the instructions in **Changing Geareducer Oil**.

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.

When using synthetic oil with extended service intervals remove a sample for lab analysis and look for evidence of foreign material, such as water, metal shavings or sludge. 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.

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. 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 visit **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**.

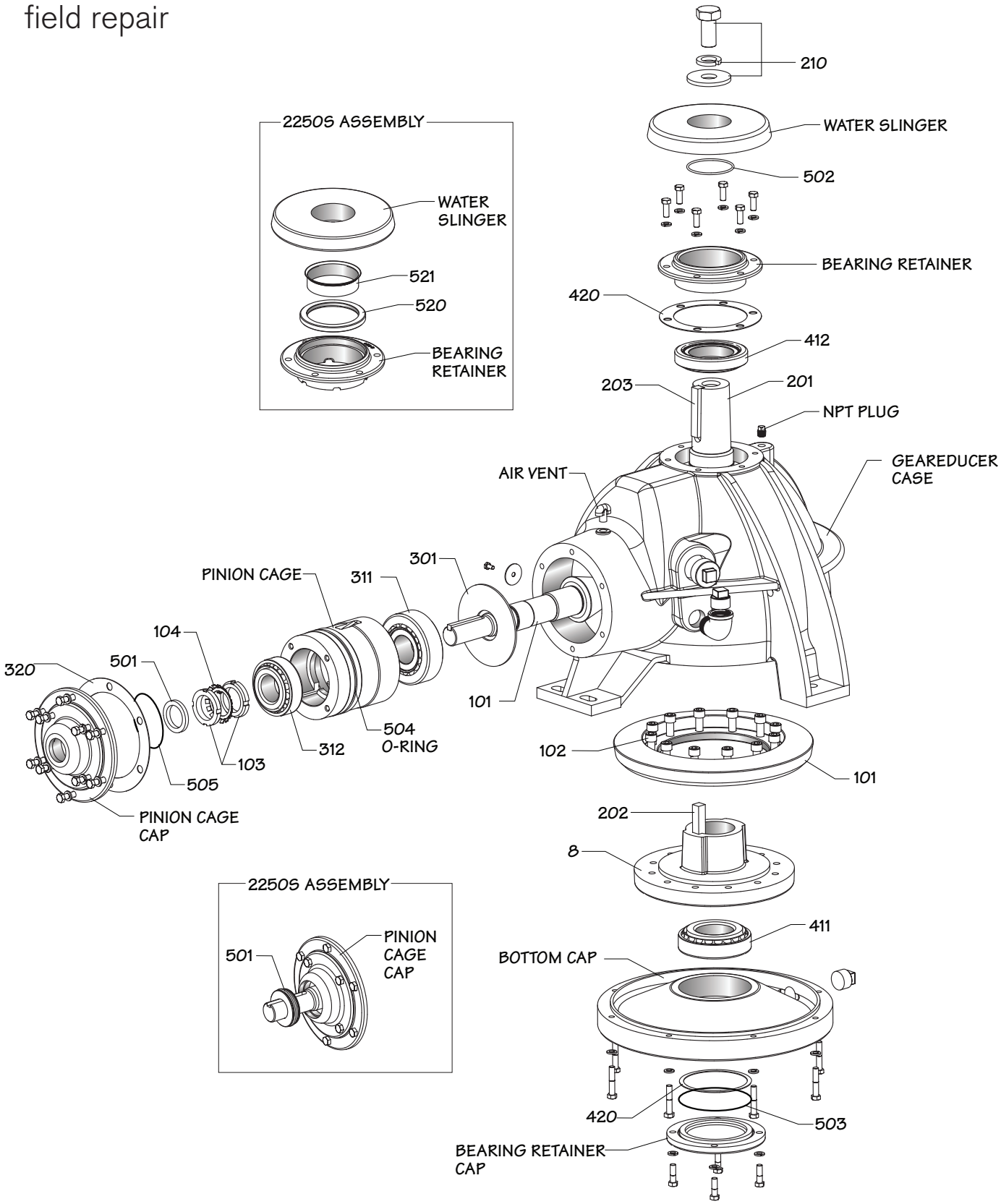


Figure 2 Exploded Cross Section

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.
- **520 Fan Shaft Oil Seal
- **521 Fan Shaft Oil Seal Sleeve

**Fan shaft Oil Seal and Sleeve used in S models only.

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.
8. **S models only:** Remove fan shaft lip seal (**520**) from upper bearing retainer, and sleeve (**521**) from water slinger.

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.

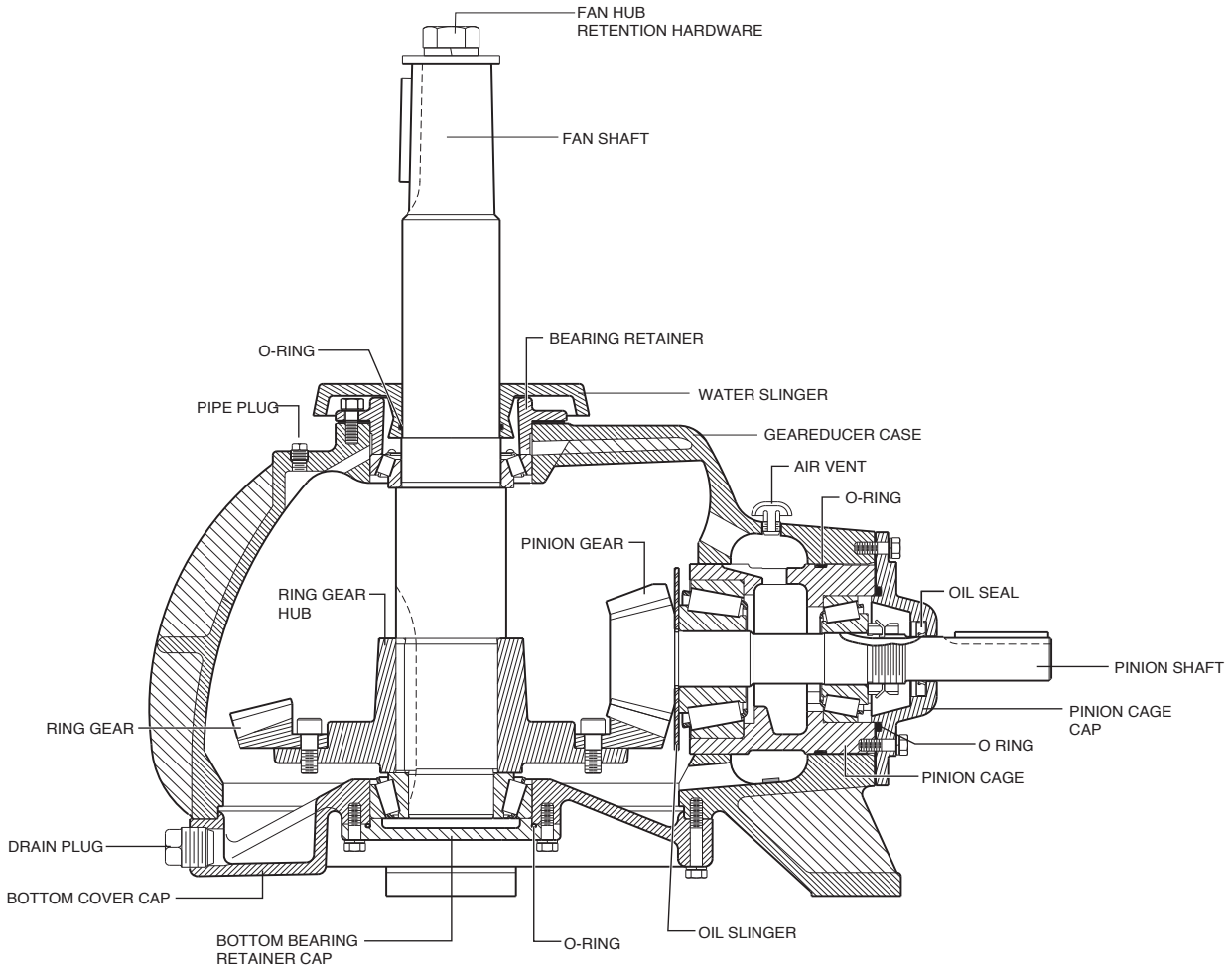


Figure 3 Cross Section

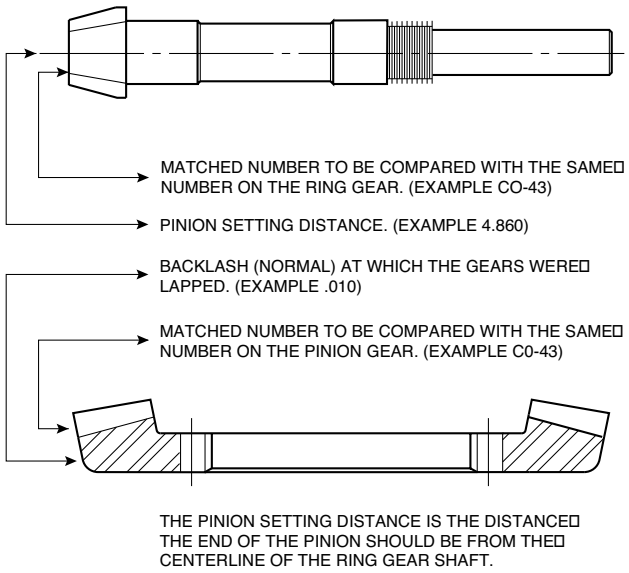


Figure 4 Gear Match Numbers and Setting Data

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**) into pinion shaft.
10. Position O-ring (**505**) and push cap (with seal) in place on shaft. Attach cap to pinion cage with cap screws.
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 upper bearing retainer.
6. **S models only:** Once proper end play is obtained install fan shaft oil seal in the upper bearing reatainer.

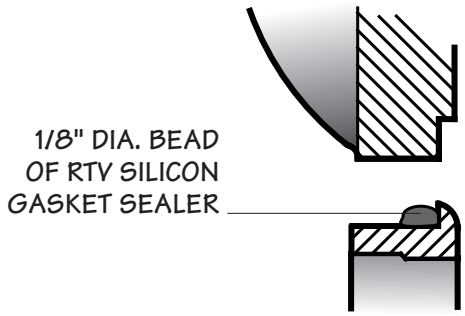


Figure 5 Flange Seal of Bottom Bearing Cap

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.

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.*

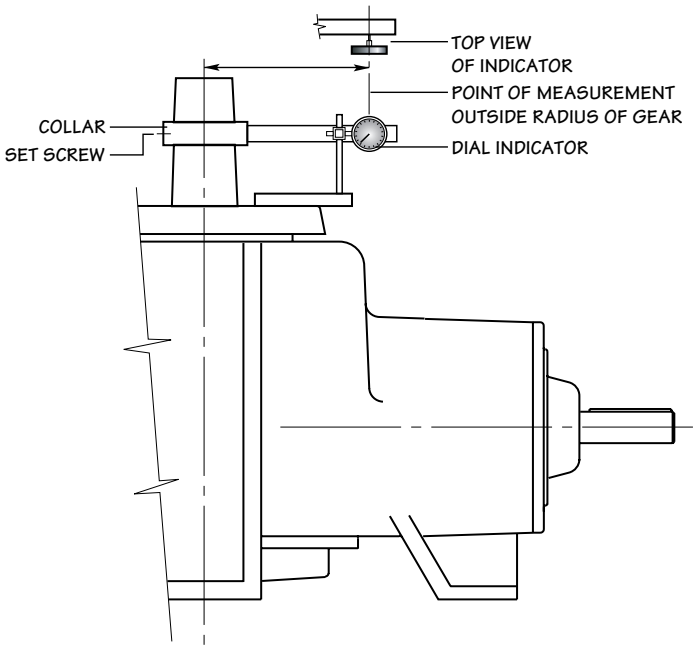


Figure 6 Gear Backlash Measurement

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. **S models only:** Install wear sleeve (**521**) on water slinger.
3. Install O-ring (**502**) in water slinger.
4. Install water slinger on fan shaft (**8**).
5. Replace air vent and all pipe plugs.
6. Fill with lubricant selected from **Table I**.

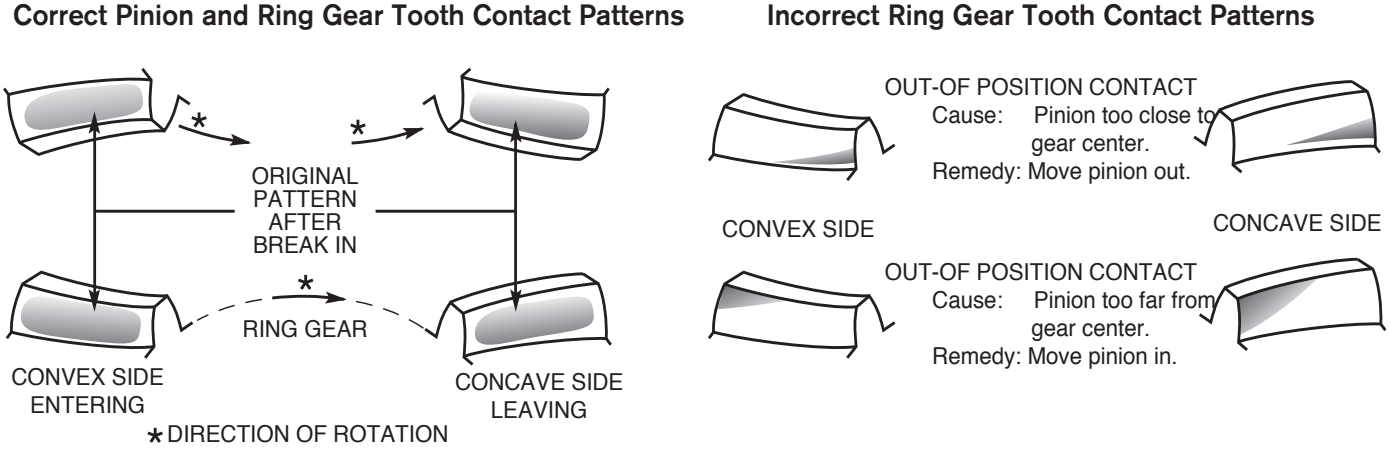


Figure 7 Tooth Contact Pattern—Correct and Incorrect

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In the interest of technological progress, all products are subject to design and/or material change without notice.

Hands on Training – Marley MX75 fill vs. MBX fill Install

Objective: Learn how to install MX75 Fill vs MBX fill in a crossflow steel tower. Gain a better understanding of the information included in the fill kit and the installation instructions. See the difference in the exterior vs interior MX75 fill install method. Learn what to look for when inspecting a tower and why it is important to include tubes, tube support and deflectors with the MX75 fill kit.

Installation Take Away Points:

- Should fill have gaps on the Eliminator and Louver sides?
  Answer: No, fill sheets should be tight on both sides, not gaps.
- How do you move the support tubes when fill is too heavy?
- Answer: Use individual straps to lift one tube at a time. The tube without weight will move, use pipe wrench, if required to turn tube.
- How do I know how many sheets I need in the tower and between individual supports or partitions?
  Answer: Count the fills sheets before removal between the cased wall on tube supports and/or partition. MX75 fill sheets are ¾" tall, so measure the distance and divide by 0.75. (Example 91.5" / .75 = 122 sheets of A&B)
- How do I install the last fill sheet?
- Answer: Use locking tabs (find # 113) to hold the fill sheets on tubes. Use a person on both sides of the fill and work in the remaining required fill sheets.

Proof In Performance Take Away Points:

- How much less labor is required to install the MBX fill?
  Answer: 30 – 40% (Proof in Performance)
- What is the performance difference between MBX vs MX75 Hanging fill?
  Answer: 8% less performance than MX75 hanging fill sheets (PIP)
- What is the performance difference between XF75 Brentwood vs MX75 Hanging fill?
  Answer: 17% less performance than MX75 hanging fill sheets (PIP)
- Can we provide an Engineered Fill Kit for BAC Towers?
  Answer: Yes – Just ask your Parts ITSR for support

Notes / Take Away Points:

Hands on Training

Notes / Take away Points:

SPX COOLING TECHNOLOGIES

PREFERRED COOLING TOWER WATER CONDITION LIMITS

NOTE: Biological treatment and control of Legionella and other potentially health-threatening bacteria is essential. Consult a competent water treatment expert or service company.

pH	6.5 to 9.0. (special materials may be required beyond these limits), Maximum 8.0, with no ammonia, recommended when chlorine is used as biocide.
Temperature	125° F (51.7° C) typical maximum; higher temperatures possible with special materials
Langelier Saturation Index	0.0 to 1.0 recommended; higher allowed if scale is controllable.
M-Alkalinity	100 to 500 ppm as $CaCO_3$
Silica	150 ppm as SiO_2 maximum (scale formation)
Iron	3 ppm maximum (staining and scale contributor)
Manganese	0.1 ppm maximum (staining and scale contributor)
Sulfides	Greater than 1 ppm can be corrosive to copper alloys, iron, steel, and galvanized steel. See table below for limits with film fill.
Ammonia	50 ppm maximum if copper alloys present; lower limits apply for film fill - see table.
Chlorine / bromine	1 ppm free residual intermittently, or 0.4 ppm continuously (double these for bromine). Excess can attack sealants, accelerate corrosion, increase drift, and embrittle PVC.
Organic solvents	These can attack plastics and promote bio-growth. Trace amounts may be acceptable, depending on the solvent.
TDS	Over 5000 ppm may require thermal performance derate.

Individual Ions:		MAXIMUM:
Cations:	**Calcium**	800 ppm as $CaCO_3$ preferred, (300 ppm with MX fills in arid climate).
	Magnesium	Depends on pH and silica level (for magnesium silicate scale).
	Sodium	No limit.
Anions:	**Chlorides**	450 ppm as Cl^- (300 for galvanized towers). upgrades are required for higher chloride levels.
	Sulfates	800 ppm as $CaCO_3$ preferred if calcium is also high ($CaSO_4$ scale).
	Nitrates	300 ppm as NO_3^- (bacteria nutrient).
	Carbonates/Bicarbonates	300 ppm as $CaCO_3$ preferred for wood or galvanized steel tower.

Fouling Contaminant Limits - based on fouling load of 2.5 pounds per cubic foot

Bacteria counts listed below relate to maintaining fill thermal efficiency only.
Biocidal treatment is required for all cooling tower installations. (see NOTE above).

Fill Type	Aerobic Bacteria Heterotrophic Plate Count	Total Suspended Solids (TSS)	Oil and Grease	Sulfides	Ammonia
MC75, MC120	10,000 CFU/ml	50 ppm	1 ppm	0.5 ppm	10 ppm
FB20, MX75 and MX625 (crossflow)	100,000 CFU/ml with TSS up to 50 ppm, or 10,000 CFU/ml with TSS up to 150 ppm		1 ppm	1.0 ppm	15 ppm
DF254, MCR16	100,000 CFU/ml	150 ppm	5 ppm	1.5 ppm	25 ppm
DF381 with 1' MC75 overlay, MCR12	1,000,000 CFU/ml with TSS up to 50 ppm, or 100,000 CFU/ml with TSS up to 150 ppm		5 ppm	1.5 ppm	25 ppm
MVC20, AAFNCS ('Cleanflow'), DF381, VC25, TrickleBloc	1,000,000 CFU/ml	250 ppm	25 ppm	2.0 ppm	25 ppm
Splash bar or grid fill	1,000,000 CFU/ml target	No specific limit, consult with SPX		N/A	N/A

Note: Any amount of oil or grease may adversely affect thermal performance. Sulfides and ammonia promote bacterial growth which can cause fill fouling; conformance to the limits above will assist in controlling bacteria to the recommended levels.

Drift Effects:

Certain contaminants or treatment chemicals such as surfactants, glycols, biodispersants and antifoams may increase drift rate. When minimizing drift is vital, the circulating water shall have a surface tension of at least 65 dynes/cm and a total organic carbon (TOC) level below 25 ppm. *Reclaim or re-use waters in particular may contain contaminants which increase drift rate either directly or by necessitating the use of treatment chemicals which increase drift rate.*

Miscellaneous Solids and Nutrients

Avoid high efficiency fill (MC75) with water containing bacteria nutrients such as alcohols, nitrates, ammonia, fats, glycols, phosphates, black liquor, or TOC greater than 50 ppm. Clog-resistant fills may be considered for contaminated water, case by case. For all film fills, avoid fibrous, oily, greasy, fatty, or tarry contaminants, which can plug fill.
In general, do not use film fill in Steel Plants, Pulp & Paper Mills, Food Processing Operations, or similar applications unless leaks and contamination by airborne or waterborne particulates, oil, or fibers are extremely unlikely. If film fill is used, biological-growth control must be stringent and diligent.

SPX COOLING TECHNOLOGIES

Scale Removal for Crossflow Film Fill

Typically calcium carbonate scale is removed from crossflow PVC film fill by two methods. The first method includes physical washing of the louver face and the fill sheets themselves. A medium pressure hose can be used to remove this less-adherent type of scale. Since scale usually precipitates in wet-dry areas, the louvers typically contains more calcium carbonate scale than the fill sheets. Care must be taken, however, not to damage the fill with excessive pressure.

If scale cannot be removed physically either because it is difficult to get to or it is simply too adherent then acid treatment can be used. By either reducing the pH of the circulating water or by applying a descaling solution, calcium carbonate should loosen from PVC surfaces. Care must be taken, however, not to expose galvanized steel surfaces (if present) to acidic conditions. Galvanized steel is very sensitive to most acids. The circulating water pH of a galvanized steel tower should not be allowed to fall below 6.0 even for a short time, or below 6.5 for continuous operation. Some descaling products are available that claim to be safe for use on galvanized steel. These are typically based on inhibited sulfamic acid or glycolic acid, and are preferable to other products if galvanized steel is present. Strong mineral acids such as hydrochloric (muriatic) or sulfuric should not be used near galvanized steel. When using any chemical product, thorough rinsing is required to minimize any damage to galvanized surfaces.

Since the integral louvers are not exposed to as much water as the fill section, pH reduction of the circulating water may not be as effective in removing adherent scale. Typically louver scale is removed by physical washing. Prior to washing a weak acid solution sprayed on the louvers should assist in softening the scale. Thorough rinsing is again recommended.

Some other types of scale such as calcium sulfate may be very difficult to remove since they are extremely adherent. Fortunately these adherent types are rarely seen in cooling towers. If present, cycle reduction, water treatment modifications, and/or fill selection is needed to prevent these adherent types of scale.

Calcium carbonate scale should be removed from PVC fill sheets or packs when they begin to inhibit the thermal performance of the tower. On crossflow towers this usually occurs when the louver face ‘honeycomb’ section reduces airflow through the fill sheets. If only a thin scale is present cleaning may not be necessary.

When working with acids or other cleaning chemicals, appropriate safety precautions should be taken to avoid exposure to harsh chemicals.

