MARLEY SCHOOL OF COOL

FOR SERVICE CONTRACTORS

MARLEY FACTORY TRAINING FOR SERVICE CONTRACTORS

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

2022

SCHOOL OF COOL

SPX COOLING TECHNOLOGIES

NOVEMBER 8 - 10

Day	Time	Topic	Presenter	ROOM
MONDAY Nov 7		*Arrivals*		
		BREAKFAST @ HOTEL…*Residence Inn, Kansas City-Country Club Plaza*		
	A.M.	Breakfast		HOTEL
	7:45 A.M.	*Depart Hotel for Olathe Plant*		Olathe Conf Room
	8:30	Overview of current offerings and Tower Designs	Robert Swafford & Gary Stauffer	
TUESDAY Nov. 8	9:15	Olathe Plant Tour	Robert Swafford & Gary Stauffer	Plant
	11:10	*LUNCH - 180 Room*		Joe's KC, 180 Room
	12:30	*Depart for Development Center*		Cave
	1:00	Development Cntr - Safety Overview	Robert Negless	
	1:30	Hands on Product Training		
	5:00	*Depart DC back to hotel*		
	6:30P	*Dinner -Zocalo Mexican Restaurant - 620 W 48th Street KCMO*		Zocalo
	A.M.	Breakfast		Hotel
	8:00	*Depart Hotel for Development Center*		
	8:30	Water Monitoring & Controls Systems (Marley Liquid Level Controls (LLC)	Mark Groothuis	CAVE
	9:50	*BREAK*		
WEDNESDAY Nov 9	10:00	*Development Center Tour*		
	12:00	*LUNCH*		
	12:45	Hands on Product Training		
	5:00	*Depart DC back to hotel*		
	6:30P	*Cooper's Hawk - 4686 Broadway Blvd; Kansas City, MO*		Cooper's Hawk
	A.M.	Breakfast		Hotel
	8:00	*Depart Hotel for Development Center*		
	8:30	Hands on Product Training		Cave
	10:00	*BREAK*		
THURSDAY Nov 10	10:15	Tower Start-up and Inspection Training - NC tower - Presentation		
	11:30	*LUNCH*		
	12:30	Hands on Tower Start-up and Inspection Training on NC8401 and Quadraflow tower		
	3:00	*DEPARTURES*		

Introduction of Trainers….

Robert Swafford

MX75 Hanging fill and MBX Bottom support fill Replacement

Ryan Sadich

Fan Pitch - Fan Blade & Hardware Replacement

Gary Stauffer

Driveshaft and Close Coupling

Mark Groothuis

Controls Overview and troubleshooting

Jerome Jennings

Pinion Shaft Oil Seal Replacement

Brent Fetters Crouch

Sheave and Belt Replacement

Marley OEM parts for BAC & Evapco

Agenda – Day 1

7:45 – Depart for Plant Tour

8:15 – Welcome and Introductions

8:30 – Overview of current offerings and Tower Designs - Presentation

9:15 – Plant Tour

11:10 – Depart for Lunch

11:20 – Lunch – KC Joe's BBQ

12:30 – Depart for Development Center (Cave)

1:00 – Safety Overview

Hands on Product Training

1:30 – Session 1

- – Team 1 – Fan Blade & Hardware Replacement
- – Team 2 – Pinion Shaft Oil Seal Replacement
- – Team 3 – Sheave and Belt Replacement / BAC & Evapco Parts
- – Team 4 – MX75 & MBX Fill Installation

3:00 – Break

3:15 – Video

3:25 – Session 2

- – Team 1 – MX75 & MBX Fill Installation
- – Team 2 – Fan Blade & Hardware Replacement
- – Team 3 – Pinion Shaft Oil Seal Replacement
- – Team 4 – Sheave and Belt Replacement / BAC & Evapco Parts

5:00 – Depart for hotel

6:30 – Dinner

Agenda – Day 2

Breakfast

8:00 – Depart for Development Center

8:30 – Water Monitoring System (LLC)