Cleaning and Maintenance of TU12 Eliminators

The TU12 Drift Eliminators require little or no maintenance. If it becomes necessary to clean them, care must be taken not to physically damage the PVC eliminator packs. For loose deposits of silt, fibers, etc., a water spray can be used, provided the spray nozzle is kept moving continually and that the water pressure is not excessive (recommend less than 30 psi). Chemical cleaning can also be done. If an acid product such as inhibited sulfamic acid or glycolic acid is used for chemical cleaning of a scale deposit (e.g., calcium carbonate), care must be taken that the acid does not attack other materials in the cooling tower or system, such as steel. The acid should be quickly and thoroughly rinsed off all metal surfaces. Do not use cleaning agents which contain hydrocarbon solvents.

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SPX COOLING TECHNOLOGIES

FACTORY MUTUAL APPROVAL DESCRIPTION

Factory Mutual (FM Global) is an insurance and fire research organization situated in North America and primarily affecting that market.

"FM Approvals" is a business unit of FM Global and conducts fire, wind resistance and other risk evaluation tests on many types of equipment, including cooling towers. Based on these tests, FM releases APPROVALS, which are widely accepted in the insurance and fire protection communities as being indicative of a low-risk product for the area of evaluation.

FM APPROVAL of a cooling tower indicates that FM has determined the tower design, including the specific configuration of structure, fill, drift eliminators, distribution system, fans, partitions, and/or casing walls described, to have "been evaluated and found to be of low fire hazard not requiring automatic sprinkler protection of themselves when used for their intended purpose... (when) installed in the specified pattern". FM Approval also involves evaluation for seismic loading, wind loading and windborne debris resistance.

This determination is accomplished by FM Approvals through witnessed burn testing, laboratory flammability tests, design calculation reviews, laboratory pressure testing and laboratory missile impact testing.

Numerous SPX/Marley towers have been FM APPROVED through stringent testing protocols.

Tower lines with available FM Approval include:
NC, NC Modular, AV, MH Fluid Cooler, MD, Unilite, MS, and Class 800.

FM Approvals conducts periodic audits of our own plants and of vendors' facilities to ensure proper materials are used in the fabrication and assembly of approved towers.

Listings of FM-Approved cooling towers can be found in the official FM Approval Guide at approvalguide.com (registration is free).

MBX Installation Instructions

When removing old fill and supports, retain the tie rods for re-installation. If unit has additional set of eliminators, retain eliminators and supports for re-installation.

1. Compare packing list with items supplied. If any items are missing, contact your sales representative immediately.

2. Upper tube supports (on casing walls) and lower tube supports on basin floor, must be removed and all holes plugged prior to installation of new fill. The U-bolts that hang from the hot water basin must also be removed. (Figure 1). Make sure that cold water basin is clean and free of dirt and debris.



Figure 1

3. Place assembled grating support in cold water basin allowing a distance to the cold water basin wall at inlet face. The distance should be adequate for the fill packs to sit flat on the grate and centered at the top with the hot water basin (Figure 2). After the grating is in place, apply polyurethane sealant to the bottom supports to hold the grating in place. Once the fill is on the grate, the weight of the fill will keep the grating from moving.



Figure 2

4. Some kits for NC towers will include a separate water diverter (Fig 3a & 3b). These diverters are marked for right and left hand. Attach diverters under hot water basin as shown.

Figure 3a

Figure 3b

5. Install largest fill packs first. Depending on model of tower, the packs will be 6 – 12 sheets/pack, plus a filler pack of 2 – 3 sheets.



Figure 4

6. In order to fit in the filler pack, the rest of the fill will need to be strapped back to make room. Make sure to use a sheet of plywood to prevent the straps from damaging the fill (Figure 6)



Figure 6

7. Insert the filler packs with the largest section of pack on the bottom. After both sections of filler pack are installed, release the straps and make sure that all the packs are aligned and plywood and tools have been removed from the tower.



Figure 7

8. Replace additional eliminators (when available). Replace tie rods at inlet face.

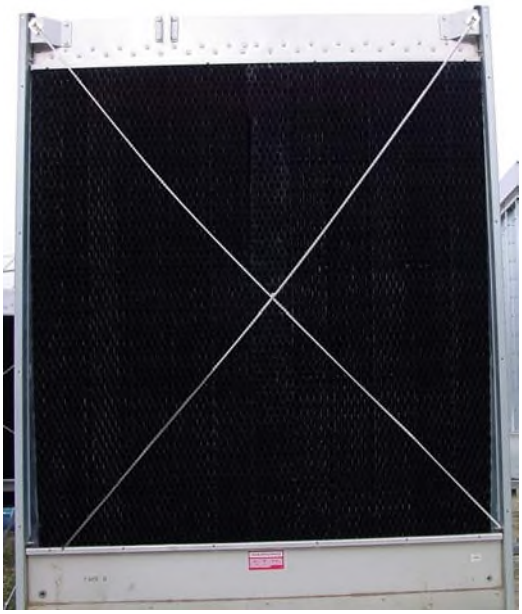
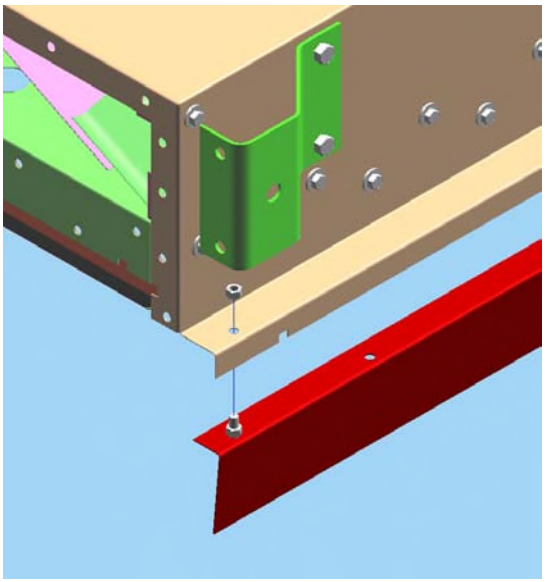
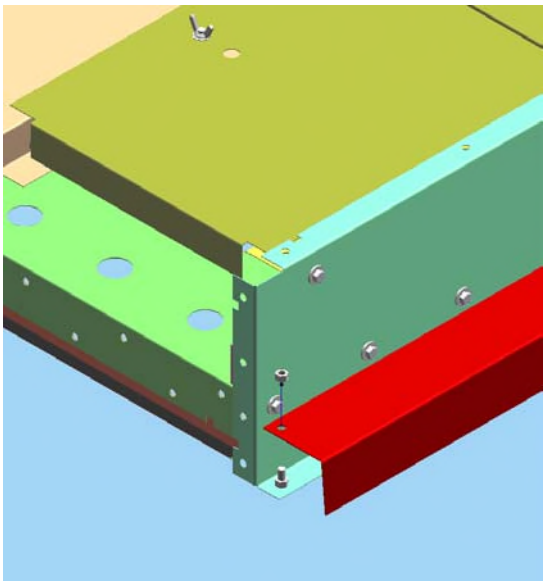


Figure 8

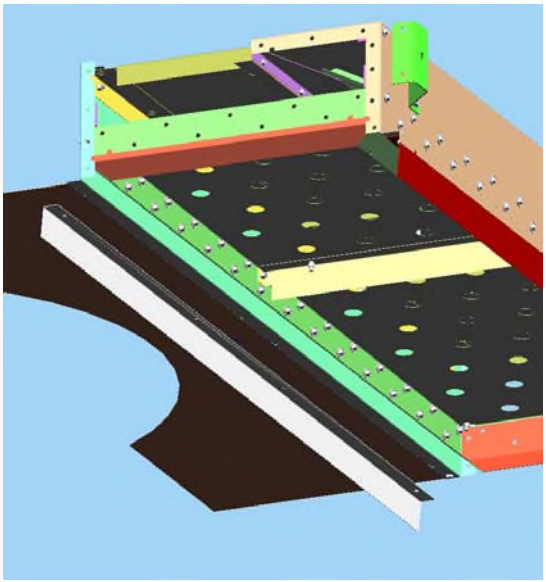
9. For NC models only install additional fill retainers using 3/8” hardware. Drill hot water basin louver and eliminator side using retainers as pattern. Minimum 4 holes are required for full hot water basin width retainer. Minimum 3 holes required for half hot water basin width retainer. Where possible use existing holes in hot water basin.



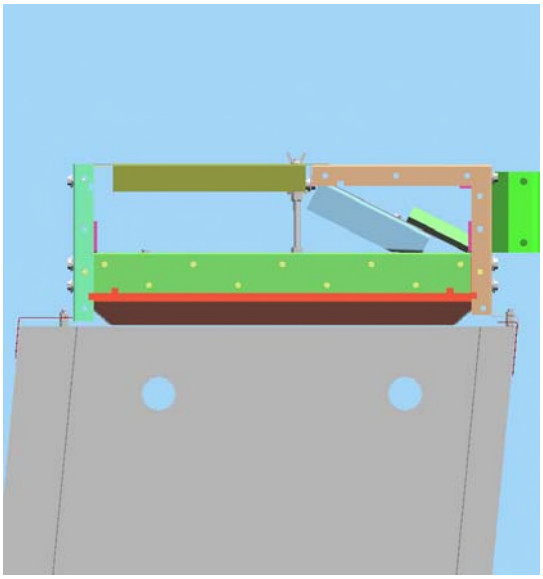
a. Louver side retainer. Install bolt thru the retainer. Tighten nut to create stud bolt. Install to HW basin as shown.



b. Eliminator side retainer.



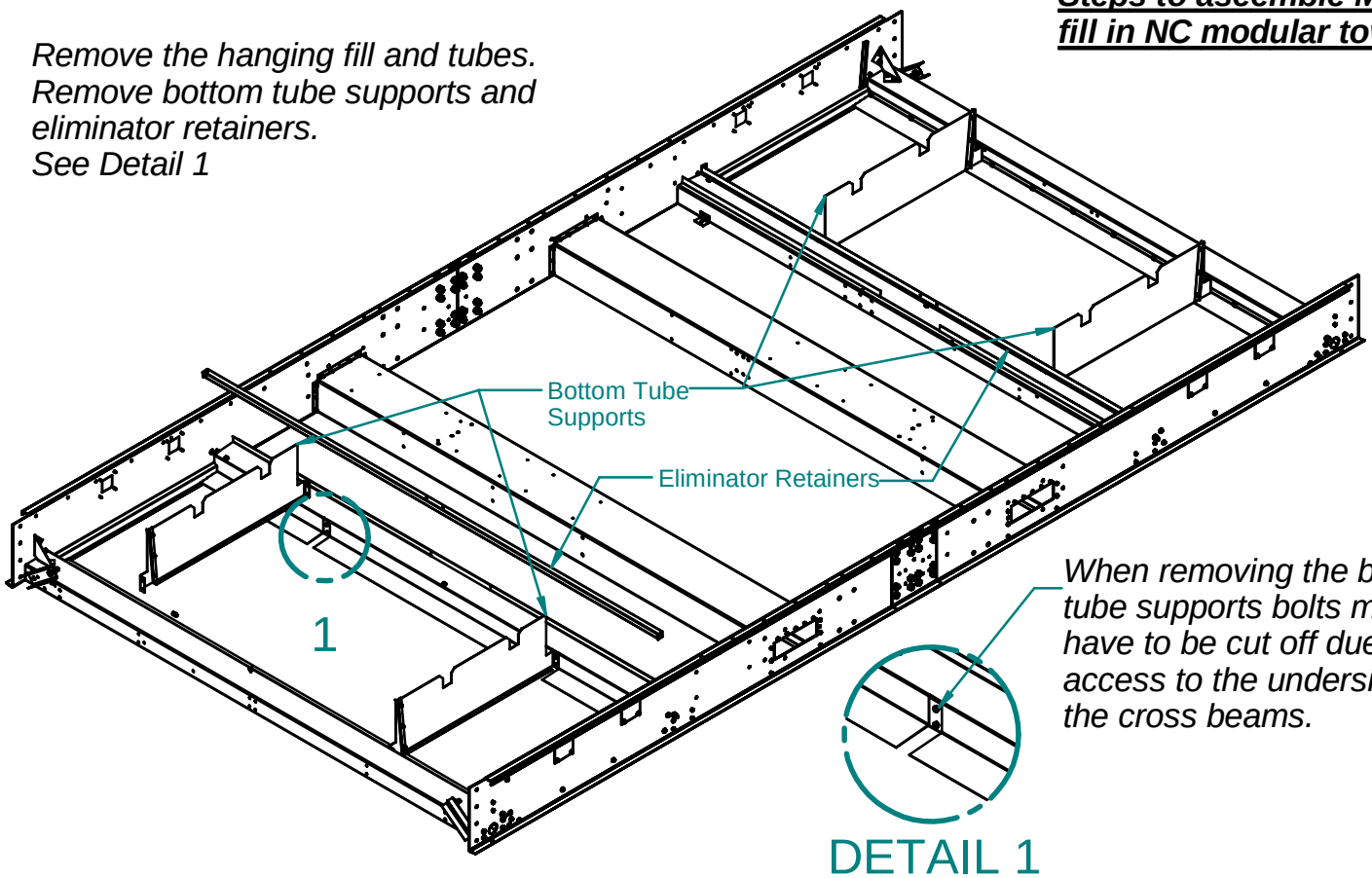
c. Eliminator side retainer (option with 8900 series tower). Retainer attaches to lower fan deck.



d. Louver and eliminator side retainers elevation view.

Steps to aseemble MBX fill in NC modular towers

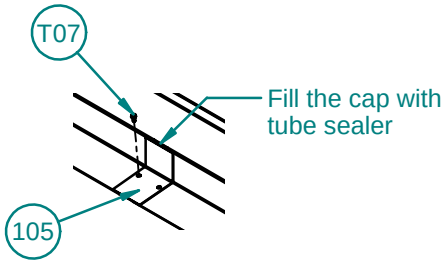
Remove the hanging fill and tubes. Remove bottom tube supports and eliminator retainers. See Detail 1



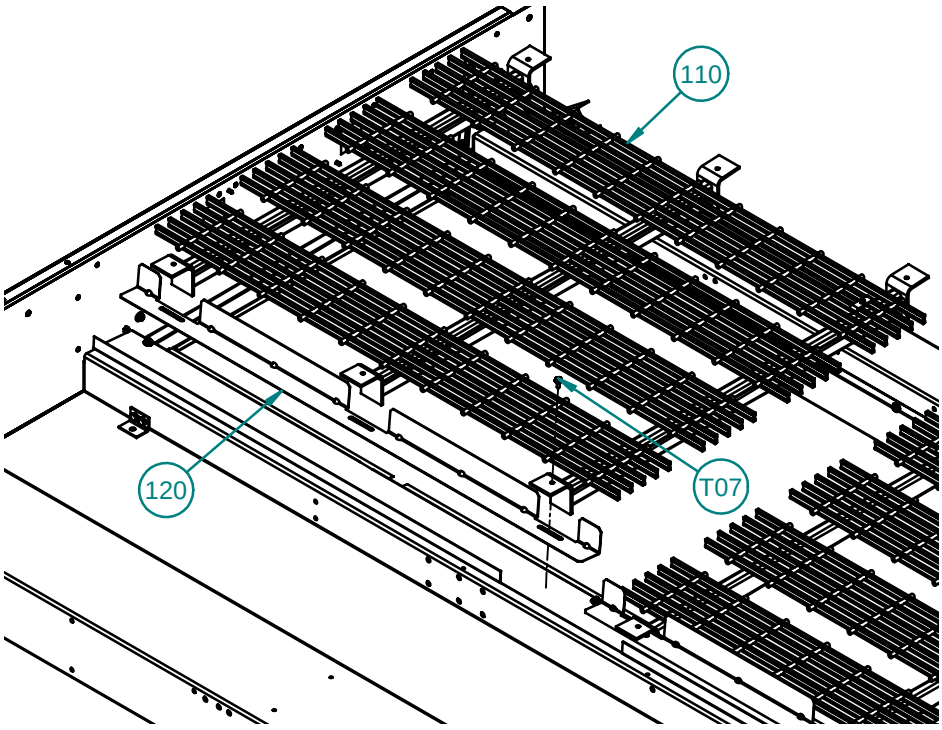
When removing the bottom tube supports bolts may have to be cut off due to no access to the underside of the cross beams.

DETAIL 1

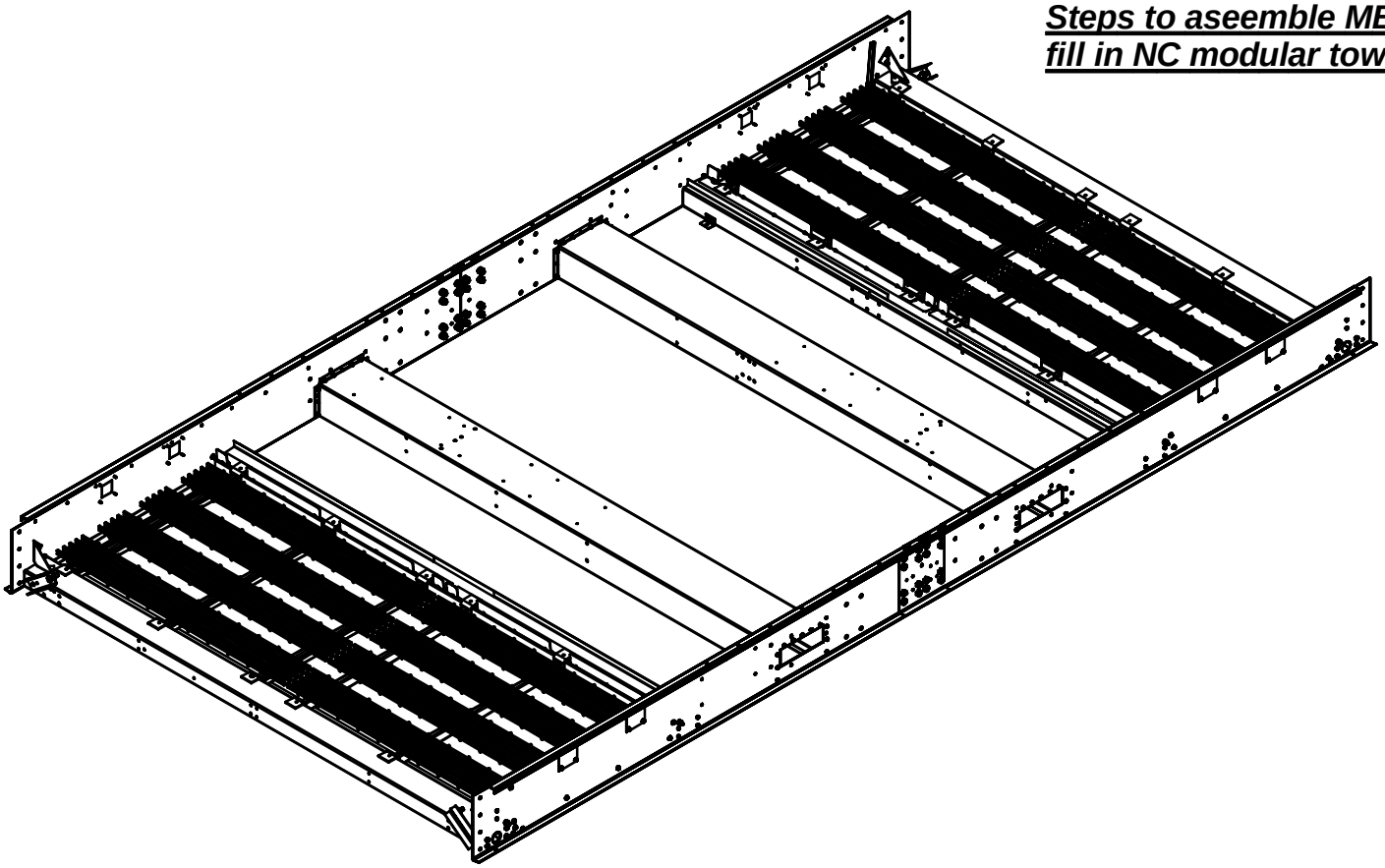
For each tube support removed, there will be 2 inch gap in the water deflector. Patch 2 inch gap with find # 105 to insure water deflection. See Detail 2



DETAIL 2



Set grating assembly find #110 in place. Drill 5/16" dia holes in tower beams. Fasten grating assembly find #110 to tower beams using 3/8 x 1 inch tap screws. Note on eliminator side new TU eliminator trays find #120 are set in place at the same time with grating supports



After all four grating assemblies find #110 have been put in place follow the same steps as for bottom fill packs to install top fill packs. Install top louver side fill retainer (see step nine). Assembly complete.

Hands on Training – Sheave and Belt Replacement

Objective: Learn how to replace and check the belt tension and to make sure sheaves are aligned correctly. Gain a better understanding of the information included in MHF User Manual maintenance section.

Scenario: Customer is complaining about belts squealing. Customer asked while we were changing out the fill if we could check the belts and make any adjustments necessary. It was determined that sheaves and belt should be replaced.

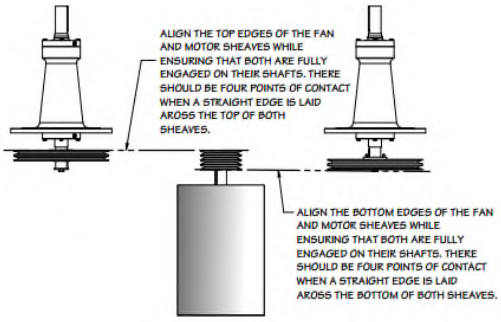
Step 1: Remove old belt and sheaves on fan and motor and reinstall new.

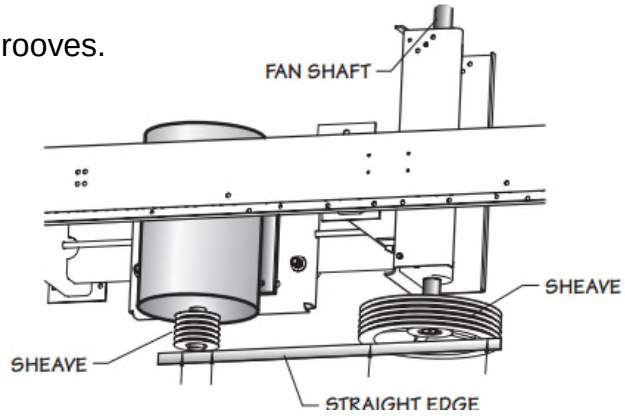
Step 2: Check Sheave Alignment

The motor and fan sheaves may have grooves that are not used. **The bottom surface of the motor and fan sheaves must be parallel of each other and level within 1⁄2° (1⁄8" in 12) in order to not adversely affect belt and sheave life.**

Alignment can be achieved by placing a straight edge or a taut string 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.

The belt is to be located in the lowest set of grooves.





Step 3: Check Belt Tension

- Ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
- Check tension frequently during the first 48 hours of run-in operation an then 4 weeks after start-up.
- Over tensioning shortens belt and bearing life.
- Keep belts free from foreign material which may cause slip.
- Never apply belt dressing, as this will damage the belt and cause early failure.

Take Away Points:

- Belt-tension is adequate when it is just tight enough to avoid squealing during start-up.
- Belts stretch and require attention soon after initial operation and then to a lesser degree over time.
- Belt Tension Testers – multiple different types for single and banded belts.

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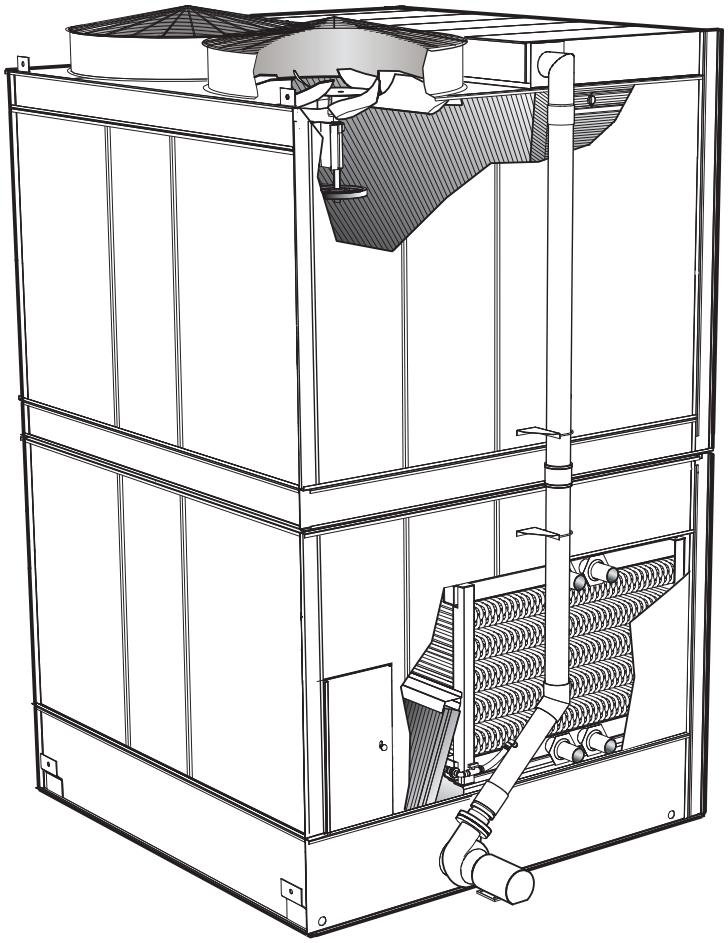
user manual

MH fluid cooler

INSTALLATION - OPERATION - MAINTENANCE

Z0920512_A ISSUED 06/2016

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



Protection Against Coil Freezing:

Ethylene and propylene glycol solutions are the best means to protect the coil from freezing. The following table provides the coil volume for each MH Fluid Cooler model. On MHF7111 and MHF7113 doubleflow models coil volumes are for both coils added together.

Model	Wet Coil US Gallons	Dry Coil US Gallons	Model	Wet Coil US Gallons	Dry Coil US Gallons
MHF7101___AN	73	–	MHF7105___CN	229	–
MHF7101___AF	105	–	MHF7105___CF	229	39
MHF7101___BN	73	–	MHF7107___AN	252	–
MHF7101___BF	105	–	MHF7107___AF	252	56
MHF7103___AN	99	–	MHF7107___BN	376	–
MHF7103___AF	99	29	MHF7107___BF	376	56
MHF7103___BN	147	–	MHF7107___CN	435	–
MHF7103___BF	147	29	MHF7107___CF	435	56
MHF7105___AN	132	–	MHF7109___AN	379	–
MHF7105___AF	132	39	MHF7109___BN	567	–
MHF7105___BN	197	–	MHF7109___CN	625	–
MHF7105___BF	197	39			

Model	Wet Coils US Gallons	Dry Coils US Gallons	Model	Wet Coils US Gallons	Dry Coils US Gallons
MHF7111___AN	613	–	MHF7113___AN	738	–
MHF7111___AF	613	133	MHF7113___AF	738	142
MHF7111___BN	885	–	MHF7113___BN	1071	–
MHF7111___BF	885	133	MHF7113___BF	1071	142
MHF7111___CN	877	–	MHF7113___CN	1063	–
MHF7111___CF	877	133	MHF7113___CF	1063	142

Copper Coil:

Model	Wet Coils US Gallons	Dry Coils US Gallons	Model	Wet Coils US Gallons	Dry Coils US Gallons
MHF7101___ANC	46	–	MHF7105___ANC	92	–
MHF7101___BNC	65	–	MHF7105___BNC	134	–
MHF7101___DNC	46		MHF7105___CNC	134	–
MHF7101___ENC	65		MHF7107___ANC	172	–
MHF7103___ANC	70	–	MHF7107___BNC	250	–
MHF7103___BNC	100	–	MHF7107___CNC	252	–

When the use of industrial antifreeze solutions is not possible, the system must be operated to meet both of the following conditions.

1. Sufficient flow rate through the coil.
2. Sufficient heat load on the process fluid. Fluid exiting the coil must be maintained at or above 45°F. Cycling of the recirculation pump should not be used to control process temperatures.

Belt Tensioning

⚠ Caution

Any bolts loosened or removed functioning as mechanical or structural hardware should be replaced with the torques specified below. Anti-seize compound is recommended for stainless steel hardware

Fastener Torque Values				
Machine Bolt Size	Galvanized		Stainless	
	ft·lb$_f$	N·m	ft·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

See **Figure 1** for MH Fluid Cooler models **MHF7101 thru MHF7109** with a single motor per fan. Loosen specified hardware located at the top and bottom of the motor support assembly before adjusting the jacking screws. ***Do not remove the hardware–it is required to support the motor***. Tighten the hardware after adjustment. 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. Over tensioning shortens belt and bearing life. Keep belts free from foreign material which may cause slipping.

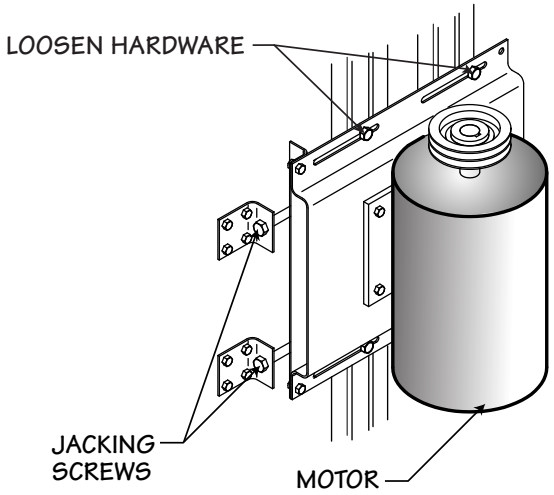


Figure 1

SINGLE MOTOR—SINGLE FAN. MHF7101 THRU MHF 7109 ONLY.

See **Figure 2** and **Figure 3** for MH Fluid Cooler models **MHF7101 thru MHF7109** for single motor with two fans. The belts are adjusted by turning the two acme bolts clockwise to tension the belts, keeping the motor plate square to the wall. Before tightening or loosening the belts loosen the four motor to motor plate bolts. **Do not remove the hardware.** Next loosen the four motor plate to side gusset bolts. **Do not remove the hardware.** It may help to grease three radial motor slots before turning the adjustment bolts. If one belt is looser than the other, the motor should rotate in the greased slots until the tension is approximately equal. After achieving proper tension tighten the hardware.

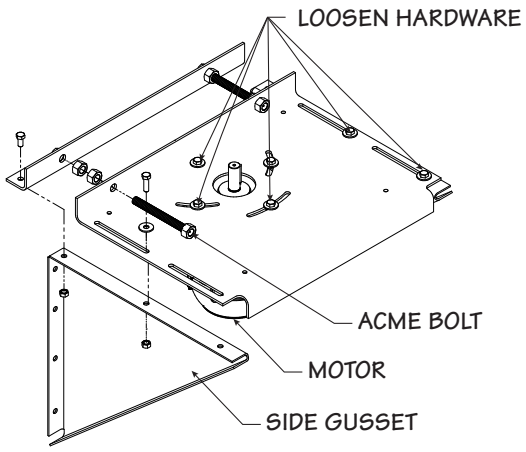


Figure 2

SINGLE MOTOR—TWO FANS. MHF7101 THRU MHF 7109 ONLY.

Fastener Torque at Motor Only				
Machine Bolt Size	Galvanized		Stainless	
	ft·lb$_f$	N·m	ft·lb$_f$	N·m
10mm	30-32	42-43	34-36	46-48
12mm	64-66	87-91	85-90	115-122
16mm	135-140	183-190	125-130	169-176
20mm	220-230	298-312	195-205	264-278

MHF7101 THRU MHF7109 ONLY. NON-LUBRICATED

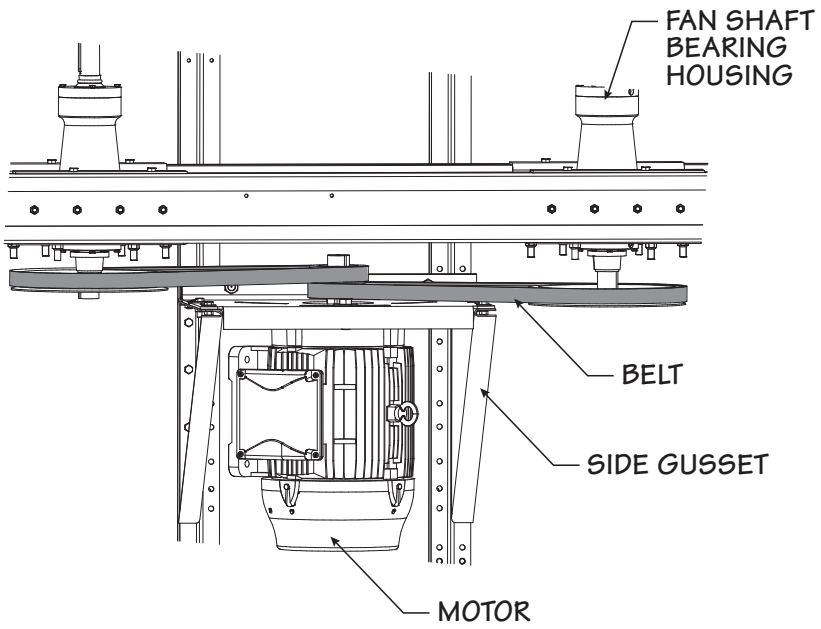


Figure 3

SINGLE MOTOR—TWO FANS. MHF7101 THRU MHF7109 ONLY.

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. Over tensioning 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. A Dodge® V-Belt Tension Tester is an alternate method for tensioning V-belts. Check with your local belt supplier.

See **Figure 4** for MH Fluid Cooler models **MHF7111 and MHF7113 with belt drive** option. The belts are adjusted by turning the threaded rod. Before tightening or loosening the belt, the double nuts holding the motor support in place must be loosened. There are two jam nuts at the end of the rod next to the casing. Turn the nut closest to the end of the rod to tighten the belt. Turn the other nut to loosen the belt. After achieving proper tension tighten the double nuts located on the fan side of the motor support against the motor support to maintain belt tension, then retighten the motor support nuts. 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. Over tensioning 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. A Dodge® V-Belt Tension Tester is an alternate method for tensioning V-belts. Check with your local belt supplier

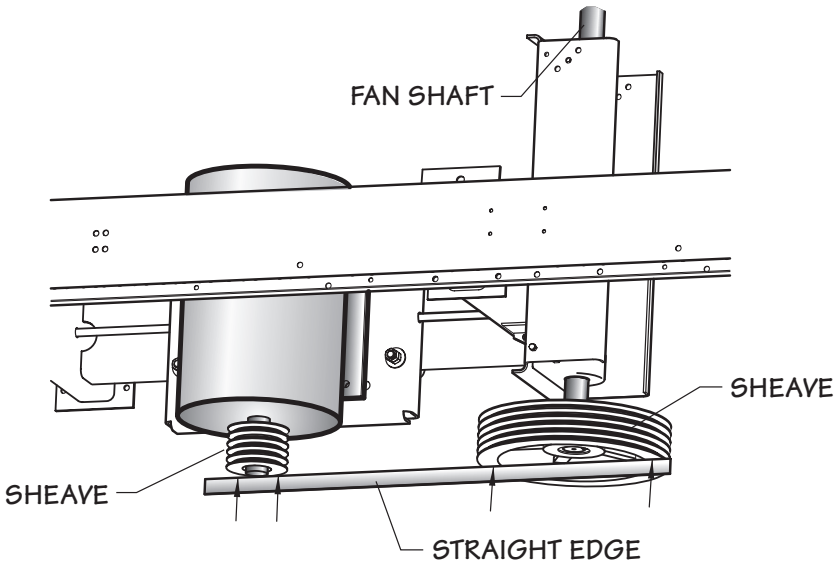


Figure 4

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 specific tensioning instructions are provided with your tensioning tool, those instructions should be used instead.

Sheave Alignment

⚠ Warning

Always shut off electrical power to the fluid cooler fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the fluid cooler. 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.
- 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.

Belt Tension

Belt Tension		
Motor Sheave diameter	**Used V-Belt** minimum	**New V-Belt** maximum
3.4" - 4.2"	4.9 lb	7.2 lb
4.4" - 5.6"	7.1 lb	10.5 lb
5.8" - 8.6"	8.5 lb	12.6 lb

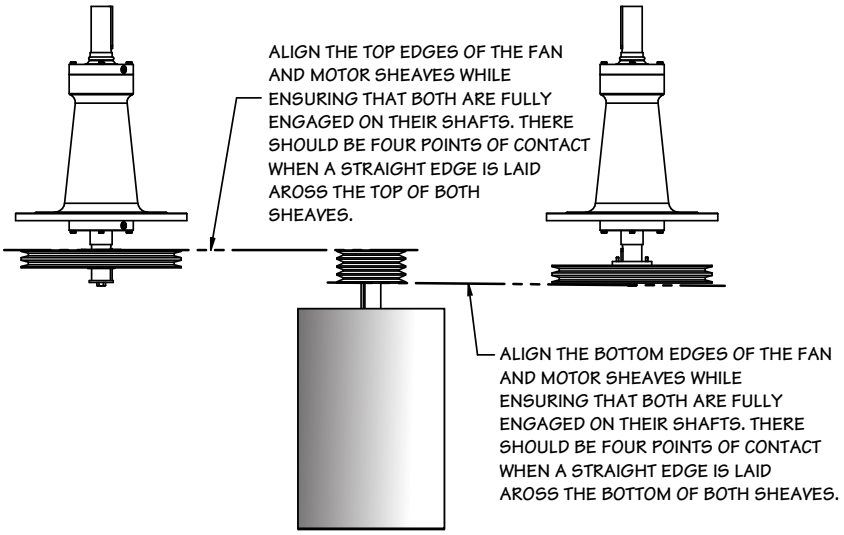


Figure 5

SHEAVE ALIGNMENT—MHF7101 THRU MHF 7109 ONLY.

Bushing Fastener Torque Values

Bushing	Fastener	Torque N·m
SH	¼ - 20	8
SDS	¼ - 20	8
SD	¼ - 20	8
SK	5/16 - 18	18
SF	⅜ - 16	30
E	½ - 13	47
F	9/16 - 12	88

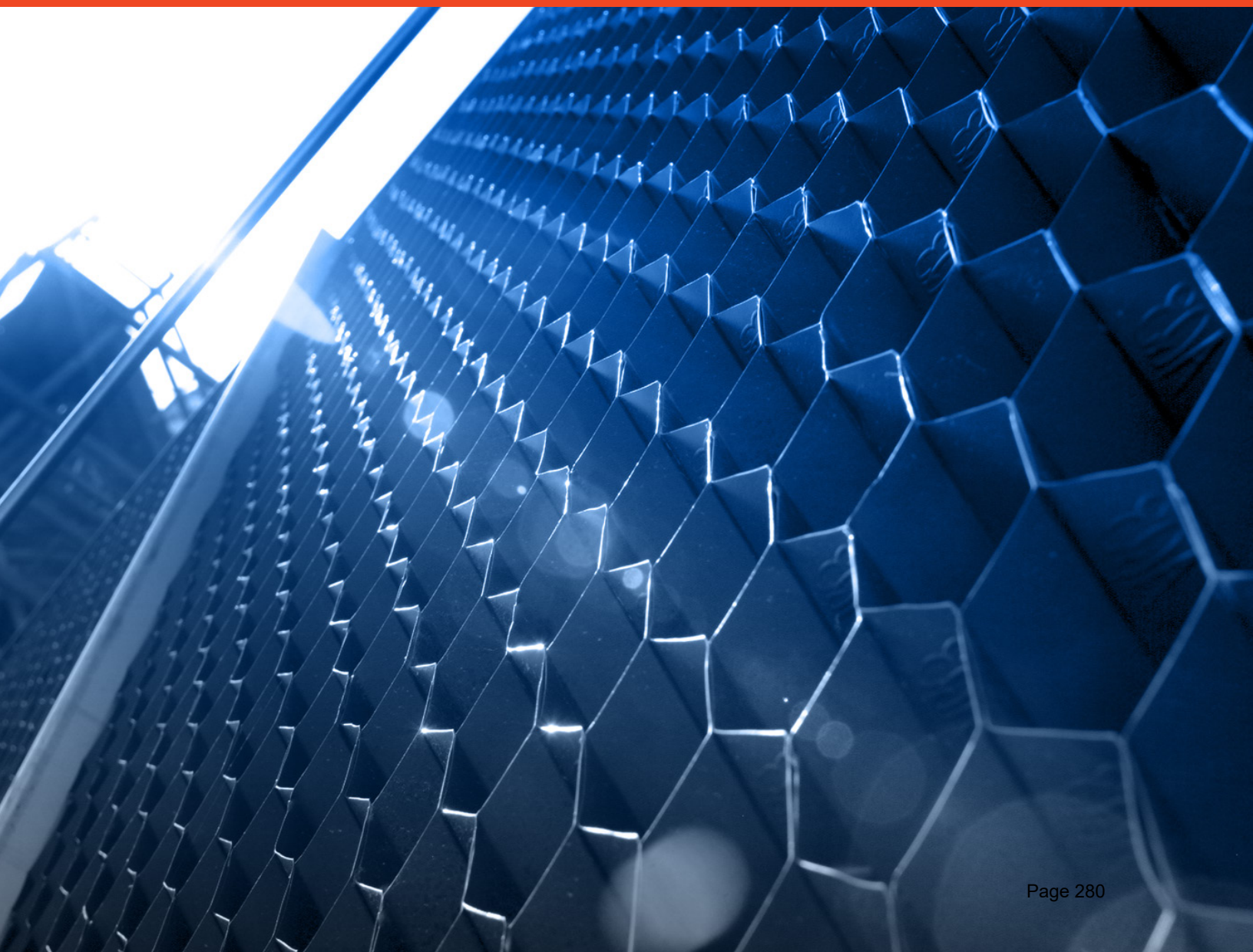
Hands on Training

Notes / Take away Points:

Marley Replacement Parts

For Your BAC Cooling Tower

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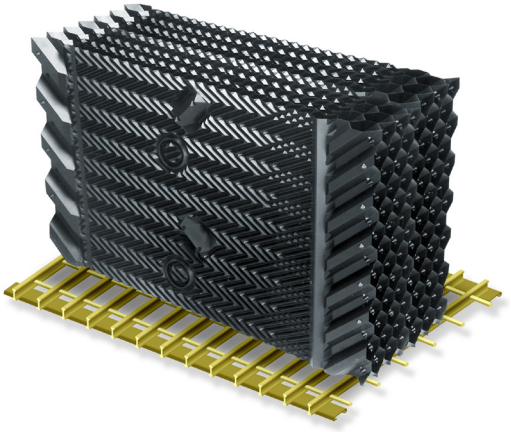


Marley Replacement Parts

FOR OTHER MANUFACTURERS' COOLING TOWERS

OUR MARLEY PARTS. YOUR BAC TOWER.

Now Marley parts are available for your non-Marley cooling tower. When your maintenance and repair projects demand quality and reliability, count on Marley, engineered to fit, cooling tower components.



Marley MBX Fill ①

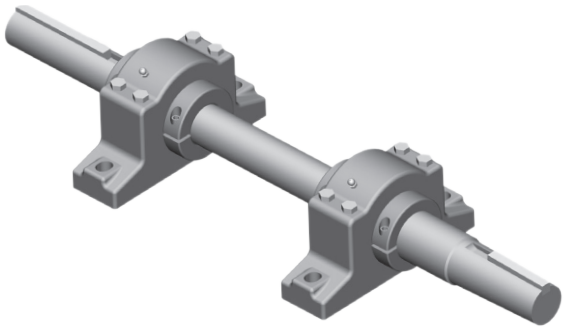
Marley MBX fill is a high performing, bottom supported PVC pack fill with integral louvers and drift eliminators. It provides faster, easier installation.





Marley X7 Fan ②

The Marley X7 fan is designed for induced-draft cooling tower applications, offering distinct advantages over other fan designs.

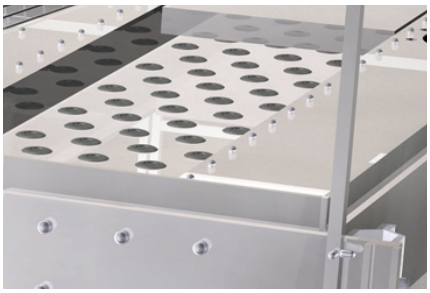


Bearings and Fan Shaft ③

Medium and heavy duty bearing replacements for vertical and horizontal mounting applications. Vertical and horizontal mounted fan shafts for direct replacements.

4 Marley Hot Water Basin

Hot water basins designed the Marley way. Includes Marley ST Nozzles to meet your flow profile.





5 Fan Belt

Replacement belts to keep your cooling tower in service.



6 Sheave

Available in both aluminum and cast iron.



7 Marley Spiral Target Crossflow Nozzles

The Marley Spiral Target Nozzle is an injection molded polypropylene unit consisting of two parts—the main body with integral target diffuser and a snap-on insert or orifice cap.



Marley Replacement Parts

FOR OTHER MANUFACTURERS' TOWERS

Marley mechanical system components are available for your Non-Marley cooling tower.

Find your Marley technical expert at spxcooling.com, 1-800-4-Marley or spxcooling@spx.com.

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Marley Replacement Parts

For Your Evapco Cooling Tower

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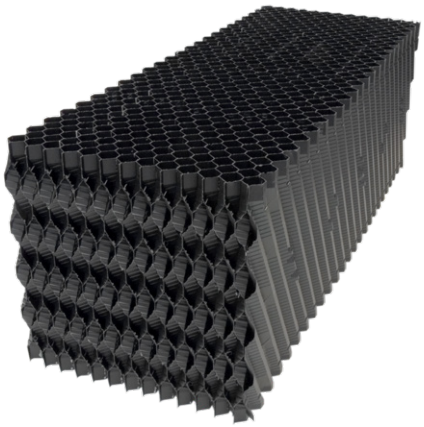


Marley Replacement Parts

FOR OTHER MANUFACTURERS' COOLING TOWERS

OUR MARLEY PARTS. YOUR EVAPCO TOWER.

Now Marley parts are available for your non-Marley cooling tower. When your maintenance and repair projects demand quality and reliability, count on Marley, engineered to fit, cooling tower components.