9:45 – Break

10:00 – Development Center Tour

12:00 – Lunch

Hands on Product Training

12:45 – Session 3

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

– Team 2 – Driveshaft and Close Coupling Replacement

– Team 3 – Fan Blade & Hardware Replacement

– Team 4 – Controls Overview and Troubleshooting

2:15 – Session 4

– Team 1 – Controls Overview and Troubleshooting

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

– Team 3 – Driveshaft and Close Coupling Replacement

– Team 4 – Fan Blade & Hardware Replacement

3:45 – Session 5

– Team 1 – Driveshaft and Close Coupling Replacement

– Team 2 – MX75 & MBX Fill Installation

– Team 3 – Controls Overview and Troubleshooting

– Team 4 – Pinion Shaft Oil Seal Replacement

5:15 – Depart for hotel

6:30 – Dinner

Agenda – Day 3

Breakfast

8:00 – Depart for Development Center

8:30 – Hands on Product Training

– Session 6

– Team 1 – Pinion Shaft Oil Seal Replacement

– Team 2 – Controls Overview and Troubleshooting

– Team 3 – MX75 & MBX Fill Installation

– Team 4 – Driveshaft and Close Coupling Replacement

10:00 – Break

10:15 – Tower Start-up and Inspection Training - Presentation

11:30 – Lunch

12:30 – Hands on Tower Start-up & inspection Training on QuadraFlow & NC8422.

2:15 – Break

2:30 – Post Start-up and "Offline" Inspection App Demo

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

3:00 – Depart

Marley Cooling Towers and OEM Parts

Marley

1. Who is SPX?
2. How Does a Cooling Tower Work?
3. What SPX offers?
4. Why Your Marley Rep and SPX?
5. What do we do next?

Who is SPX?

SPX

SPX Cooling Technologies, Inc.

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

Current Brands:

MARLEY RECOLD

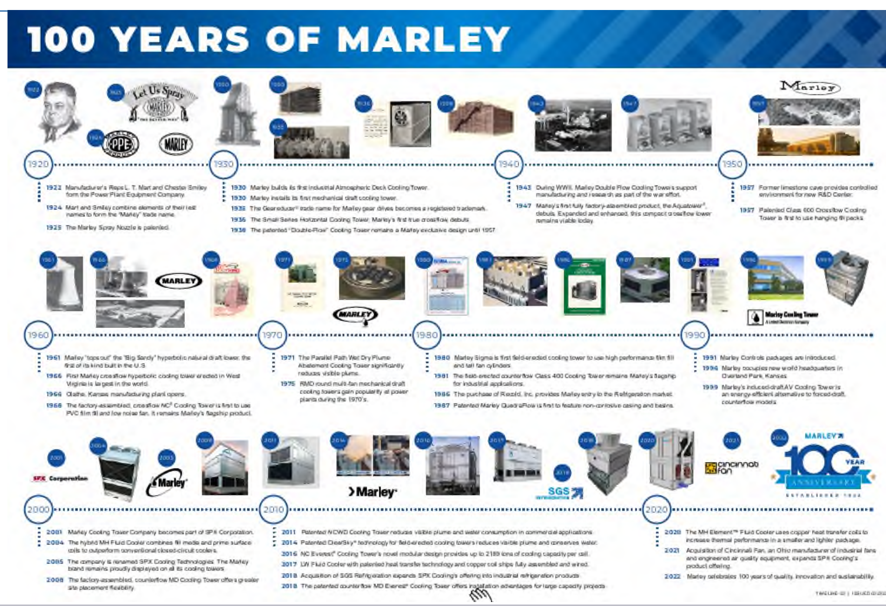
Legacy Brands:

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

250 global patents in the HVAC, industrial, refrigeration, and power markets.