Marley MC120S™ Fill ①

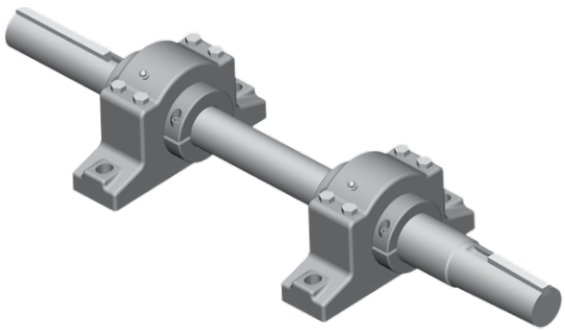
Marley MC120 is a high-performing, bottom-supported film fill system designed for factory-assembled counterflow towers. It requires a minimum number of supports and is an ideal replacement for competitive products with similar fill sheet spacing.





Marley X7 Fan ②

The Marley X7 fan is designed for induced-draft cooling tower applications, offering distinct advantages over other fan designs.

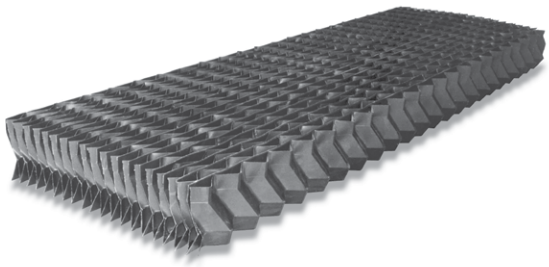


Bearings and Fan Shaft ③

Medium and heavy duty bearing replacements for vertical and horizontal mounting applications. Vertical and horizontal mounted fan shafts for direct replacements.

4 Marley XCEL TU12C Eliminators

The XCEL TU12C Eliminator is an advanced design that meets or exceeds today's demanding specifications for drift emissions without sacrificing fan horsepower.





5 Fan Belt

Replacement belts to keep your cooling tower in service.



6 Sheave

Available in both aluminum and cast iron.



7 Marley Float Valves

Designed specifically for cooling tower duty, Marley makeup water float valves provide long life with little maintenance.



Marley Replacement Parts

FOR OTHER MANUFACTURERS' TOWERS

Marley mechanical system components are available for your non-Marley cooling tower.

Find your Marley technical expert at spxcooling.com, 1-800-4-Marley or spxcooling@spx.com.

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Component Case Study

BAC 3000 Series – Bottom Supported Fill Packs

Application	Process Cooling
Problem	Over time, PVC heat transfer fill undergoes changes from environmental exposure that impacts its performance and original design. Inspection of this tower confirmed brittle fill, sagging and biological fouling, requiring replacement.
Solution	Marley® MBX replacement fill packs with bottom supports and integral louvers allowed simple component replacement, saved contractor time, minimized outage duration and restored tower operation.
Results	Extended tower life.



Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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Component Case Study

BAC FXV – Replacement Fill & Eliminators

Application	Fluid Cooling
Problem	Tower exhibited increased drift and decreased performance from fouled fill.
Solution	Installation of Marley® MBX fill, which utilizes simple bottom supports instead of structural members and fill tubes, and XCEL TU12X drift eliminators that do not require retrofitting.
Results	Minimized downtime while returning the tower to operation; cellular design of eliminator decreased drift rate.



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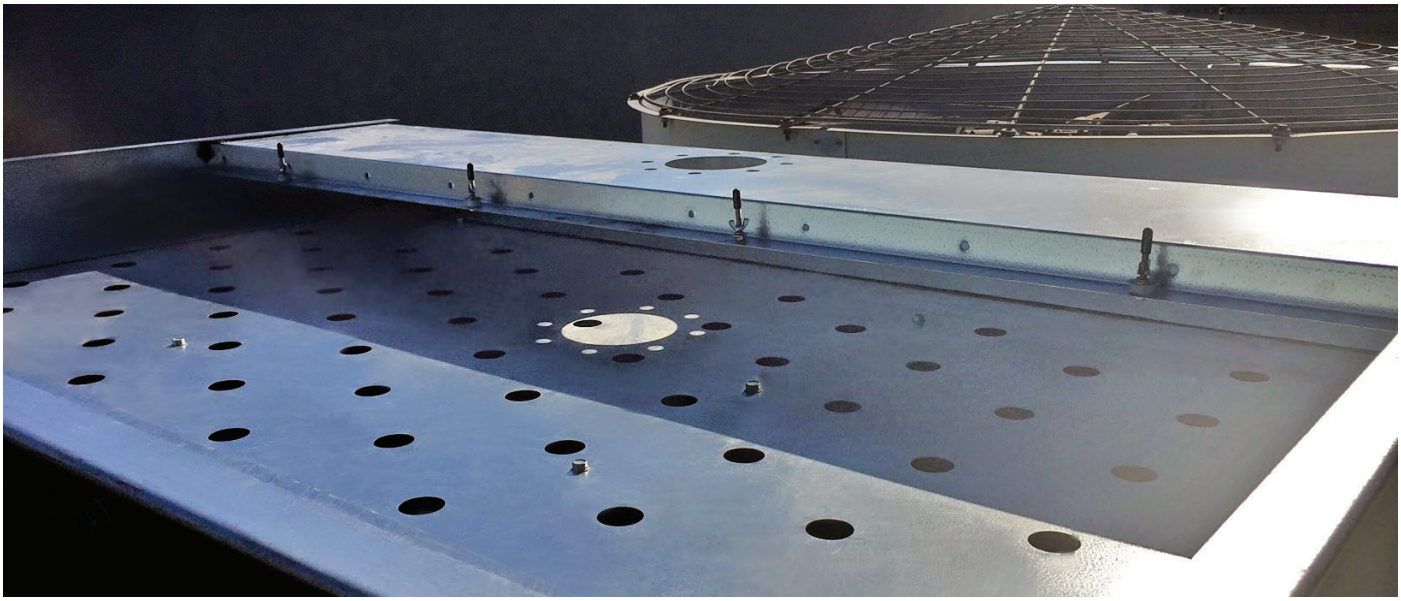
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Component Case Study

BAC 3000 Series – Hot Water Basin Replacement

Application	Process Cooling
Problem	Original basin had inlet boot entering through inboard side, creating poor water flow and resulting in uneven water distribution and dry portions of fill.
Solution	Marley replacement hot water basin with standard top inlet design and flume steadies and equalizes water for uniform distribution across heat transfer fill.
Results	Extended tower life; enhanced performance.



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Component Case Study

BAC 3000 Series – Custom Components

Application	HVAC
Problem	Hot water basin covers on BAC model 33373 cooling tower were corroded and created dangerous conditions for routine cleaning and maintenance.
Solution	After taking cover dimensions, SPX fabricated new galvanized steel basin covers.
Results	Basin covers created a clean and functional walking surface while keeping nozzles clear of external debris; extended tower life; improved tower appearance.



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Component Case Study

BAC 3000 Series – Fan Replacement

Application	HVAC
Problem	Components were beginning to fail. Sheaves fractured and the fan shaft and blades corroded, increasing the potential for major damage to the tower.
Solution	Replaced failing parts with Marley® components, including X7 fan, bearings, fan shaft, belt, basin covers, motor, sheaves and bushings.
Results	Tower restored to safe and efficient operating level; tower life extended



Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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Component Case Study

Evapco Fan Replacement

Application	HVAC
Problem	The original fan was showing signs of failure, as cracks and fissures began to appear around the hub.
Solution	Before failure occurred, SPX Cooling Technologies expedited a Marley X7 fan to replace the original fan, preventing mechanical and structural damage.
Results	The customer's tower was returned to operating order.



Photo courtesy of Bob Stortz, Midwest Machinery

Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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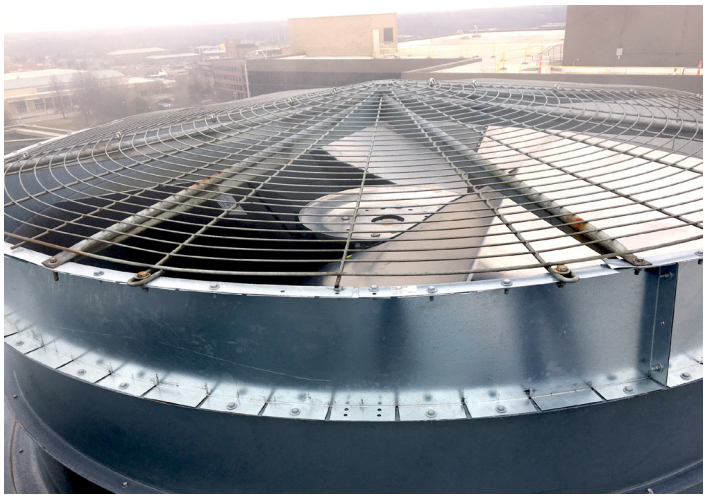
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Component Case Study

Evapco UT Series - Fan Replacement

Application	HVAC
Problem	Fan blade cracks were beginning to form where the blades meet the center hub. Because of the single-piece construction, the entire fan had to be deconstructed on-site to remove it.
Solution	The Marley Ultra Quiet Fan features a separate hub and individual fan blades to allow easy assembly and component replacement as needed. Manual blade pitch adjustment optimizes fan performance.
Results	The tower was restored to safe and efficient operating level. Easy installation of lightweight components – 70% lighter than FRP fans – saved the customer time and money. Quiet operation – up to 12 dBA reduction in sound levels – compared with standard low-sound fans.





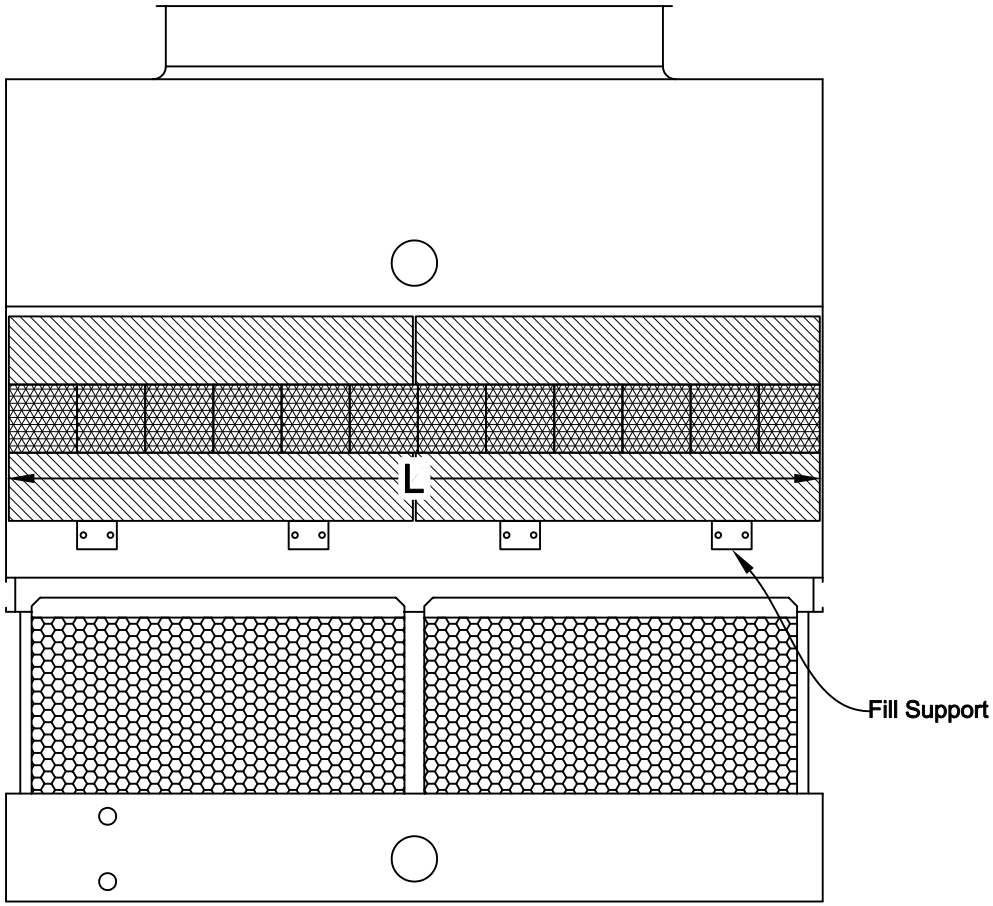
New Marley Ultra Quiet Fan

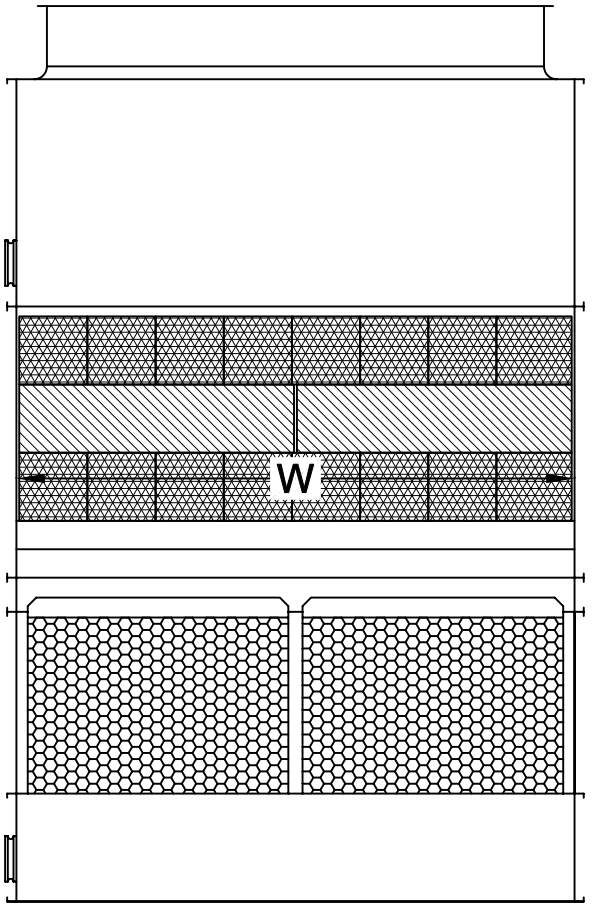
Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

SPX COOLING TECHNOLOGIES, INC.
7401 WEST 129 STREET
OVERLAND PARK, KS 66213 USA
913 664 7400 | spxcooling@spx.com
spxcooling.com

CCS-UQF-18 | ISSUED 05/2018
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In the interest of technological progress, all products are subject to design and/or material change without notice.

SPX®





Field Data for Fill for MC120 Fill Replacement		
Dimension	Description	Field Measurement
L	Inside-Inside Casing Length	
W	Inside-Inside Casing Width	
Fill Supports	QTY of Fill Supports Per Cell	

Notes:

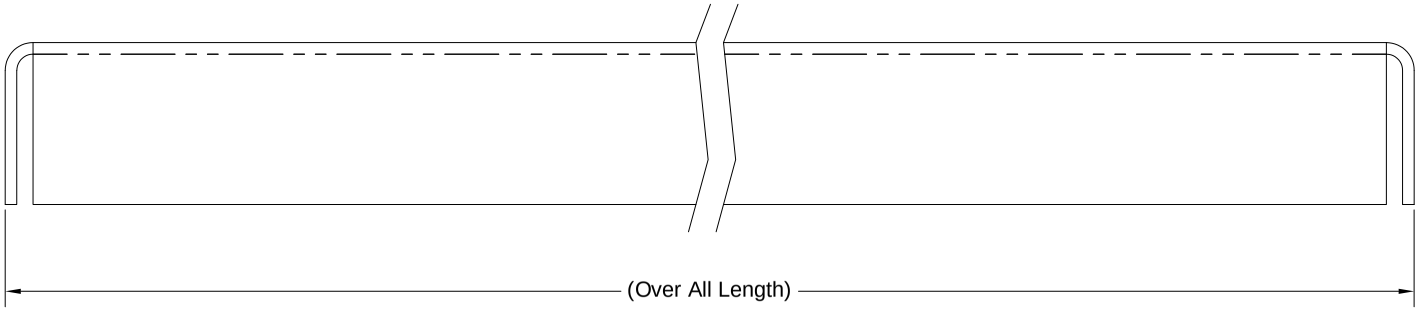
[1] The Inside-Inside Casing Dimensions are easily measured by removing a pair of opposing louver frames to expose the underside of the fill area.

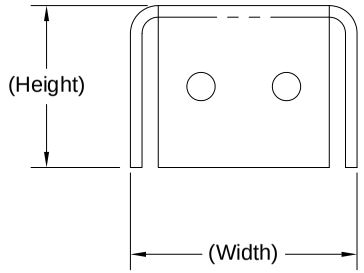
[2] If the tower is not able to be shut down. Measurements can be taken from the outside-outside casing and subtracting ¼" for the interior dimensions.

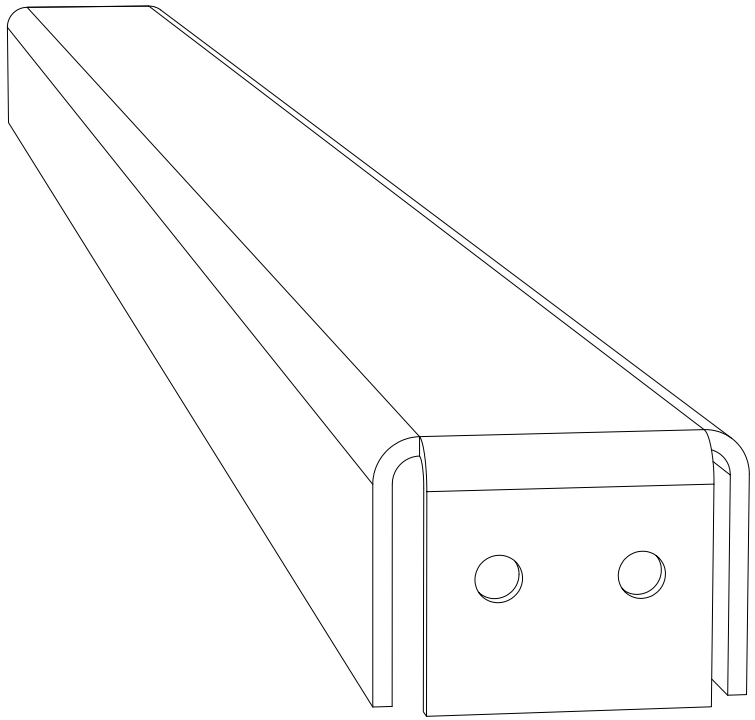
Marley After-Market Field Data

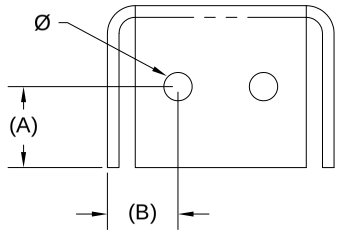
SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-FLL-001	Fill Replacement Data
DATE 02/01/2018		









Fill Support Field Data	
Over All Length	
Width	
Height	
(A) Bolt Hole Height	
(B) Bolt Hole Width From Flange	
Bolt Hole Diameter(Ø)	
Material (HDG or Stainless)	

Notes:

[1] Please use inches when specifying field measurements.

[2] Specify to the closest $\frac{1}{16}$ of an inch.

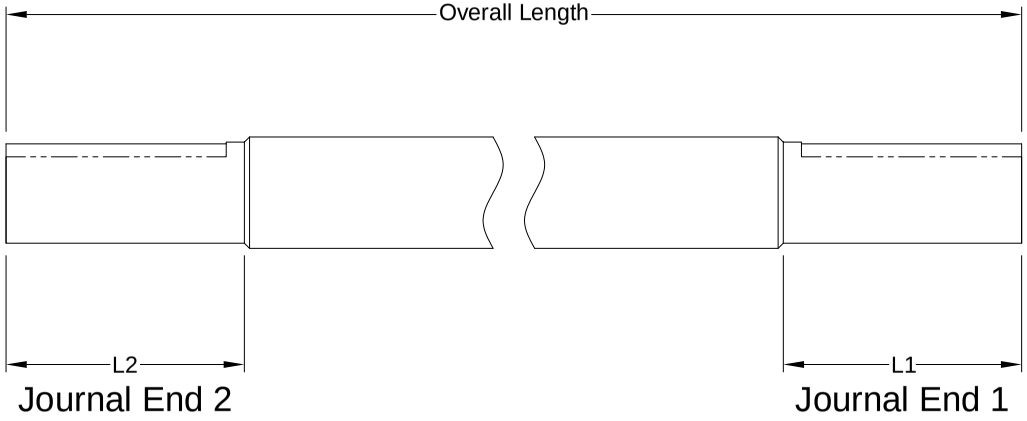
[3] Double Check all Measurements.

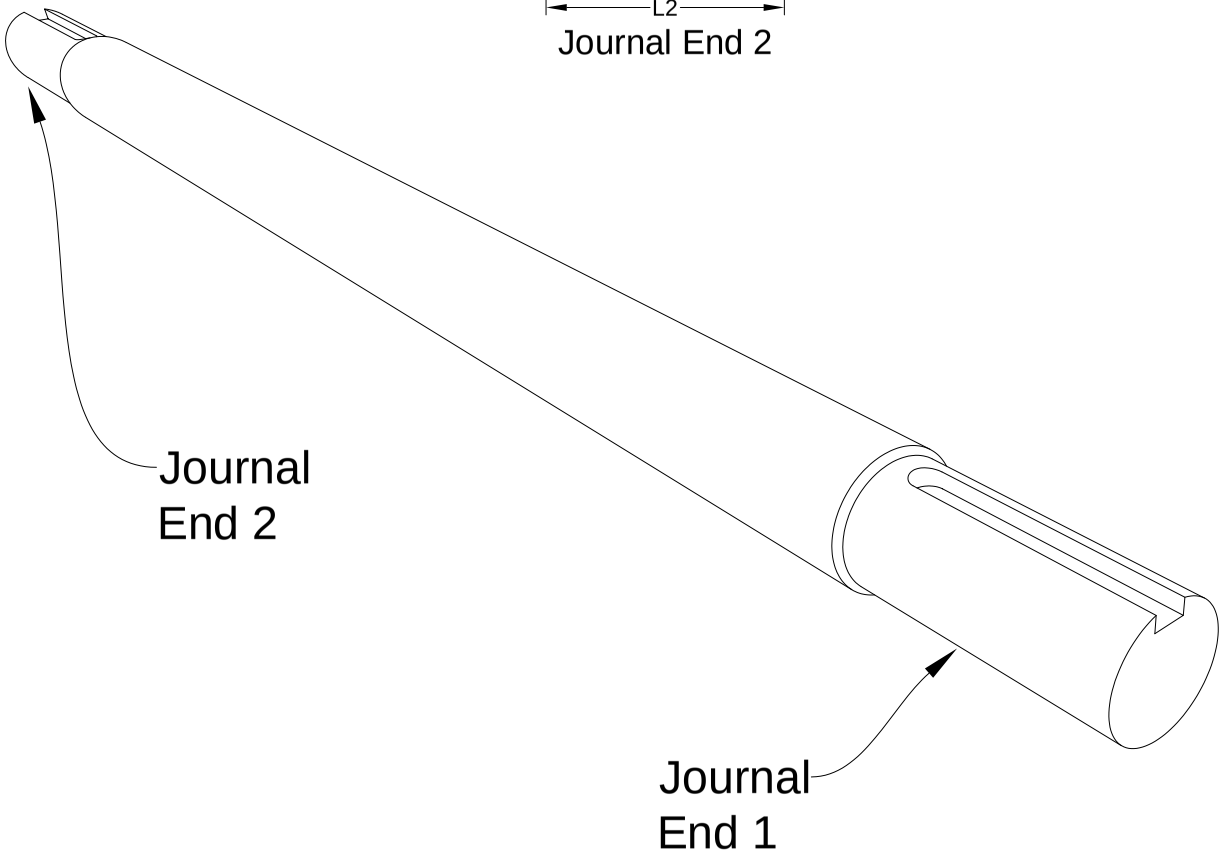
[4] Fill Supports will be fabricated with 10ga steel.

Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-FSP-001	Evapco Fill Support
DATE 12/13/2017		



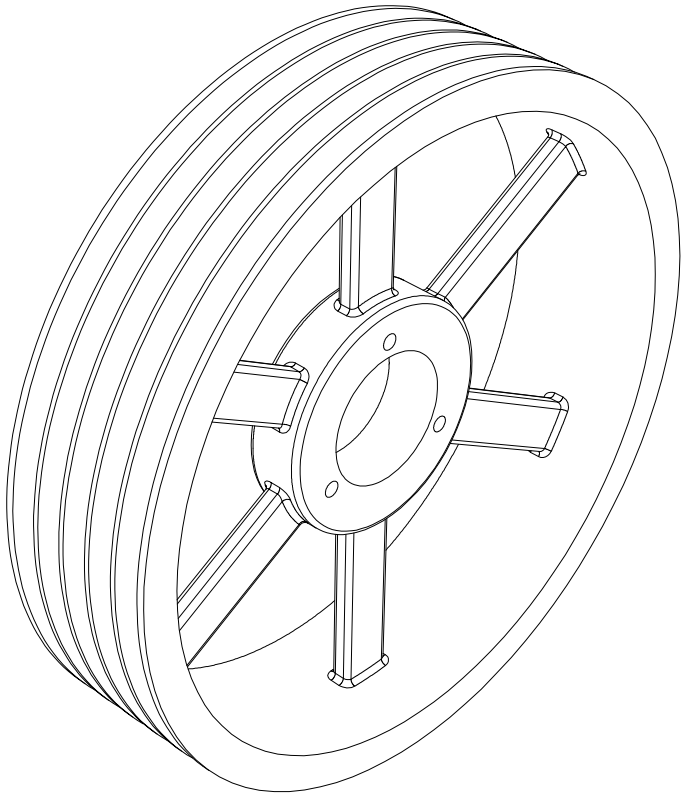


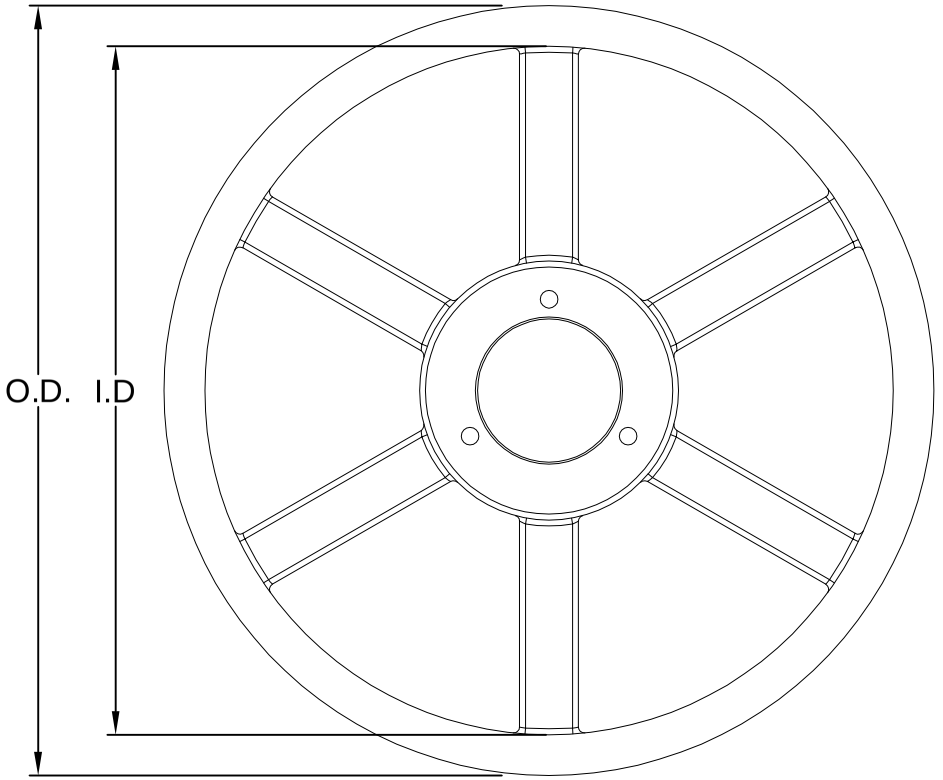
Fan Shaft Data	
Shaft Body Diameter	
Journal 1 Diameter	
Journal 2 Diameter	
Journal 1 Length (L1)	
Journal 2 Length (L2)	
Overall Length	

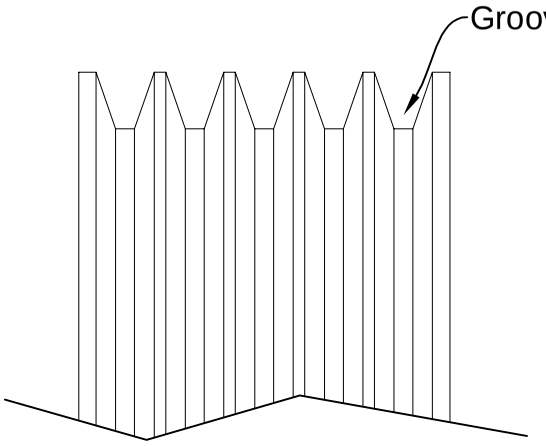
Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-SFT-001	Evapco Fan Shaft
DATE 12/12/2017		





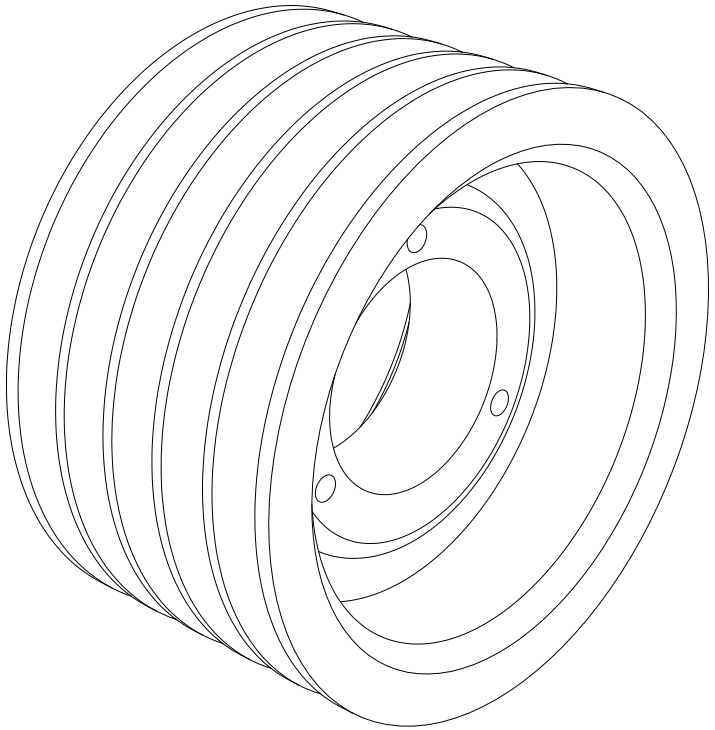


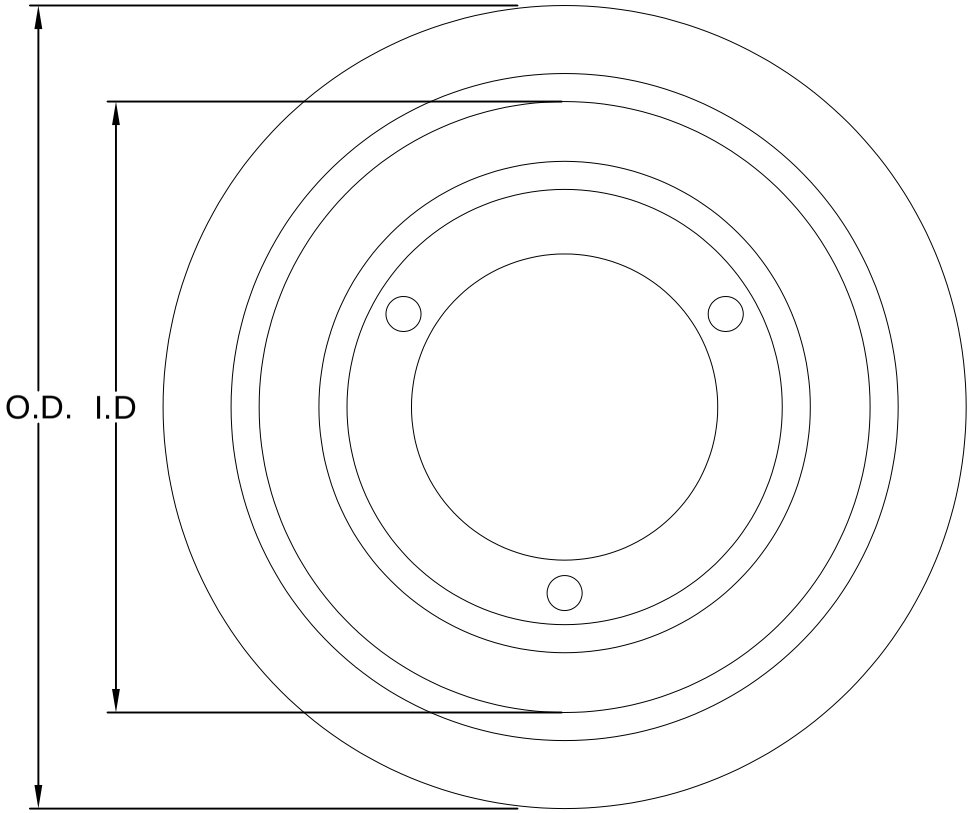
Measurement Data	
Groove Count	
O.D.	
I.D.	
Material (CI,ALUM)	
Bushing Diameter and type	

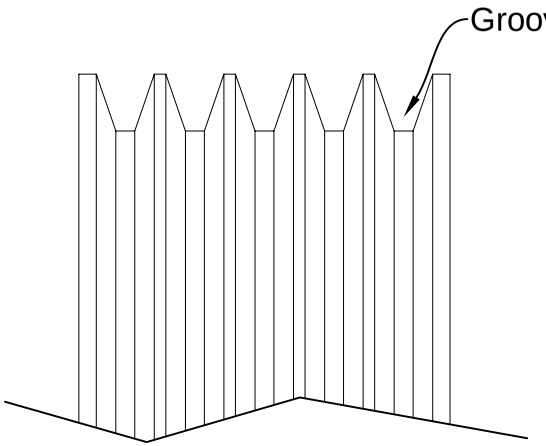
Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-SDM-001	Sheave Dimensions
DATE 12-29-2017		







Measurement Data	
Groove Count	
O.D.	
I.D.	
Material (CI,ALUM)	
Bushing Diameter and type	

Marley After-Market Field Data

SPX Cooling Technologies

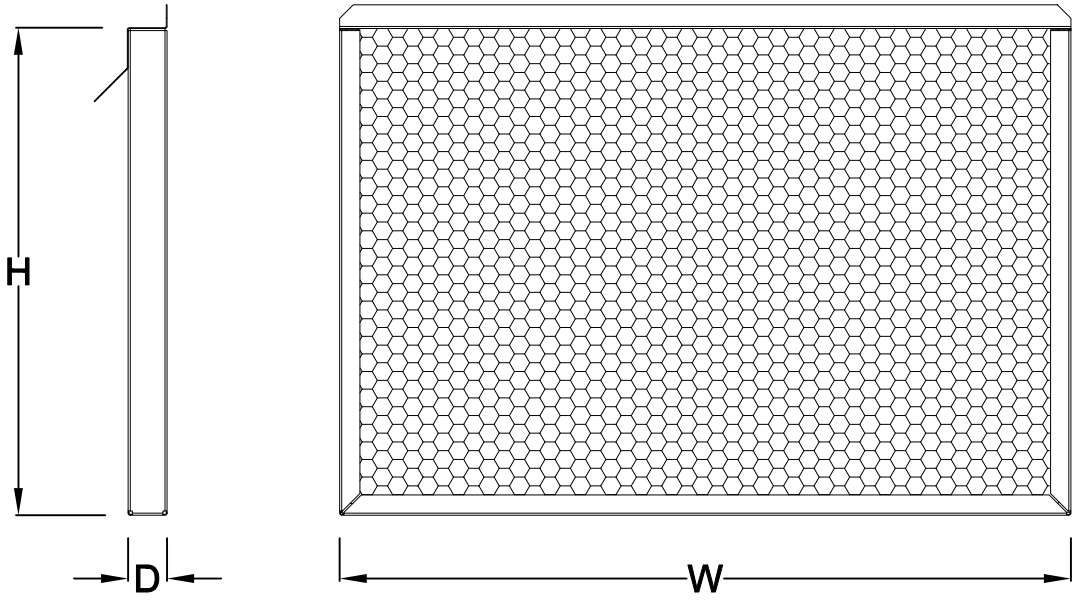
DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-SDM-002	Sheave Dimensions
DATE 02-06-2017		

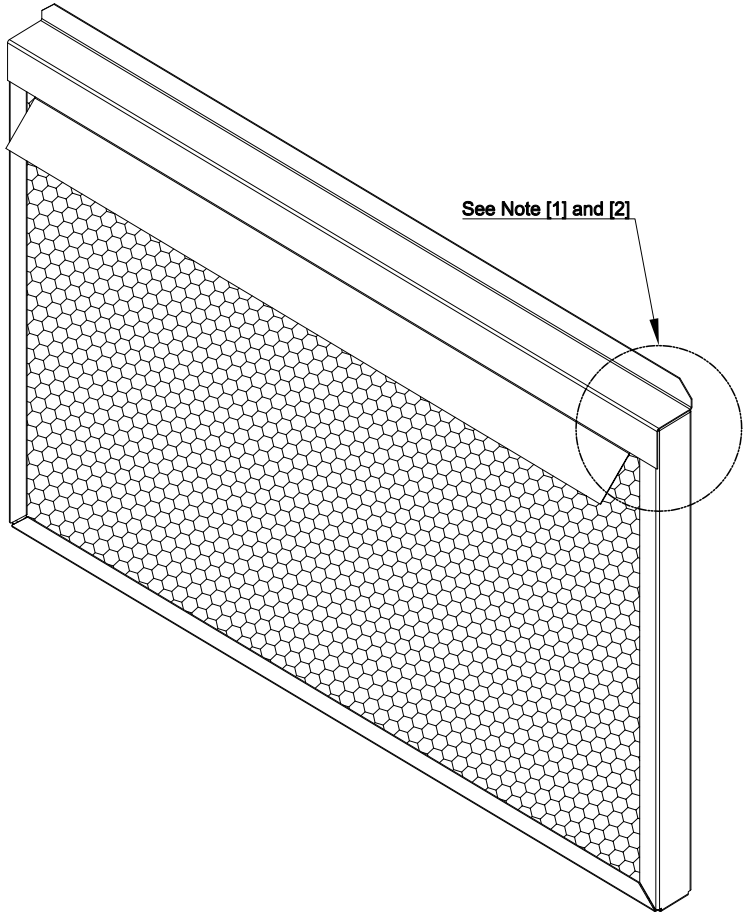
NOTES

[1] The dimensions in this drawing are in conjuctions with drawing MAM-LVR-002. Both drawings will need to be submitted upon order.

[2] The frame design and connection style has changed over time. The dimensions illustrated in drawing MAM-LVR-002 are intended to capture the frame style and connection type.

[3] All dimensions are from out to out of the framed assembly.



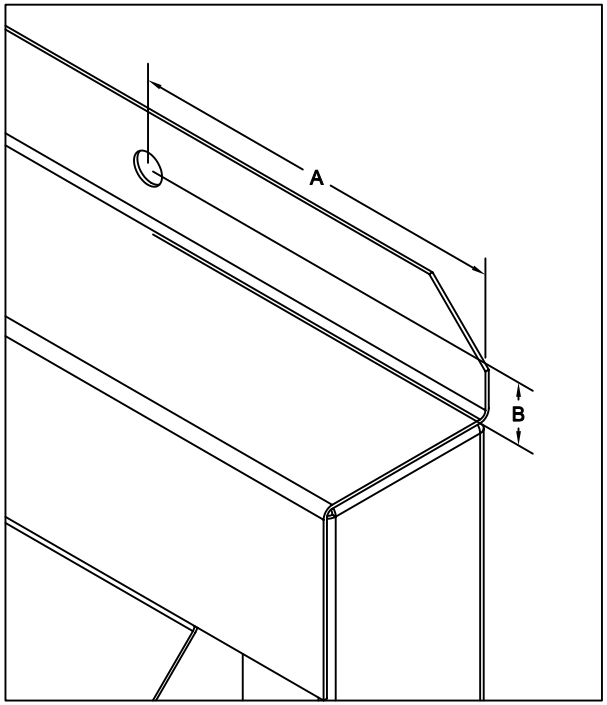


Out to Out of Frame Detailes		
Dimension	Side Louvers	End Louvers
Width (W)		
Height (H)		
Depth (D)		
Frame Material (SS or Galv.)		
Evapco Tower Model and Serial Number	Model:	Serial:

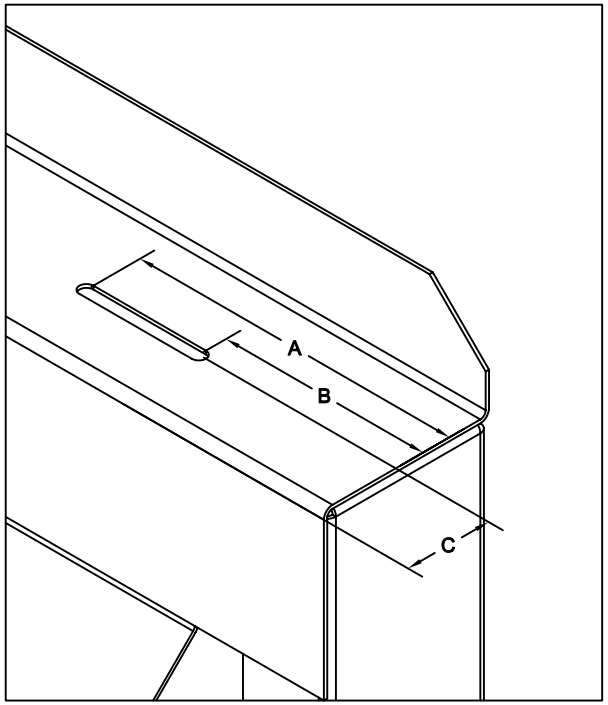
Marley After-Market Field Data

SPX Cooling Technologies

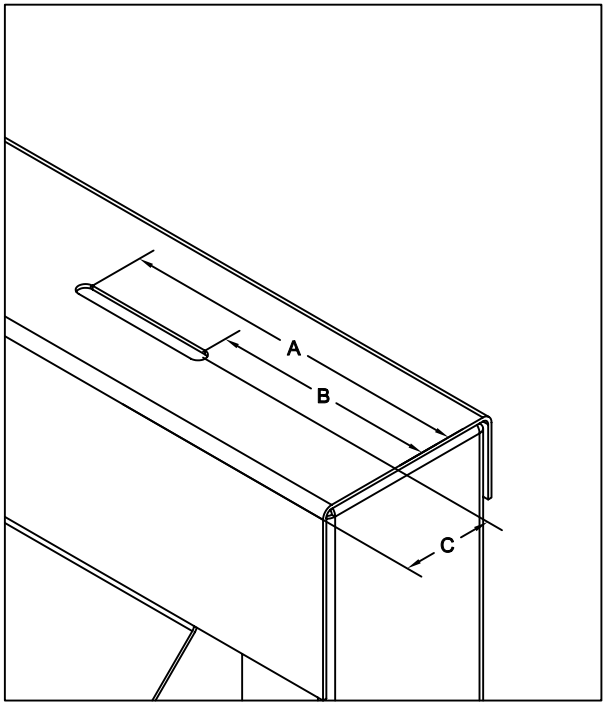
DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-LVR-001	Evapco Louver Old Style
DATE 01-03-2018		



Flange Style 1 (Hole for Knob Connection)



Flange Style 2 (Slotted Connection)



Flange Style 3 (Slotted Connection)

Flange Style 1		
Dimension	Side Louvers	End Louvers
A		
B		
C	N/A	N/A

Flange Style 2		
Dimension	Side Louvers	End Louvers
A		
B		
C		

Flange Style 3		
Dimension	Side Louvers	End Louvers
A		
B		
C		

Notes:

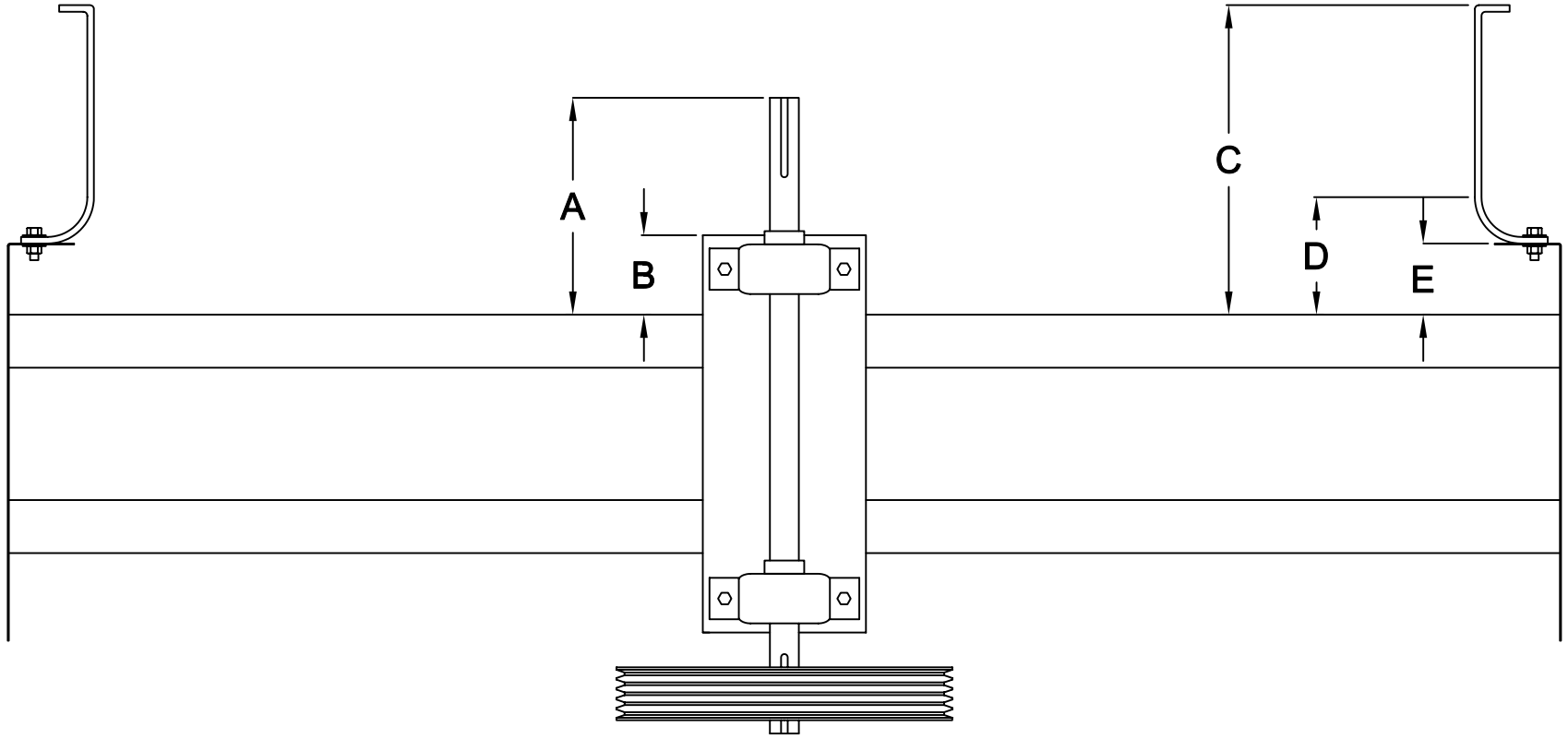
[1] The Top Flange Design of the Evapco Louver Frames has Changed Over Time. Reference notes [1] and [2] from drawing MAM-LVR-001.