Company Timeline

SPX



Evaporative Cooling Global Locations

Overland Park, Kansas (US)

- World Headquarters
- 97,000 sq. ft.
- 350 employees
- Regions Served: Global

Olathe, Kansas (US)

- Package Cooling tower and Fluid Cooler assembly, metal fabrication, fill and component manufacturing
- 250,000 sq. ft.
- 290 employees
- Regions Served: Americas

Brea, California (US)

- Coil manufacturing, Recold production facility
- 40,000 sq. ft.
- 40 Employees
- Regions Served: Americas

Worcester, UK

- Package cooling tower assembly
- 26,000 sq ft.
- 54 employees
- Regions Served: EMEA

Foho, China

- Package cooling tower assembly
- 108.000 sq ft.
- 57 employees
- Regions Served: Asia

Global Presence and Footprint

HVAC Cooling and Power Generation Segment

- SPX Manufacturing
- SPX Sales and Marketing

Marley

1. Who is SPX?
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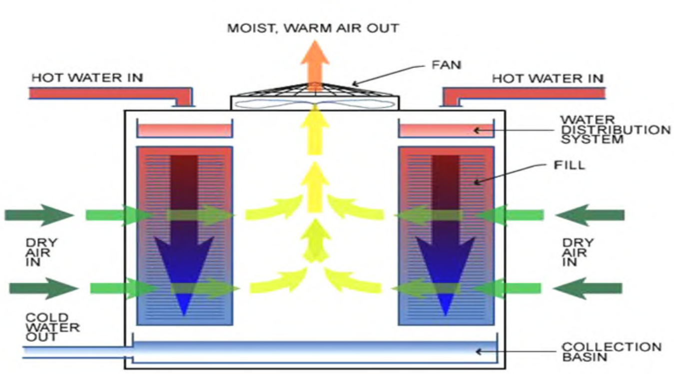
SPX

How Does a Cooling Tower Work?

SPX

Cooling Tower
Process



- 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

MARLEY

Selection Parameters

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

MARLEY

Marley

1. Who is SPX?
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SPX

Induced Draft Crossflow

Characteristics:

- Air flows ***across*** the falling water (crossflow)
- Gravity-fed water distribution
- **Advantages**
  - Lower Pump Head
  - Tall, accessible plenum – easy mechanical access
  - Variable Flow Capabilities
- **Disadvantages**
  - Footprint at lower tonnage

MARLEY

Induced Draft Counterflow

Characteristics:

- Air flows ***counter*** to the falling water (counterflow)
- Pressurized water distribution
- **Advantages**
  - Smaller footprint at low tonnage
- **Disadvantages**
  - Inlet Sound
  - Maintenance
  - Capacity per cell

MARLEY

Forced Draft

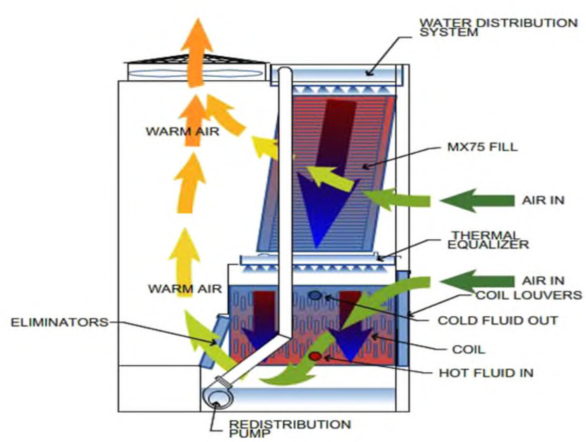
Characteristics:

- Uses centrifugal blowers instead of axial fans
- Pressurized water distribution
- **Advantages**
  - External static applications
  - Low noise
  - Low profile (Recold)
- **Disadvantages**
  - High Horsepower **(Up to 2X)**

Closed Loop – Fluid Cooler

Characteristics:

- 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



What SPX Offers?


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


MD
165 to 500 tons per cell


AV
125 to 772 tons per cell


AQUATOWER®
8 to 126 tons per cell


MCW
142 to 489 tons per cell


QUADRAFLOW®
129 to 1,047 tons per cell


JT
30 to 415 tons per cell

Full line of <u>cooling towers</u> to replace any brand

What SPX Offers?