[2] Flange Style 3 may or may not be Slotted. If this is the Case, Please use "N/A" for the measurement dimensions for Flange Style 3.

Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-LVR-002	Louver Flange Details
DATE 01/08/2018		



Field Measurements for Locating Fan		
Dimension	Description	Field Measurement
A	Top of Fan Shaft to Top of M.E. Support	
B	Top of Fan Shaft Support Plate to Top of ME Support	
C	Top of Fan Cylinder to Top of ME Support	
D	Beginning of Cylinder Throat to ME Support	
E	Fan Deck to ME Support	

Notes:

[1] The intention of this Field Measurement Drawing is to ensure that our replacement fan can be located within the throat of the fan cowl.

[2] All measurements are to be taken from the same reference location. It is generally easiest to take the Mechanical Equipment Support Beam as the reference structure.

[3] In some cases our fan will not fit in the cowl with the original design of the tower. It is possible to send a custom fan shaft and/or cylinder extension to correctly locate the fan assembly.

[4] Special care is to be taken when there is the possibility of interference from other structures (i.e. Motors, Fan Guards). Any sort of possibly interference is to be measured from the same reference structure and noted on the drawing.

Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY	Aftermarket Drawing No.	Description
BFC	MAM-FAN-001	Fan Fitting
DATE 01/25/2018		

Cooling Tower Start-up and Tower Inspection

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Site Visit - Preparation

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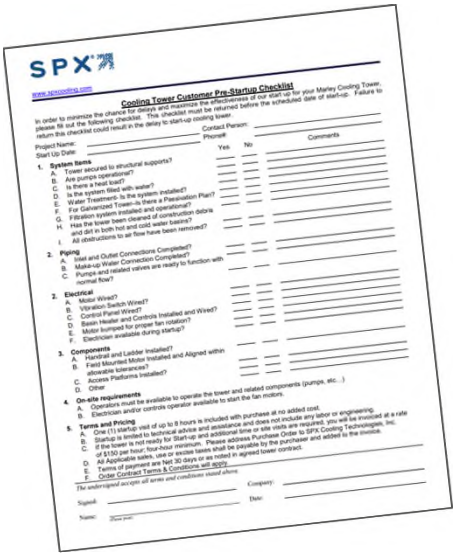
Site Visit: Reasons for Visit

- Inspection for aging towers
  - Parts, recon, replacement towers
- Start-up/inspection for new towers
  - Fulfilling contract, identifying spare parts, customer-needed options
- Troubleshooting for specific issue
  - Future business



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Site Visit – Preparation: Start-up



SPX

www.spxcooling.com

Cooling Tower Customer Pre-Startup Checklist

In order to minimize the chance for delays and maximize the effectiveness of our start-up for your Marley Cooling Tower, please fill out the following checklist. This checklist must be returned before the scheduled date of start-up. Failure to return this checklist could result in the delay to start-up cooling tower.

Project Name: _____ Contact Person: _____

Start Up Date: _____ Phone#: _____

	Yes	No	Comments
1. System Items			
A. Tower secured to structural supports?			
B. Are pumps operational?			
C. Is there a heat load?			
D. Is the system filled with water?			
E. Water Treatment- Is the system installed?			
F. For Galvanized Tower-Is there a Passivation Plan?			
G. Filtration system installed and operational?			
H. Has the tower been cleaned of construction debris and dirt in both hot and cold water basins?			
I. All obstructions to air flow have been removed?			
2. Piping			
A. Inlet and Outlet Connections Completed?			
B. Make-up Water Connection Completed?			
C. Pumps and related valves are ready to function with normal flow?			
2. Electrical			
A. Motor Wired?			
B. Vibration Switch Wired?			
C. Control Panel Wired?			
D. Basin Heater and Controls Installed and Wired?			
E. Motor bumped for proper fan rotation?			
F. Electrician available during startup?			
3. Components			
A. Handrail and Ladder Installed?			
B. Field Mounted Motor Installed and Aligned within allowable tolerances?			
C. Access Platforms Installed?			
D. Other			

4. On-site requirements

A. Operators must be available to operate the tower and related components (pumps, etc...)

B. Electrician and/or controls operator available to start the fan motors.

5. Terms and Pricing

A. One (1) startup visit of up to 8 hours is included with purchase at no added cost.

B. Startup is limited to technical advice and assistance and does not include any labor or engineering.

C. If the tower is not ready for Start-up, and additional time or site visits are required, you will be invoiced at a rate of $150 per hour; four-hour minimum. Please address Purchase Order to SPX Cooling Technologies, Inc.

D. All Applicable sales, use or excise taxes shall be payable by the purchaser and added to the invoice.

E. Terms of payment are Net 30 days or as noted in agreed tower contract.

F. Order Contract Terms & Conditions will apply.

The undersigned accepts all terms and conditions stated above.

Signed: _____ Company: _____

Name: _____ Date: _____

Upon notification for a start-up:

- Confirm that everything is ready on site
- Request completed Pre-Startup Checklist



Why?

- To ensure that the tower/site is ready for start-up before making the trip out.

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Site Visit – Preparation: Start-up

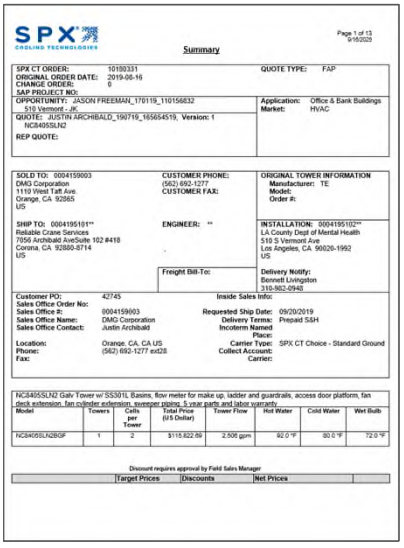
After receiving the completed checklist:

1. Pull up order summary in QTC to become familiar with tower selected.
2. Determine what options and specials are included.
3. Review Tower User Manual
4. Review Component User Manuals
   - Geareducer, Fan, Vibration Switch, Oil Level Switch, LLC, Basin Heater, etc.
5. Review Start-up Checklist
6. Create Spare Parts list



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Site Visit – Preparation: Start-up



SPX COOLING TECHNOLOGIES

Summary

Page 1 of 13
9/16/2020

SPX CT ORDER:	10100331
ORIGINAL ORDER DATE:	2019-06-16
CHANGE ORDER:	0
SAP PROJECT NO:	
QUOTE TYPE:	FAP
OPPORTUNITY:	JASON FREEMAN_170119_110156832 519 Vermont - JK
QUOTE:	JUSTIN ARCHIBALD_190719_165654519, Version: 1 NC8405SLN2
REP QUOTE:	
Application:	Office & Bank Buildings
Market:	HVAC

SOLD TO: 0004159003 DMG Corporation 1110 West Taft Ave. Orange, CA 92865 US	CUSTOMER PHONE: (562) 692-1277 CUSTOMER FAX:
SHIP TO: 0004195101** Reliable Crane Services 7056 Archibald AveSuite 102 #418 Corona, CA 92880-8714 US	ENGINEER: **
Freight Bill-To:	
ORIGINAL TOWER INFORMATION Manufacturer: TE Model: Order #:	
INSTALLATION: 0004195102** LA County Dept of Mental Health 510 S Vermont Ave Los Angeles, CA 90020-1992 US	
Delivery Notify: Bennett Livingston 310-562-6940	

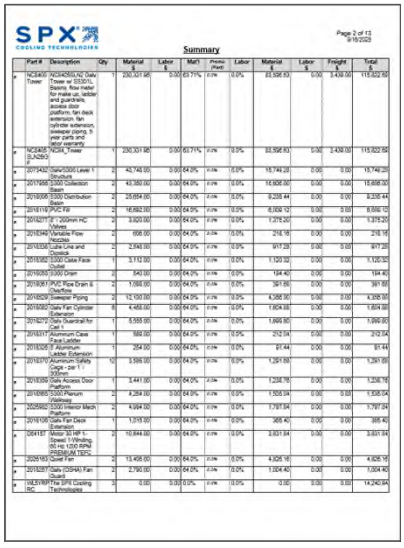
Customer PO:	42745	Inside Sales Info:	
Sales Office Order No:			
Sales Office #:	0004159003	Requested Ship Date:	09/20/2019
Sales Office Name:	DMG Corporation	Delivery Terms:	Prepaid SSH
Sales Office Contact:	Justin Archibald	Incoterm Named Place:	
Location:	Orange, CA, CA US	Carrier Type:	SPX CT Choice - Standard Ground
Phone:	(562) 692-1277 ext28	Collect Account:	
Fax:		Carrier:	

NC8405SLN2 Galv Tower w/ SS301L Basins, flow meter for make up, ladder and guardrails, access door platform, fan deck extension, fan cylinder extension, sweeper piping, 5 year parts and labor warranty.

Model	Towers	Cells per Tower	Total Price (US Dollar)	Tower Flow	Hot Water	Cold Water	Wet Bulb
NC8405SLN2BGF	1	2	$115,822.69	2,506 gpm	92.0 °F	80.0 °F	72.0 °F

Discount requires approval by Field Sales Manager

Target Prices	Discounts	Net Prices



SPX COOLING TECHNOLOGIES

Summary

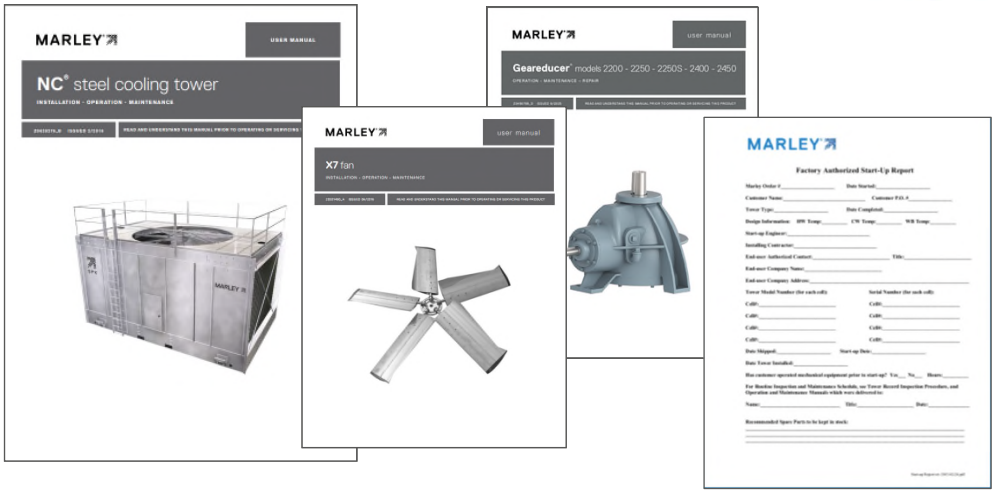
Page 2 of 13
9/16/2020

Part #	Description	Qty	Material $	Labor $	Mat'l	Promo (Part)	Labor	Material $	Labor $	Freight $	Total $
*	NC8400 Tower	NC8405SLN2 Galv Tower w/ SS301L Basins, flow meter for make up, ladder and guardrails, access door platform, fan deck extension, fan cylinder extension, sweeper piping, 5 year parts and labor warranty.	1	230,331.95	0.00	63.71%	0.0%	0.0%	83,596.53	0.00	3,439.00	115,822.69
*	NC8400 Tower	NC8405_Tower SLN2BG	1	230,331.95	0.00	63.71%	0.0%	0.0%	83,596.53	0.00	3,439.00	115,822.69
*	2073430	Galv'2000 Level 1 Structure	2	40,748.05	0.00	64.0%	0.0%	0.0%	15,746.28	0.00	0.00	15,746.28
*	2017068	0.000 Collection Basin	2	43,380.00	0.00	64.0%	0.0%	0.0%	15,606.00	0.00	0.00	15,606.00
*	2018006	0.000 Distribution Basin	2	25,654.05	0.00	64.0%	0.0%	0.0%	9,235.44	0.00	0.00	9,235.44
*	2018118	PVC Fill	2	16,682.00	0.00	64.0%	0.0%	0.0%	6,006.12	0.00	0.00	6,006.12
*	2018277	3" 0.000in PC Valves	2	3,520.00	0.00	64.0%	0.0%	0.0%	1,315.20	0.00	0.00	1,315.20
*	2018340	Variable Flow Nozzles	2	606.00	0.00	64.0%	0.0%	0.0%	218.16	0.00	0.00	218.16
*	2018338	Lube Line and Oilstick	2	2,643.00	0.00	64.0%	0.0%	0.0%	917.28	0.00	0.00	917.28
*	2018382	0.000 Cable Face Outlet	1	3,112.00	0.00	64.0%	0.0%	0.0%	1,120.32	0.00	0.00	1,120.32
*	2018299	0.000 Drain	2	540.00	0.00	64.0%	0.0%	0.0%	194.40	0.00	0.00	194.40
*	2018061	PVC Pipe Drain & Overflow	2	1,088.00	0.00	64.0%	0.0%	0.0%	391.68	0.00	0.00	391.68
*	2018029	Sweeper Piping	2	12,100.00	0.00	64.0%	0.0%	0.0%	4,356.00	0.00	0.00	4,356.00
*	2018082	Galv Fan Cylinder Extension	6	4,458.00	0.00	64.0%	0.0%	0.0%	1,604.88	0.00	0.00	1,604.88
*	2018277	Cam Overdrive for Fan	1	5,555.00	0.00	64.0%	0.0%	0.0%	1,999.80	0.00	0.00	1,999.80
*	2018317	Aluminum Cage Ease Ladder	1	589.00	0.00	64.0%	0.0%	0.0%	212.04	0.00	0.00	212.04
*	2018326	3' Aluminum Ladder Extension	1	254.00	0.00	64.0%	0.0%	0.0%	91.44	0.00	0.00	91.44
*	2018277	Aluminum Safety Cage - 24' 1 1/2"Dom	10	3,599.00	0.00	64.0%	0.0%	0.0%	1,295.64	0.00	0.00	1,295.64
*	2018356	Gate Access Door Platform	1	3,441.00	0.00	64.0%	0.0%	0.0%	1,238.76	0.00	0.00	1,238.76
*	2018083	0.000 Plenum Walkway	2	4,284.00	0.00	64.0%	0.0%	0.0%	1,505.04	0.00	0.00	1,505.04
*	2025992	0.000 Interior Mech Platform	2	4,994.00	0.00	64.0%	0.0%	0.0%	1,797.84	0.00	0.00	1,797.84
*	2018109	Galv Fan Deck Extension	1	1,018.00	0.00	64.0%	0.0%	0.0%	366.40	0.00	0.00	366.40
*	2041157	Motor 30 HP 1 Speed 1 Winding, 60 Hz 1200 RPM PREMIUM TEFC	2	10,844.00	0.00	64.0%	0.0%	0.0%	3,831.84	0.00	0.00	3,831.84
*	2026197	Quiet Fan	2	13,406.00	0.00	64.0%	0.0%	0.0%	4,826.16	0.00	0.00	4,826.16
*	2018287	Galv (OSHA) Fan Guard	2	2,790.00	0.00	64.0%	0.0%	0.0%	1,004.40	0.00	0.00	1,004.40
*	INTERNATIONAL	Technologies	3	0.00	0.00	0.0%	0.0%	0.0%	0.00	0.00	0.00	14,242.94

QTC Quote Summary can be provided by a Marley representative.

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Site Visit – Preparation: Start-up



Located on www.spxcooling.com

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Site Visit – Preparation: Inspection

Pre-Meeting

1. Develop your pre-meeting questions.
2. Review service record for design conditions
3. Review “Google” map of site for other towers
4. Understand past repairs, maintenance, and upgrades
5. Understand plant policies (access, safety, camera permits etc.)
6. Review type of options that are on the tower
7. Pull copy of Tower Assembly Manual.
8. Start your Inspection checklist/report – via inspection application.
9. Create “Spare Parts list”
10. Create your list of potential offerings

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Site Visit – Leave Behinds



Place information label here.

Make sure your customer knows who to call!

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Site Visit – Start-up or Inspection Equipment

- Harness, lanyards, and beam straps
- Hard hat, safety glasses, hearing protection
- Appropriate boots and gloves
- Disposable rain suit
- Notepad and several pens/pencils
- Fluorescent tape
- Appropriate wrenches
- Tape measure
- Screwdrivers
- Pliers
- Hammer
- Flashlight and headlight
- Dial Indicator and inside calipers
- Smart level, Protractor, Tension meter
- A couple of bottles of water
- Hand sanitizer
- Cell phone/tablet



Needs may change based on inspection scope

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Site Visit – Pre-Inspection: Safety



Safety before tower entry

- Is proper LOTO in place?
- Do I understand all of the specific hazards relative to this site and tower?
- Do I have the proper training including, but not limited to, fall protection, water chemistry, energy sources, tower structural conditions, etc.?
- Do I understand the plant evacuation procedure?
- Do I have the proper support regarding hole watches, etc.?
- Do I know exactly what I would do in the case of a fall and all other potential situations?
- Should I ask for help?

If you are unsure or uncomfortable – it is not worth the risk.

SPX has resources to help. Do not hesitate to reach out.

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Start-up – Process & Report

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Check-in and Tower Overview

- Check-in if needed to get necessary access to the towers.
- Become familiar with the tower and the area in which they are located.
- Find the towers disconnect or control panel so that you can lock out the tower before entering.



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Overall Tower Condition





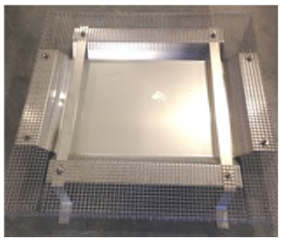


- Make sure tower is secured to structural supports
- Clean and free of debris inside and outside the tower
- Check that all hardware is in place and properly tightened

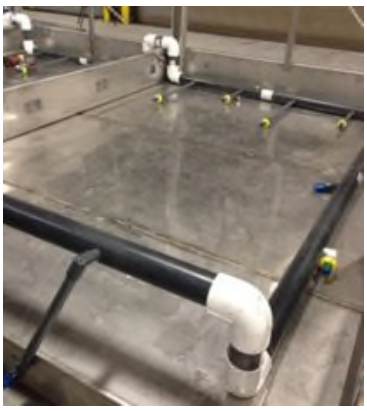
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Basin Cleanliness and Optional Equipment Checks

- Check that all anti-vortex screens are in place and tight as well as splash plate over tower bypass line.
- If equipped, check that all sweeper piping is properly in place and secured.







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Basin Cleanliness and Optional Equipment Checks



- Check and see that all water level probes have tips attached and tight.
- Make sure that tower cold water basin is clean and filled to proper water level.



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Mechanical Equipment Checks

- Inspect all mechanical components
- Fan tip clearance and fan pitch
- Verify gearbox oil level

- Confirm all tower options have been installed
  - Guardrails
  - Ladders
  - Internal platforms
  - etc







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Top of the Tower Checks





- Check that hot water basins are free of debris and all covers are in place and secured.
- Verify you have the correct orifice size nozzle by comparing back to your order summary.
- Check and see that the fan guard is in place and properly fastened.

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Piping and Water Treatment

- All piping for feed and return lines are complete and overflow and drain installed properly
- Water treatment system in place
- Pumps are wired and system valves are open and operational.





Double Check that the Valves are Opened Correctly before Starting the Pumps.

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Wiring Completion Checks



- Motors and all electrical controls are wired
  - Vibration switches
  - Water level control
  - Etc.
- Confirm vibration switch functionality if inside airstream
- The fan motor has a disconnect switch near the tower

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Wiring Completion Checks



- Control panel wiring is complete (if applicable)
- Verify if VFD start-up has been completed
- Fan motor direction has been confirmed. This should be completed in both automatic and manual/bypass mode if the tower has a VFD.

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Start-up – Pumps Only



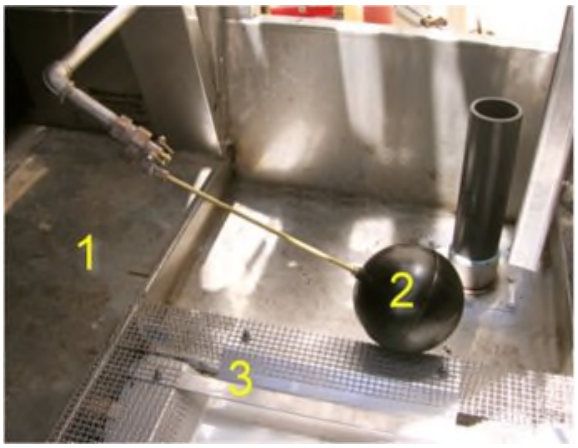
- Have customer start pumps / keep fans off at this time
- Check to see that water is not overflowing the top of the tower
- Check level in hot water basin
- At this time, check for leaks on top of the fan deck



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Start-up – Pumps Only

- If float ball is used, check that it is free and clear to operate and the water make-up valve functions and shuts off
- At this time all level sensors should be checked for proper operation
- Water make-up solenoid valves (if equipped) must also be checked for proper operation
- Check for leaks around tower and cold water basin now that water is flowing



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Start-up – Fan Motor



- Startup fan (if on VFD, run to 25-30% speed)
- Check to see that fan tips do not rub on cylinder
- Run fan to full speed to check for proper operation
- Check for unusual noises from mechanical equipment
- Check for excessive tower vibration levels throughout thetower and on the fan deck

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Start-up – Optional Controls Check

- Test operation of basin heaters if equipped
- Reconnect all basin heater control wires that were removed
- Check vibration switch functionality if accessible outside air stream.