Marley MH
78 - 628 Tons per Cell


Recold JW
GPM Range: 10 - 1700


Recold MH


Marley MC


Marley DT
45 - 265 nominal tons per cell


Marley LW
18-107 nominal tons per cell

Full line of <u>Fluid Coolers</u> to replace any brand

What SPX Offers?


Recold JC


Recold MC


Cube BTC
187 to 1358 ammonia R717


Cube DTC
136 to 1272 ammonia R717 Tons


Recold Vector Adiabatic
Capacity – Condensing: 25-295 Tons
Capacity – CO_2 Gas Cooling: 32-372 Tons


Recold LC
80-371 nominal tons per cell

Full line of <u>Evap Condensers</u> to replace any brand

What SPX Offers?

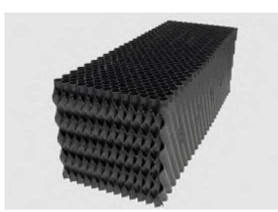

Marley Geareducer


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

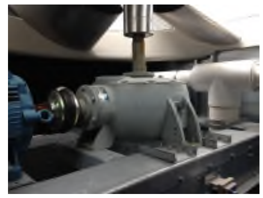

Marley MBX Crossflow fill
Bottom Supported type

Marley OEM Parts – Precision-Engineered

What SPX Offers?

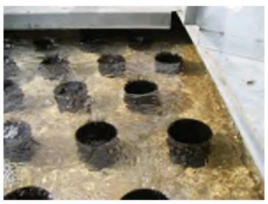
Fill Replacement
Hanging fill & Bottom Supported

Hot Water Basin Replacement
Galvanized or Stainless Steel



Increase 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

What SPX Offers?

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

MARLEY®

What SPX Offers?

SPX

(Source: MMCO

Before

(Source: MMCO

After

Marley MBX Fill Kits – Engineered to fit

MARLEY®

What SPX Offers?

SPX

(Source: MMCO

Before

(Source: MMCO

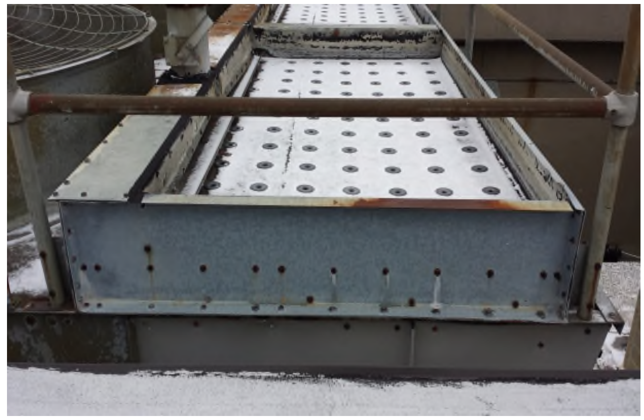
After

Hot Water Basin Kits – Engineered to fit

MARLEY®

What SPX Offers?

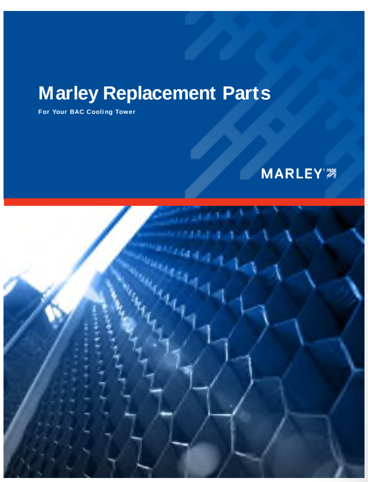
- Hot Water Basins are designed for direct replacement of existing unit - *Some field drilling may be required for the retrofit replacement.*
- Available in stainless and galvanized steel
- Steel HW basin covers
- Nozzle cups and basin dams are available for low flow profiles



(Source: SPX

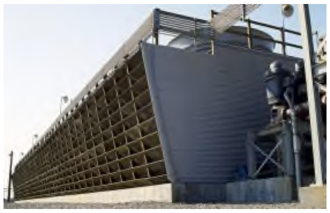
Engineered Marley Hot Water Basins - Goal: Keep Inlet At Same Location

What SPX Offers?



Marley Parts for BAC towers - Available on spxcooling.com

What SPX Offers?



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

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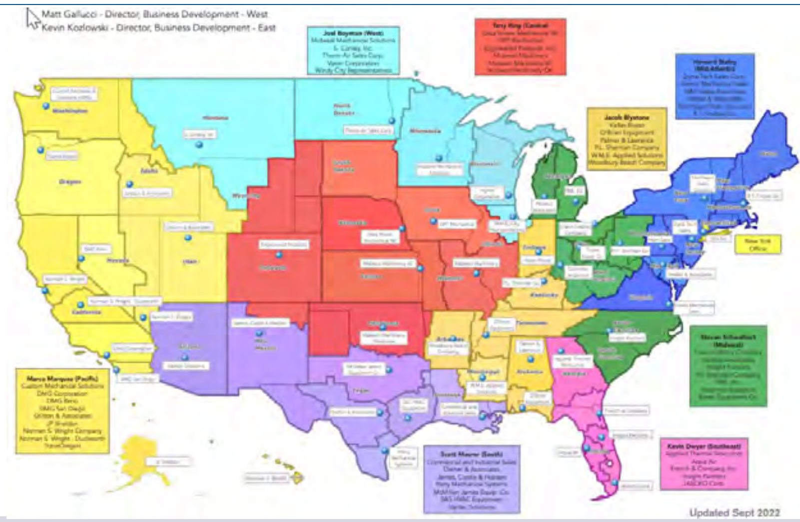
Why Your Marley Rep and SPX?

SPX

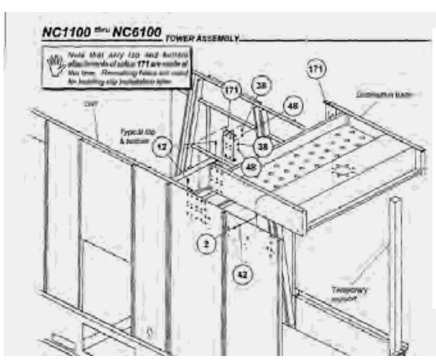


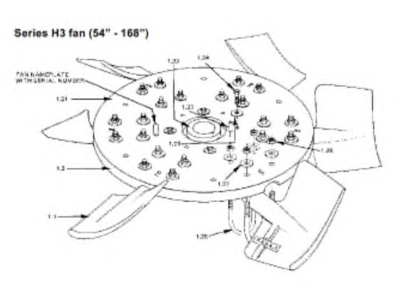
Local Marley "Technical" Representatives

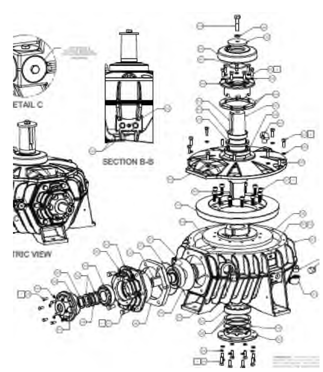
MARLEY®

Why Your Marley Rep and SPX?

SPX







Exploded views of towers and components with "Find" or "Balloon" number

"Technical" Information at the Rep's "finger" tips to support your needs.

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

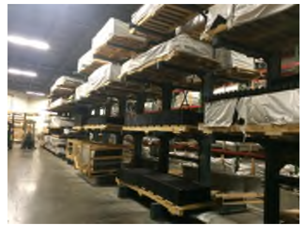
MARLEY®

Why Your Marley Rep and SPX?

SPX

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

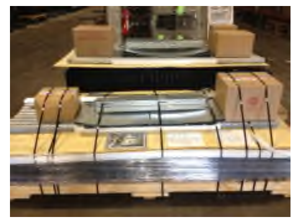


Photo Documentation
LTL - Stapled to skid

Marley Warehouse Inventory – 40% of shipments ship out same day.