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Start-up – Check for Leaks



- At hot and cold water basins
- At casing seams
- At drift eliminators to plenum area
- At all feed and return connections
- At basin heater and other cold water basin connections
- At coil connections (if applicable)
- Check for HC regulating flow valve leaks

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Start-up – Checks after the Pumps & Fan are Off

- Make sure LOTO is in place before re-entering the tower.
- Check for gearbox pinion shaft leaks.
- Confirm all functions related to control panel are working properly.
- Be sure everything is back in its proper place.
- Ladders put up, access doors latched, any conduit boxes, control cabinets closed and secured, etc.



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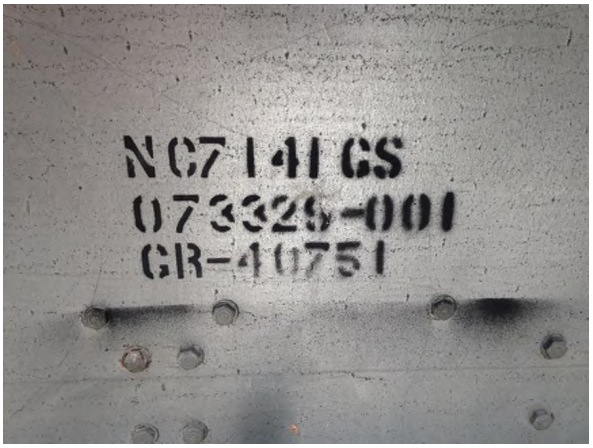
Inspection – Process & Examples

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Inspections – Capture Customer Information



Serial Number Plate located on Access Door



Also painted on cold water basin side on some models

Capture Customer information and Tower Serial Number

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Inspections – Tower Casing

- Look for leaks, cracks, holes or general deterioration
- Inspect steel casing for corrosion or scale build up
- Attaching hardware is tight and in good condition
- Access doors in good working order

- Capture picture of overall tower



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Inspections - Louvers



- Make sure all louvers are in place
- Look for deterioration of base material
- Check for excessive scale build up or biological growth
- Check conditions of supports and the connections between the supports and the tower

Walk around the tower twice looking low and high.

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Inspection – Fan Deck, Ladder and Handrail

Fan Deck

- Check general condition of fan deck material noting any steel corrosion
- Ensure hot water basin covers are tightened



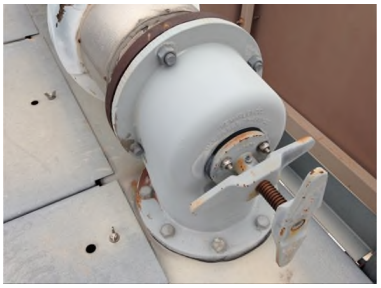
Ladder and Handrail

- Check general condition of material and make sure all connections are tight
- Check welds on steel and aluminum ladders



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Inspection – Basic Flow Valves and Spray Nozzles





Basic Flow Control Valves

- Inspect valve components for corrosion or signs of wear
- Operate valve manually through its full range of travel and reset the valves to balance water flow

Spray Nozzles

- Check for clogging or wear
  - Remove nozzle to look for internal clogging
- Make sure all nozzle components are in place and working properly

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Inspection – Distribution Basin and Piping

Distribution Basin

- Check for deterioration of basic material
- Look for leaks
- Inspect integrity of basin supports
- Check tightness of bolted joints

Piping

- Inspect iron pipe for corrosion and loss of coating
- Inspect supports
- Spot checks for leaks



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Inspection – Interior Walkway and Water Make-up System





Interior Walkway

- Look for broken treads and rails on fiberglass walkways
- Inspect steel walkways for evidence of corrosion
- Check tightness of connections between walkway and tower structure

Water Make-up System

- Check to make sure Float Valve and/or Electronic water make-up systems are working properly.

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Inspection – Cold Water Basin

- Check for excessive build-up of sludge and debris
- Breeding ground for bacteria
- Check condition of sum and sump screen
- Screen should be free of trash
- Note any corrosion or loss of metal



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Inspection – Structure



- Inspect steel tower for evidence of corrosion (loss of metal)
- Check joints to be sure that hardware is tight and in good condition

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Inspection – Motor

- Ask about lubrication schedule for regreasable motors.
- Check motor anchor bolts and tighten as required.
- Ensure drain plugs are pulled for given orientation.
- Understand customer method of operation with multi-cell towers.



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Example Motor issues



Corroded grease fitting – needs to be replaced

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Inspection – Belt Drive System

- Check condition of pulleys, looking for corrosion or loss of metal in the grooves
- Make sure that bushing holding pulleys are tight and in good condition
- Check for proper belt tensioning
- Check fan shaft lubricant
- Check the supports and connections to the tower structure



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Inspection – Gear Boxes

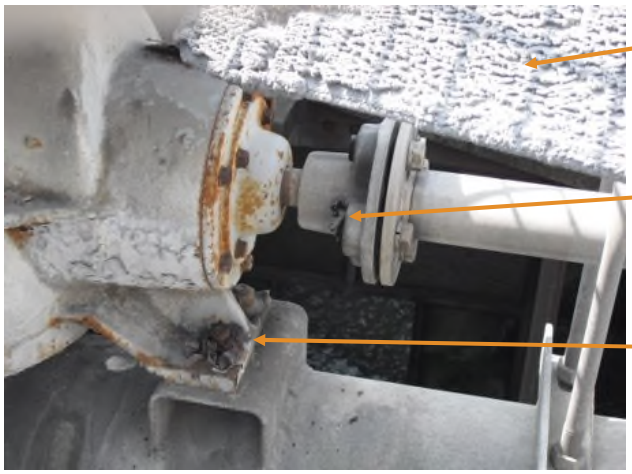




- With the fan off, check the oil level and add or replace as needed.
- Drain off oil sample and check for evidence of foreign material such as water or metal shavings.
- Check for oil leaks around seals.
- Check backlash by rotating the pinion shaft back and forth.
- Check end play by pulling up and down on a fan blade tip.
- Make sure casing is free from excessive deposits which may inhibit cooling.

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Example Fan and Gear Box Issues



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Inspection – Driveshafts and Couplings

- Check alignment using approved method
- Look for evidence of corrosion or damage on tube
- Check all connections between tube and flex elements
- Check connections between coupling and motor and gear shafts
- Examine metallic flex elements for signs of corrosion or fatigue, cracks, brittleness and other signs or wear



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Inspection - Driveshaft

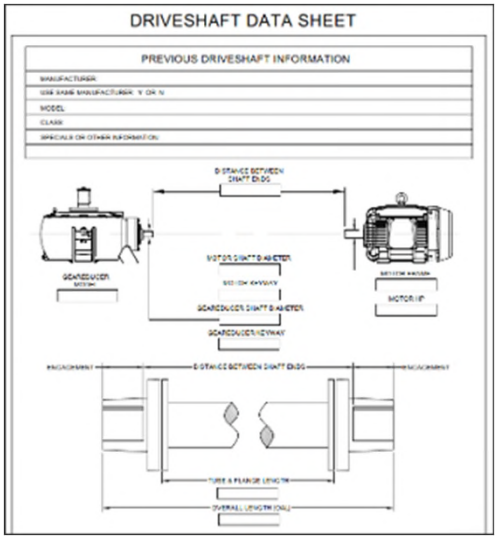
Driveshaft inspections should be performed on a semi-annual basis.

- Inspect for corrosion, checking or cracking of rubber bushings and couplings, and looseness of hardware.
- Inspect for excessive wear of flexible elements
- Replace rubber components showing excessive deterioration, and tighten all loose nuts and screws
- If vibration readings indicate imbalance or misalignment, follow instructions for correcting this found in the appropriate driveshaft service manual



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Driveshaft Replacement


DRIVESHAFT DATA SHEET

PREVIOUS DRIVESHAFT INFORMATION

We can replace other drive shaft brands too.

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Inspection – Fans/Blowers

Centrifugal Blowers

- Check for broken or missing blades
- Check condition and tightness of the hub and bushings

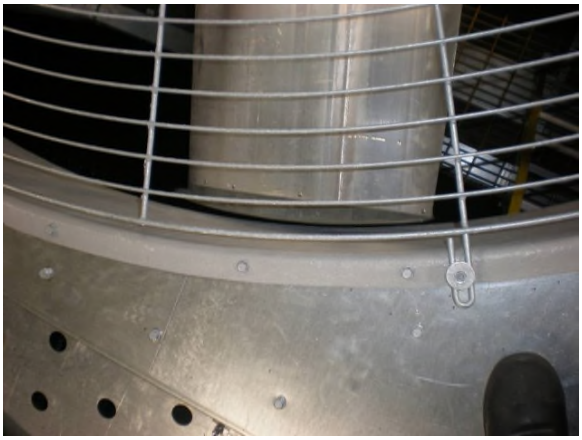


Propeller (Axial) Fans

- Check fan blades for signs of corrosion between the blades and the hub, and for excessive build up of deposits
- Check condition and tightness of bushing between hub and shaft
- Measure pitch angle and readjust blades with within+1/2º of the manufacturer's recommended pitch
- Examine connections between the hub cover and the fan hub

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Inspection – Fan Cylinders



- Check overall condition of the material paying particular attention to any welds
- Check the condition and tightness of all assembly and hold down hardware
- Look for leaks between adjoining stack segments
- Measure fan blade tip clearance all around the cylinder and adjust as necessary as per the manufacturer's instructions

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Inspection – Mechanical Equipment Support

- Examine all steel components for corrosion or loss of metal
- Check tightness of connections between the mechanical equipment and the support
- Check all bolted connections in the support itself for proper tightness
- Check condition of hardware and replace as necessary



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Example Mechanical Support Issue



Corroded mechanical support.

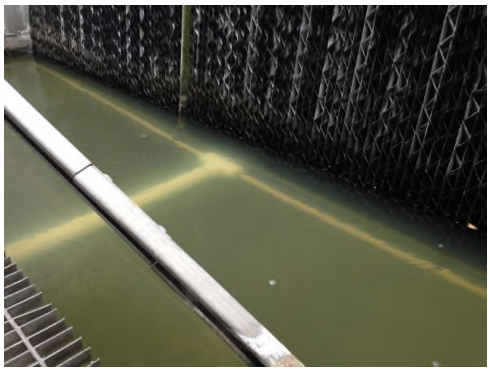
If corrosion is mild, a wire brush can remove.

If heavy corrosion, support must be replaced.

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Inspection – Drift Eliminators

- Make sure all passages are clear of debris and as clean as possible
- Check condition of seals
- Check that all components are properly installed





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Inspection – Fill

- Check for build-up of scale, algae or other contaminants
- Check for erosion, sagging, torn sheets, or evidence of ice damage
- Check condition of supports



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Fill Maintenance

- Calcium carbonate is the most typical build upon film fill
  - Louvers typically contain more calcium carbonate than the rest of the fill sheet
- Wash louver face and fill sheets
  - Medium pressure hose can be used
  - Excessive pressure will damage fill
- Acid treatment can be used for harder scale
  - Reducing pH of the water should loosen the scale build up
  - pH of water should not fall below 6.0 or galvanized steel surfaces could be damaged



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Causes of PVC Film Fill Failures

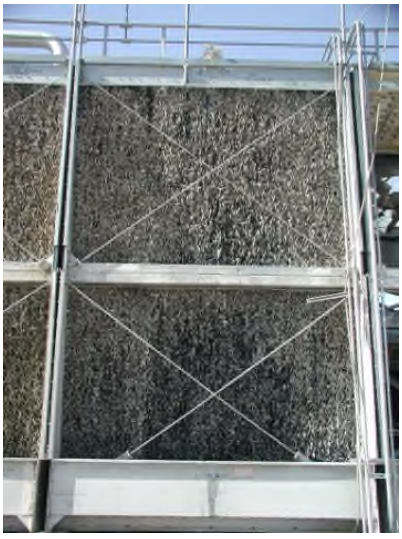


- External
  - Physical damage caused by mishandling
  - Cleaning damage
  - Shipping damage
  - Improper water treatment
- Environmental
  - Excessive hot water temperatures
  - Chemical and solvent exposure
- Operational / Maintenance
  - High water loading
  - Over pumping
  - Spray nozzles missing

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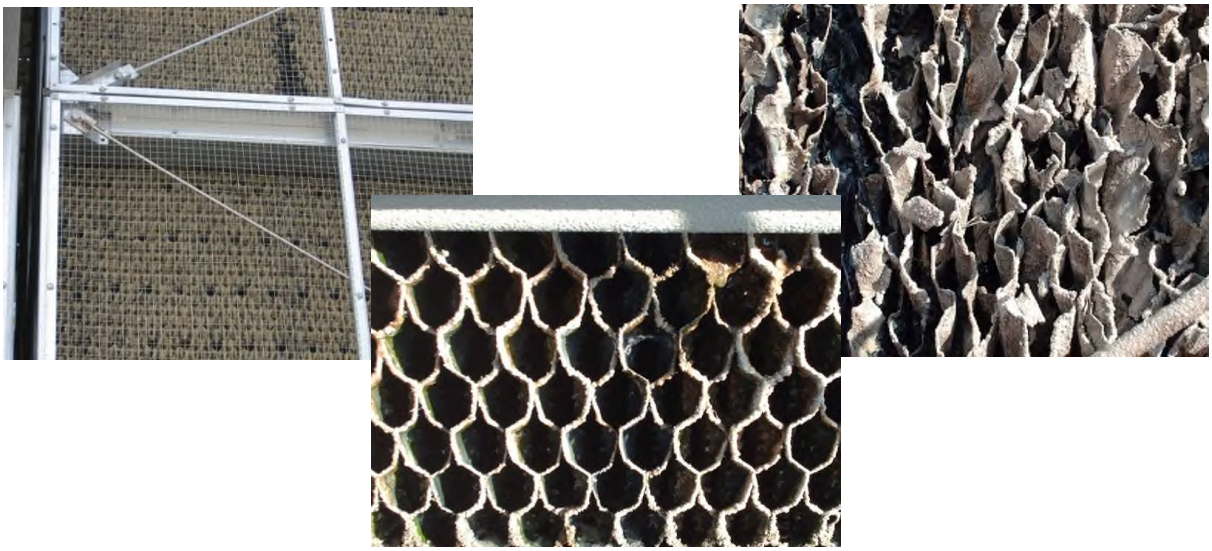
Causes of PVC Film Fill Failures

- Operational / Maintenance (cont)
  - Excessive process
  - Ice build up
- Material defect
  - Defective material
  - Mechanical failure
  - Poor supports
- Manufacturing
  - Incorrect number of sheets / packs
  - Excessive sheet movement
    - Causes torn sheets
    - Not installed tight enough



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Examples of Fill Issues



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Examples of Fill Issues



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Other Cooling Tower Issues – Excessive Drift



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Other Cooling Tower Issues – Foreign Substance in Water



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Other Cooling Tower Issues – Scale & Corroded Tower



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Site Visit – Post Start-up and Inspection: Report & Tips

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Post Start-up Checklist

- Complete startup checklist, review your notes, and develop a list of any spare parts required or, possible options to suggest and quote.
- Prep for final on-site discussion with contractor/customer.
- A list of items that needs to be completed or corrected (action items).
- Conduct your face-to-face discussion/meeting.
- Complete startup report and suggest:
  - spare parts list
  - options not installed on tower

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Inspection - Report

Application Details

- Input Form (Checklist)
- Web Output (via. SPXPartners.com)
- PDF Report Output
- Edit page
- Edit via. App and SPXPartners.com



E-mail inspection report before leaving the site.

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Site Visit – Post-Inspection

- Debrief on critical findings with site contact
  - Call meeting to discuss immediate safety or operational concerns.
  - Take them to the tower to show issues if possible.
- Ask about constraints… ie: budget, tower capacities, outage schedules, etc.
  - Always ask about tower performance needs to determine proper repairs.
  - Determine annual budgeting constraints in order to provide usable, long term repair proposal.
  - Determine outage schedules and constraints.
- Outline deliverables.. ie: report submittal, follow up meeting, etc.
  - Determine basic list of what SPX is going to submit back to them
  - Determine if project will be formally bid…. This will determine how report is prepared.
- Discuss next steps
  - RFQ process, follow up meetings, next inspections, etc..

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Replacing Other OEM Tower Parts

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Replacing Other OEM Parts

Product	Marketplace Offering(s)	Marley Offering(s)
Gearbox	Amarillo Gear Drive	Marley Geareducer with adapting material
Driveshaft	Addax Composite	Marley Stainless Steel (6Q, 175, 250) Marley Composite (COMP-DS)
Fan	Cofimco M, U, or CX Series Howden K or FPX Series	Marley X7 Marley Ultra-Quiet
Motor	Multiple Brands possible	Marley Cooling Tower Duty
Nozzle	BAC XF Nozzle Evapco EvapJet Nozzle	Marley ST Nozzle Marley NS7 Nozzle w/laterals
Fill	BACross EVAPAK	Marley MX75 or MBX75 Marley MC120
Eliminator	Brentwood XF150/CF150	Marley TU12X/TU12C

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Replacing Other OEM Parts

- Fill Change
  - Crossflow - BAC DIMENSIONS FOR MBX REPLC helps outline the specific dimensions we need to perform a pack replacement on a BAC tower
  - Counterflow - need to know cubic feet volume requirement, basic pack sizes currently on tower, and locations of fill support beams
- Gearbox/Driveshaft Replacement
  - Existing gearbox serial number, model number, ratio, and if any options(oil level switch, special paint, etc.) are required
  - Motor HP, speed, and frame size.
  - Drawing or photos w/critical dimensions of supporting steel
  - Driveshaft/coupling manufacturer, model, DBSE and/or OAL, bores and keyways (fill out Driveshaft Data Sheet 09-1329)
  - Fan manufacturer, model, diameter, & blade count

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Hands on Training – NC Hot Water Basin Nozzle Troubleshooting

Your customer has recently had a process change which required an increased inlet flow to their cooling tower. They have advised that their hot water basin is now overflowing. You suspect that they will need larger orifice nozzles to accommodate the increase in flow rate. You visit the tower site, measure the Hot Water Basin depth, and determine the basin will overflow if the water level depth is greater than 5.4". First verify the current nozzle orifice is too small using the nozzle curves then determine a suitable nozzle size for the new flow rate.

-Tower Model: NC8301D-1GS

-New Tower Flow Rate: 583.00 GPM/Cell

-Nozzle Quantity Per Cell: 108

-Current Nozzle Orifice Size: -042

Step 1- Calculate the flow rate per nozzle by dividing the tower flow rate by the nozzle quantity.

$$\frac{583.00\ \frac{Gal}{Min}}{108\ Nozzles} = 5.4\ \frac{Gal}{Min{-}Nozzle}$$

Step 2 – Draw a vertical line from 5.4 GPM PER NOZZLE on the horizontal axis till you intersect the operating line of the -042 nozzles. From the point of intersection, draw a horizontal line to the vertical axis and compare the HEAD ABOVE BASIN FLOOR to the 5.4" maximum water level you determined from your measurement.

Conclusion 1 – From the graph you have concluded that at 583.00 GPM/Cell the Hot Water Basin would be operating with 6" of head and is thus overflowing.

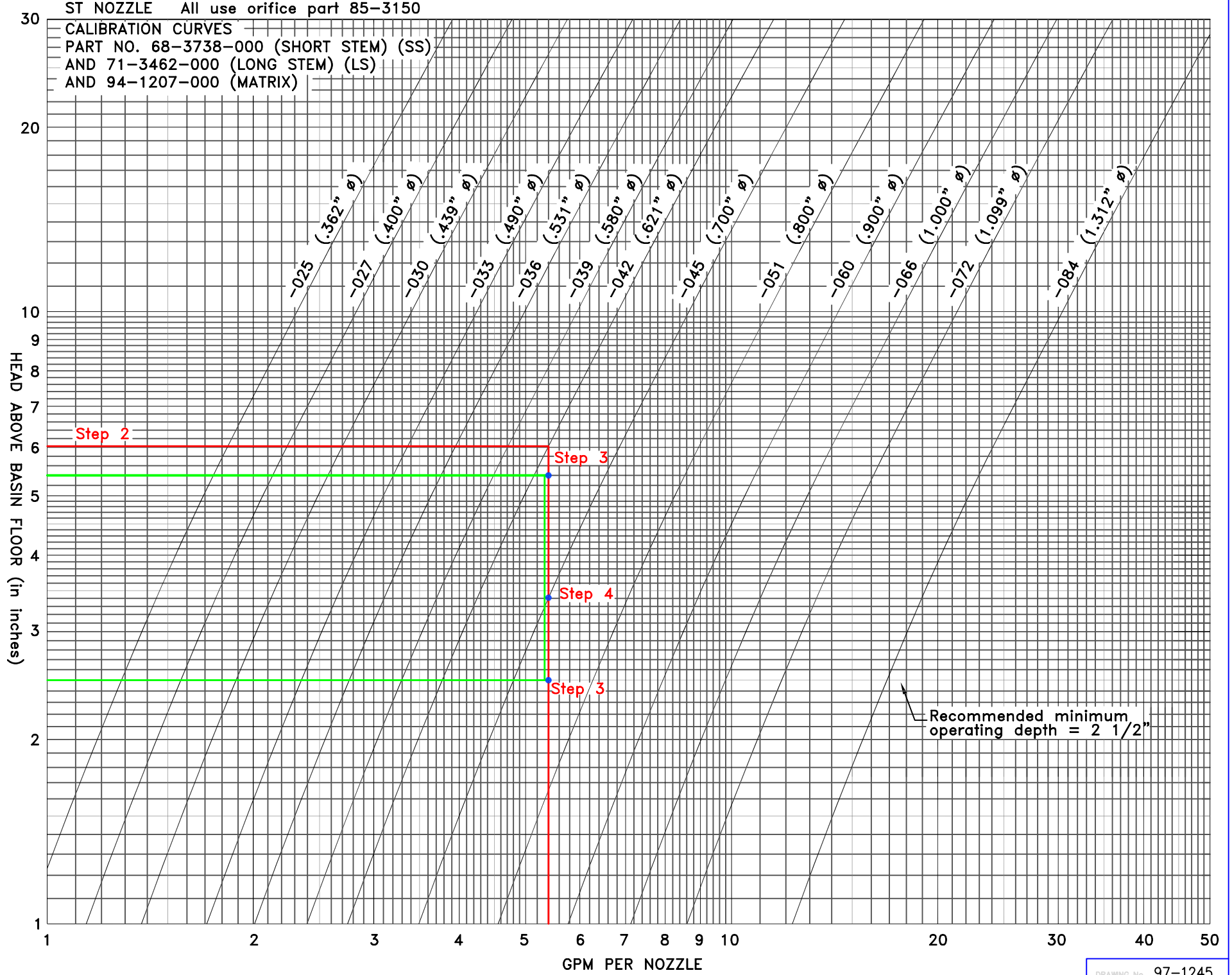
Step 3 – Notice from the lower left hand corner of the graph that the minimum low water flow rate is determined from the minimum operating depth of 2.5" of water. Therefor we need to select a nozzle capable of operating between 2.5" and 5.4" of water. Starting at the vertical axis draw two horizontal lines from 5.4" and 2.5" till they intersect the vertical line drawn in step 2. Mark the intersection of each line by points.

Step 4 – Draw a line connecting the two points drawn in step 2. Mark the point where this line intersects a nozzle operating curve.

Conclusion 2 – From the point of intersection we can determine that the -045 nozzle will be capable of operating within the 2.5" to 5.4" range. By tracing an imaginary point back to the vertical axis we find that the basins will operate with 3.4" of head with the new flow rate of 583.00 GPM/Cell using the -045 nozzle

ST NOZZLE All use orifice part 85-3150

CALIBRATION CURVES
PART NO. 68-3738-000 (SHORT STEM) (SS)
AND 71-3462-000 (LONG STEM) (LS)
AND 94-1207-000 (MATRIX)



DRAWING No. 97-1245

Name
Company
Address
City, State
Office, Cell, Fax, or phone number
e-mail address

www.spxcooling.com

Cooling Tower Customer Pre-Startup Checklist

In order to minimize the chance for delays and maximize the effectiveness of our start up for your Marley Cooling Tower, please fill out the following checklist. This checklist must be returned before the scheduled date of start-up. Failure to return this checklist could result in the delay to start-up cooling tower.

Project Name: _____ Contact Person: _____
Start Up Date: _____ Phone#: _____

		Yes	No	Comments
1.	**System Items**			
A.	Tower secured to structural supports?			
B.	Are pumps operational?			
C.	Is there a heat load?			
D.	Is the system filled with water?			
E.	Water Treatment- Is the system installed?			
F.	For Galvanized Tower–Is there a Passivation Plan?			
G.	Filtration system installed and operational?			
H.	Has the tower been cleaned of construction debris and dirt in both hot and cold water basins?			
I.	All obstructions to air flow have been removed?			
2.	**Piping**			
A.	Inlet and Outlet Connections Completed?			
B.	Make-up Water Connection Completed?			
C.	Pumps and related valves are ready to function with normal flow?			
2.	**Electrical**			
A.	Motor Wired?			
B.	Vibration Switch Wired?			
C.	Control Panel Wired?			
D.	Basin Heater and Controls Installed and Wired?			
E.	Motor bumped for proper fan rotation?			
F.	Electrician available during startup?			
3.	**Components**			
A.	Handrail and Ladder Installed?			
B.	Field Mounted Motor Installed and Aligned within allowable tolerances?			
C.	Access Platforms Installed?			
D.	Other			

4. On-site requirements

A. Operators must be available to operate the tower and related components (pumps, etc…)
B. Electrician and/or controls operator available to start the fan motors.

5. Terms and Pricing

A. One (1) startup visit of up to 8 hours is included with purchase at no added cost.
B. Startup is limited to technical advice and assistance and does not include any labor or engineering.
C. If the tower is not ready for Start-up and additional time or site visits are required, you will be invoiced at a rate of $150 per hour; four-hour minimum. Please address Purchase Order to SPX Cooling Technologies, Inc.
D. All Applicable sales, use or excise taxes shall be payable by the purchaser and added to the invoice.
E. Terms of payment are Net 30 days or as noted in agreed tower contract.
F. Order Contract Terms & Conditions will apply.

The undersigned accepts all terms and conditions stated above.

Signed: _____ Company: _____

Name: _____ Date: _____
(Please print)

MARLEY

Factory Authorized Start-up Report

Order #		Today's date	
Customer Name		Startup Contact	
End User		Startup contact phone #	
End user Address		Tower Model	
		Tower Serial #	
Contact Name phone #		Date shipped	

Comments

Customer startup acceptance signature _____

Startup Engineer signature _____

This report is intended to be used as a guide only. This report may not cover all potential issues and should not be relied upon as a substitute for the Start-up Engineer's professional judgment. The person completing this report should report on all issues. Any issues that are identified for which a space is not otherwise provided in the report should be noted in the applicable "Comments" sections provided or in a supplementary document. Nothing herein shall relieve End-User of his/her responsibility to notify SPX Cooling Technologies, Inc. of any post-startup issues.

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Tower serial number: _____

Insert X into applicable box if good, E if corrected by Engineer and NC if needs to be corrected. N/A if not applicable. All NC notes need to be documented

Fan

Cell	Fan Ubolts	Bolts tight	Uniform Pitch	Tip Track and Clearance

Gear Reducer

Cell	Oil Level	Oil and Vent lines	Filter	Cap Screws	Anchor Bolts	Oil Seals	Ratio	Overall Assembly

Power transfer

Cell	Coupling	Driveshaft	Belt Tension (If Applicable)	Pulleys tight and Aligned	Overall assembly

Hot water Distribution

Cell	Header Piping	Flow Control Valves		Water Level	Covers in place	Nozzles in place

Cold water basin

Cell	Fill and Drift Eliminators	Sweeper Piping	Float Valve	Water Level	Anti vortex screens	Weep Hole open	Flumes installed	Balanced Water Flow

Access and Safety

Cell	Ladder installed & accessible	Walkway correctly Installed	Handrails correctly installed	Stairway installed correctly	Fan Guards installed correctly

Structure

Cell	Gasket seal installed between cells	Upper Module secured to lower module?	Inlet screens in place	Inlet/outlet piping not supported by tower	Tower is properly secured to support structure

Electrical

Ability to Lockout/Tagout Motor and other Feeds at tower? Y or N (Circle one)

Motor Amp Draw (Water Flowing over Tower) Voltage leg to leg should be within 10%

Cell	voltage	phase	Amp draw leg 1	Amp Draw leg 2	Amp Draw leg 3

Basin Heater test

Cell	Voltage	Phase	Amp draw leg 1	Amp Draw leg 2	Amp Draw leg 3

Electrical Components

Cell	LLC	M/U valve	Vibration Switch	Connections

Water Treatment

Among other sources, outbreaks of Legionnaire's Disease have been traced to cooling towers. Maintenance and water treatment procedures that prevent amplification of Legionella and other airborne bacteria should be formulated and implemented BEFORE systems are operated and continued regularly thereafter to avoid the risk of sickness or death.

MARLEY®

user manual

Cooling Tower inspection tips

INSPECT-16 ISSUED 11/2016

READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING PRODUCT



cooling tower inspection tips

Use these instructions to perform a thorough inspection on virtually any cooling tower. These instructions are completely general, so some portions won't apply to your cooling tower.

When you've filled out the checklist, use the results to help plan your cooling tower repair and maintenance. Always refer to your tower's user manual if you have specific questions about your cooling tower.

Your Marley sales representative will be happy to help you with parts and service or to guide you toward a qualified service contractor. Call **913 664 7400** and ask for the name of your nearest Marley representative or check the web at **spxcooling.com**.

safety and health

Before starting a cooling tower inspection it is important to identify all potential safety and health hazards associated with the work and identify how each hazard will be eliminated or controlled. Planning ahead helps alert workers to potential safety hazards and take appropriate preventive action.

Always follow safety and health regulations published by local authorities. Use the following general guidelines for basic worker protection.

Legionnaire's Disease

Legionnaire's Disease is caused by infection from the *Legionella pneunophila* bacteria, which is present in all natural environments. The bacteria, which thrives in warm moist environments, can enter the lungs when carried in small water droplets. Cooling towers can create the potential for Legionella infection, particularly when biological growth is present.

Basic safety precautions include:

- Turn off and lock out cooling tower fans before working inside any cooling tower.
- Wear a full or half face respirator with HEPA (high efficiency particulate air) filters.

Persons using respirators must be properly trained in their use, including a pulmonary function test and medical evaluation to determine the ability to wear and use the respirator.

Personal Protective Equipment

Always follow local Safety and Health regulations regarding personal protective equipment (PPE). As a minimum, cooling tower workers should wear a hard hat, safety glasses or goggles, work gloves, and high top leather boots with nonslip soles. Fall protection should be provided as required.

When climbing the cooling tower structure is required, workers should be equipped with a full body harness and two shock absorbing lanyards of at least six feet in length. Two lanyards allow movement while providing fall protection at all times. Safety belts or single lanyard systems do not provide adequate fall protection.

Tower Cleanliness

An unclean tower can be an amplifier of unhealthy biological agents. It is important to periodically inspect an operating cooling tower for good biological control. The inspection should include, at a minimum, visual evaluation of the condition of the water and the distribution basins.

Good biological control is indicated by clean, clear water with no green or brown algae below the water line. Poor control is detected by cloudy, dirty, or foul smelling water. Also look for rust colored corrosion "pockets". These pockets may be filled with black liquid that smells like rotten eggs. If observed conditions indicate poor biological control, the tower should be thoroughly cleaned and the water treatment system evaluated. Clean cooling towers result from practicing biological testing and using effective biological control procedures.

Tower Casing

Look for leaks, cracks, holes or general deterioration, including air leaks between adjoining panels. Make sure that hardware attaching the casing to the structure is tight and in good condition.

Inspect steel casing for corrosion or scale buildup and examine wood casing for signs of wood decay, including soft rot or plywood delamination. Look for evidence of brittleness or cracking in fiberglass casing.

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

If your budget allows, consider replacing ACB (asbestos cement board) casing immediately, regardless of its condition.

In handling and/or disposing of ACB or ASB material, it is recommended that you contact the Federal Agency, OSHA, EPS, as well as the local and state agencies for information concerning specific state regulations and requirements for handling and the disposal of asbestos wastes.

Structure

Inspect the structure of a steel tower for evidence of corrosion—particularly any loss of metal. Spot check the tightness of bolted joints. Look closely for signs of corrosion near welded joints on galvanized steel towers.

Look for signs of wood deterioration, including through-cracks, fractures, or decay in wood members. Inspect wood members both visually and by tapping with a hammer. A dull, low pitch sound indicates softness, while a higher pitched sharp sound indicates good solid wood. If you find soft spots, carefully probe with an ice pick or similar device. Pay particular attention to the wood around steel or cast iron fasteners and connectors, as well as the bottom of columns. Spot check the tightness of bolted structural joints. Inspect joint connectors for evidence of corrosion or other signs of deterioration.

Check the assembled joints of a fiberglass or plastic tower to be sure that hardware is tight and in good condition. Look for evidence of tearing or cracking in the structure.

Fan Deck

Check the general condition of the fan deck material, noting any steel corrosion or wood decay. Make sure the fan deck support members are in good condition and that connections between the fan deck and the supports are tight. Look for air leaks between adjoining fan deck panels.

Loose fan deck overlays are a tripping hazard. Be sure that overlays are properly attached and that the overlay material is in good condition. Consider replacing ACB overlays immediately, regardless of condition.

Stairway

Look for evidence of wood decay or steel corrosion. Check for loose treads, handrails, or deteriorated stringers. Make sure all bolted connections are tight and that hardware is in good condition.

Ladder and Handrail

Check general condition of material and make sure that all connections between the ladder and the tower are tight and in good condition. Check the welds on steel and aluminum ladders.

Interior Walkway

Look for broken or deteriorated treads and rails on wood or fiberglass walkways. Inspect steel walkways for evidence of corrosion. Check the tightness of connections between the walkway and the tower structure. Pay particular attention to any damage or deterioration that may pose a potential safety hazard for operating and maintenance personnel.

Cold Water Basin

Check for excessive buildup of sludge and accumulated debris which provides an ideal breeding ground for bacteria. Check condition of sump, sump screen, and anti-cavitation device (if one is used). Sump screen should be free of trash. Note particularly any corrosion or loss of metal in cold water basin components. Inspect wood, steel and fiberglass basins carefully for any signs of leaks or breakdown of sealing material.

Distribution Basin

Check for deterioration of the basic material. Check wood for decay, and check for corrosion of steel. Look for leaks between adjoining panels. Inspect the integrity of basin support members. Check tightness of bolted joints in steel or fiberglass basins.

Piping

Inspect iron pipe for corrosion and loss of coating material. Examine all supports to insure their integrity for continued service. Spot check for leaks and for tightness of bolted joints. Look for signs of deterioration on PVC or fiberglass pipe.

Basin Flow-Control Valves

Inspect valve components for corrosion or signs of wear. Operate valve manually through its full range of travel and reset the valves to balance water flow to all basin sections.

Spray Nozzles

Check for clogging or signs of internal wear. If necessary, temporarily remove a nozzle and disassemble it to look for internal clogging. Be sure that all nozzle components (such as removable splash plates) are in place and working properly. Look for any loss of material resulting from corrosion or erosion. Check for adequate connection to branch pipe or distribution basin floor.

Fill (Packing)

Fill comes in two general types—splash and film. Splash fill consists of wood or plastic bars in various shapes, supported in a fixed spacing and orientation, usually using a wire or fiberglass grid. Ceramic bricks are another type of splash fill. Film fill consists of multiple parallel formed sheets, either hung in the tower or resting on fixed support members.

For splash fill, check the condition of the splash bars themselves. Look for sagging, broken or decaying splash bars or excessive buildup of scale. Look also for fallen or misplaced splash bars. Be sure that all supporting grids are in place and evenly spaced in the tower. Check the coating on steel grids, the condition of the welds on stainless wire grids, and the general condition of fiberglass grids. If a section of grid shows excessive deterioration, it should be replaced. Also, examine the tower members which support the grid itself.

For reference purposes—in case you need to order parts—note the material of splash bars and grids— note the horizontal and vertical spacing between adjacent splash bars; note whether the splash bars are installed parallel or perpendicular to the louver face— and note the shape of the splash bar (wood lath, T-bar, V-bar, M-bar, half-round, etc.).

For film fill, check for buildup of scale, algae, or other contaminants on the surface of the sheets. Also check for erosion, sagging, torn sheets, or evidence of ice damage. Check the condition of support members. Note the sheet material and spacing in case you plan to order parts.

In either case, consider replacing asbestos fill immediately. You'll also benefit improved performance from the modern families of high-efficiency fill designs.

Drift (Mist) Eliminators

Cleanliness and effectiveness of drift eliminators are critical in preventing the spread of *Legionella pneunophila* bacteria.

Make sure that all air passages are clear of debris, and as clean as possible. Check that all components are properly installed. Check condition of seals to assure that water can't bypass the eliminators through deteriorated or missing seals. Wood blades and frames are subject to severe conditions, and should be checked for rot and decay.

In case you need to order replacement parts, note the material and configuration of drift eliminators. The major types are wood blades, plastic blades, and PVC cellular configurations, including eliminators molded on the fill sheets.

Louvers

Make sure that all louvers are in place. Look for any deterioration of the base material, such as wood rot or corrosion of steel louvers. Check for excessive scale buildup or biological growth. Check the condition of louver support members, and of the connections between the louvers (supports) and the tower itself. Note the material, arrangement and vertical spacing of louvers. Typical varieties include plywood, steel, ACB, fiberglass and cellular configurations molded on the fill sheets. Consider replacing ACB louvers immediately regardless of condition.

Belt Drive Fan System

Check the condition of the pulleys, looking for any corrosion or loss of metal in the pulley grooves or on the webs. Make sure that the bushings holding the pulleys on the shafts are tight and in good condition.

Check for proper belt tension and alignment. Look for signs of wear, such as checks and gouges, indicating that belts should be changed.

Check the fan shaft bearing lubricant, and re-lubricate if necessary. Make sure that shafts and seals are in good condition. Check for loose or damaged bearings. Make sure that all connections between the bearing housing and the support are tight and in good condition. Check the support itself for evidence of corrosion or other damage, and check the tightness of connections between the support and the tower structure.

Gear Box

With the fan off check the oil level and add or replace oil as necessary. Drain off an oil sample and look for evidence of foreign material such as water, metal shavings, or sludge. Check for oil leaks around seals (particularly input pinion seals) and replace the seal if leakage seems excessive.

Check backlash by rotating the pinion shaft back and forth, noting the amount of free rotation before the gear teeth engage fully. Check endplay by pulling up and down on a fan blade tip, noting the amount of movement in the gear box output shaft. Some amount of backlash and endplay are necessary for proper gear life. If you have doubts about your gear box, consult a qualified service contractor.

Make sure that the outside of the case is free from excessive deposits which may inhibit cooling. Check that all hardware connecting the gear box to the support is tight and in good condition.

Direct Drive Fan System

Make sure that the fan bushing is tight on the motor shaft and that the bushing and its hardware are in good condition. Check the joints between the motor mount and its support.

Drive Shaft and Couplings

Check alignment using any approved method, such as a dial indicator or optical device. Look for evidence of corrosion or other damage on the tube, particularly near any welds. Check all connections between the tube and the flex elements, and between the coupling halves and the motor and gear box shafts. Examine metallic flex elements very carefully for signs of corrosion or fatigue. Examine elastomeric flex elements for cracks, brittleness or other signs of wear.

Most drive shafts consist of a single span. However, some still include two shafts together with an intermediate bearing housing support. If your drive shaft includes a mid-span bearing, check the bearing carefully, adding lubricant as necessary. Check alignment of both shafts and make sure that bearing hold-down hardware is tight and in good condition. If you must replace any component in a two-shaft system, you should investigate replacing the entire system with a single span shaft which will reduce your maintenance costs dramatically.

Fan

If your tower has centrifugal blowers, check for broken or missing blades. Look for corrosion or erosion of the blades, particularly near any welds between the blades and the end plates. Check the condition and tightness of the hub and the bushings between the hub and shaft.

Propeller fans may be either fixed-pitch, with welded or riveted connections between the blades and hub; or adjustable pitch, having bolted connections between the blades and hub and some means of readjusting blade pitch angle.

Check fixed-pitch fan blades for corrosion or erosion. Carefully examine the connections between the blades and hub. Check the condition and tightness of the bushing between the hub and shaft.

Check the blades and hub of adjustable-pitch fans for signs of corrosion, erosion, or excessive buildup of deposits. Carefully measure the pitch angle of each blade, and readjust blades to the manufacturer's recommended pitch angle within +1/2°. Check the tightness and condition of the hardware attaching the blades to the hub. Tighten as necessary using manufacturer's recommended procedures.

Examine the connections between the hub cover (if there is one) and the fan hub.

Fan Cylinder (Shrouds)

Check overall condition of the material, paying particular attention to any welds in steel shrouds Check the condition and tightness of all assembly and hold-down hardware. Look for any leaks between adjoining stack segments. Measure fan blade tip clearance all around the cylinder, using the longest fan blade. Adjust tip clearance by adjusting the cylinder or support according to the manufacturer's instructions.

Mechanical Equipment Support

Examine all steel components for corrosion or loss of metal, particularly near welds and bearing surfaces. Check tightness of connections between the mechanical equipment and the support; and between the support and the tower structure. Check all bolted connections in the support itself for proper tightness and condition of hardware.

On wood towers, look for evidence of iron rot wherever the support contacts the structure. On steel and fiberglass towers, check all bolted connections between the support and the structure itself.

Makeup Valve

Operate the float valve or float switch manually to make sure that it opens and closes properly.

Tower Location _____ Date Inspected _____

Owner / Company _____ Inspected by _____

Company Contact _____ Inspector _____

Signature _____ Signature _____

Owner's Tower Designation _____

Tower Manufacturer _____ Model No. _____ Serial No. _____

Process Served by Tower _____ Operation: Continuous ❑ Intermittent ❑ Seasonal ❑

Design Conditions: gpm _____ HW _____°F CW _____°F WB _____°F

Cell No. _____ Number of Fan Cells _____ Tower Type: Crossflow ❑ Counterflow ❑

Date Tower was Installed _____

This checklist is intended to be used as a guide only. This checklist may not cover all potential issues and should not be relied upon as a substitute for Authorized Service Provider's professional judgment. Authorized Service Provider should report on all issues. Any issues that are identified for which a space is not otherwise provided in the checklist, should be noted in the Other Component sections or in a supplementary document.

Condition: 1–Good 2–Keep an eye on it 3–Needs immediate attention

	1	2	3	Comments
Structure				
Casing Material _____				
Structural Material _____				
Fan Deck Material _____				
Stairway ❑ Material _____				
Ladder ❑ Material _____				
Handrail ❑ Material _____				
Interior Walkway ❑ Material _____				
Cold Water Basin Material _____				
Silt, Debris Buildup _____				
_____				
Water Distribution System				
Open Basin System				
Distribution Basin Material _____				
Inlet Pipe Material _____				
Inlet Manifold Material _____				
Flow Control Valves _____ Size				
Nozzles – Orifice Diameter _____ Size				
Silt, Algae, Debris _____				
Spray Type System				
Header Pipe Material _____				
Branch Pipe Material _____				
Nozzles – Orifice Diameter _____ Size				
Up spray ❑ Down spray ❑				
Heat Transfer System				
Fill – Type and Material _____				
Eliminators – Type and Material _____				
Louvers – Type and Material _____				
Biological Fouling _____				

Use this space to list specific items needing attention: _____

Condition: 1–Good 2–Keep an eye on it 3–Needs immediate attention

	1	2	3	Comments

Mechanical Equipment

Speed Reducer Type: Belt ❑ Gear ❑ Direct Drive ❑

Belt Drive Unit

Belt Designation _____				
Fan Sheave Designation _____				
Motor Sheave Designation _____				

Gear Drive Unit

Manufacturer _____ Model _____ Ratio _____

Oil Level: Full ❑ Add Immediately ❑ Low, Check Again Soon ❑

Oil Condition: Good ❑ Contains Water ❑ Contains Metal ❑ Contains Sludge ❑

Oil Type Used _____

Seals _____				
Backlash _____				
Fan Shaft Endplay _____				

Unusual Noises? No ❑ Yes ❑ Action Required _____

Drive Shaft

Manufacturer _____ Material _____				

Fan

Fan Type: Propeller ❑ Blower ❑

Manufacturer _____ Fixed Pitch ❑ Adjustable Pitch ❑

Diameter _____ Number of Blades _____

Blade Material _____				
Hub Material _____				
Hub Cover Material _____				
Blade Assembly Hardware _____				
Tip Clearance _____" min _____" max				
Vibration Level _____				
Fan Cylinder Height _____				
Mechanical Equipment Support _____				
Oil Fill and Drain Line _____				
Oil Level Sight Glass _____				
Vibration Limit Switch _____				

Motor

Manufacturer _____

Name Plate Data: HP _____ RPM _____ Phase _____ Hz _____ Volts _____

F L Amps _____ Frame _____ S F _____ Special Info. _____

Last Lubrication – Date _____

Grease Used – Type _____

Unusual Noises? No ❑ Yes ❑ Action Required _____

Unusual Vibration? No ❑ Yes ❑ Action Required _____

Unusual Heat Build-up? No ❑ Yes ❑ Action Required _____

Make-up Valve _____				
Other Component _____				
Other Component _____				

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