MARLEY

Why Your Marley Rep and SPX?

SPX

Videos

- “How To” Videos on www.spxcooling.com

Training Workshop

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

½ Day classroom

Controls Troubleshooting

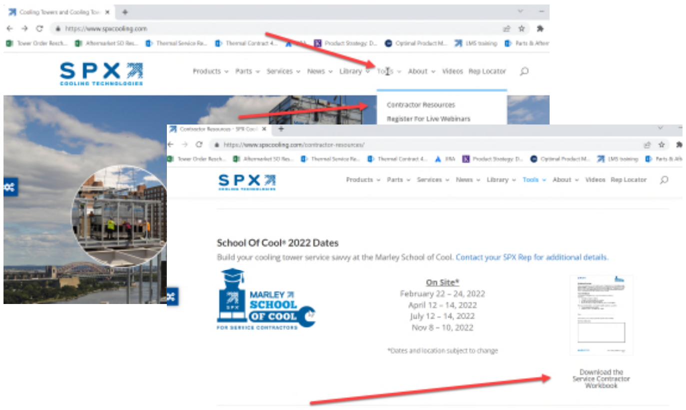
Mechanical Equipment Alignment

Service Contractor Training

MARLEY

Why Your Marley Rep and SPX?

https://www.spxcooling.com/contractor-resources



2023 Scheduled Training Dates:
Feb 21st - 23rd 2023
April 11 - 13th 2023
July 11 - 13th 2023
Nov 7 - 9th 2023

Download Binder Content

Service Contractor Training

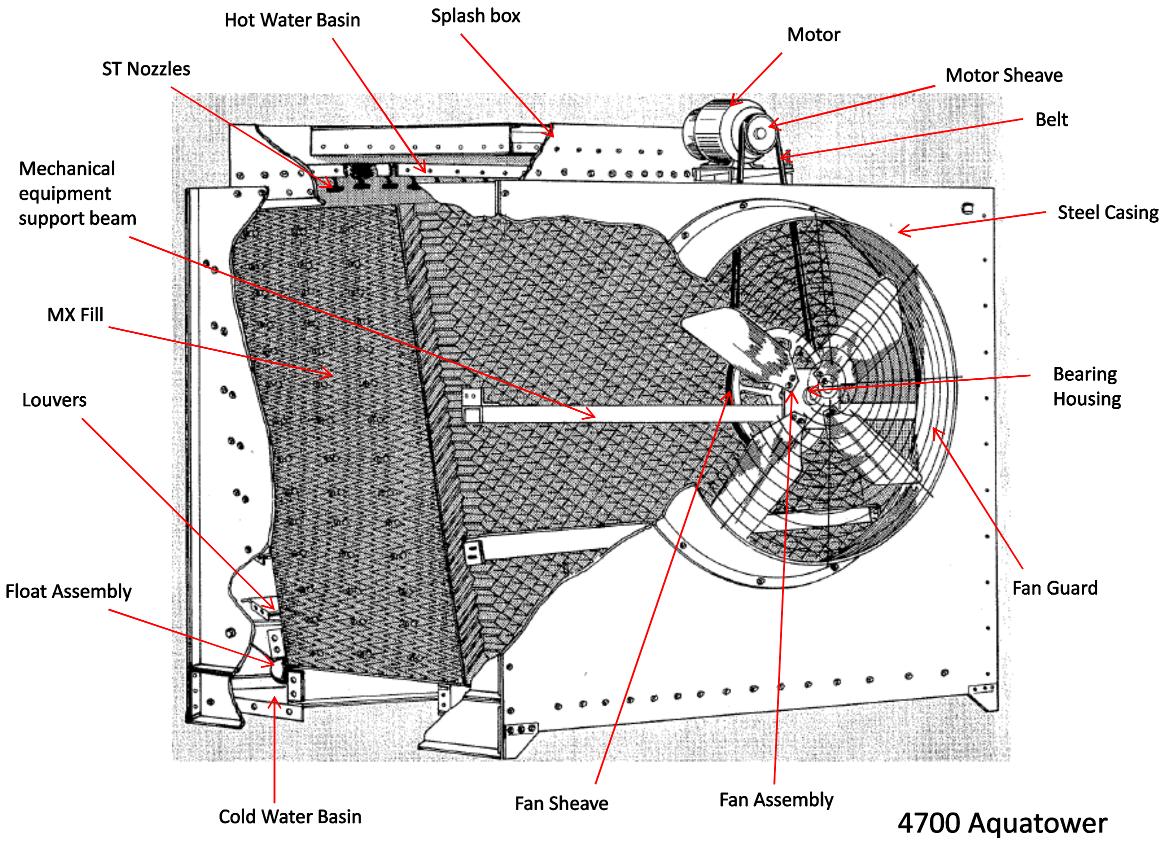
MARLEY

Thank You.

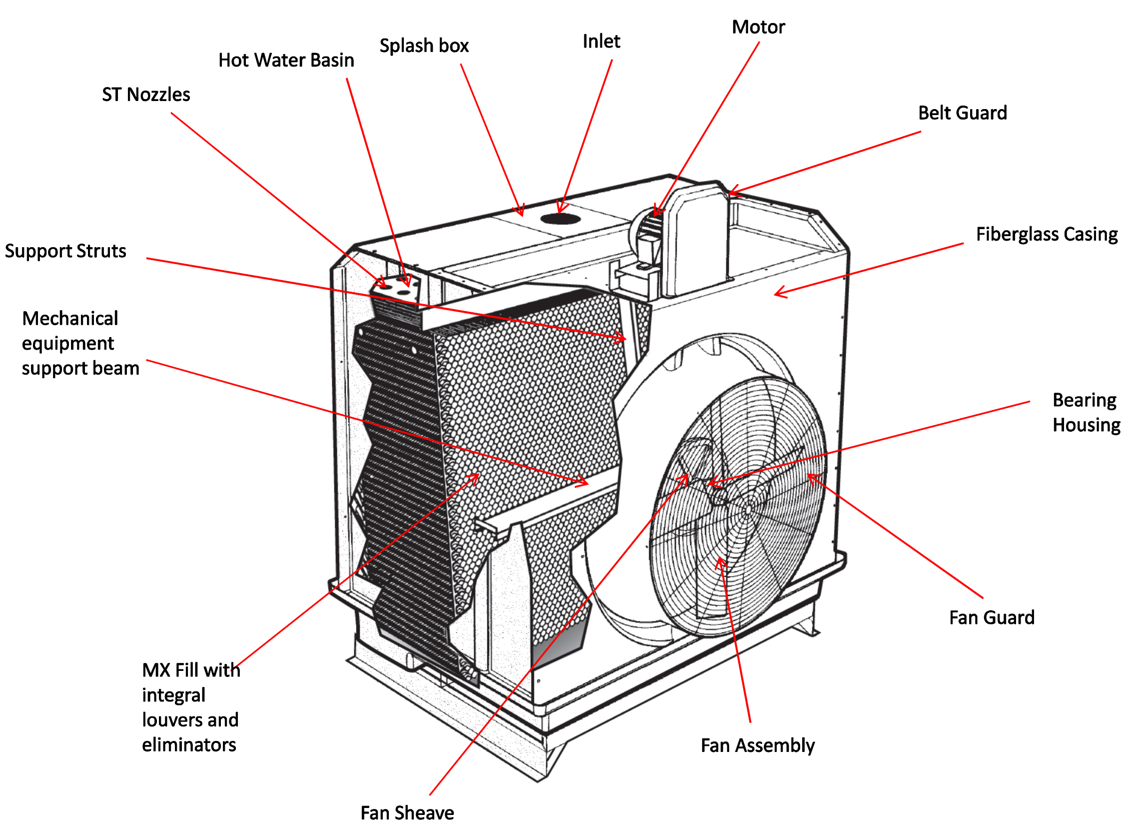
Questions?

SPX Cooling Technologies, Inc.
TEL 913.664.7400
spxcooling.com

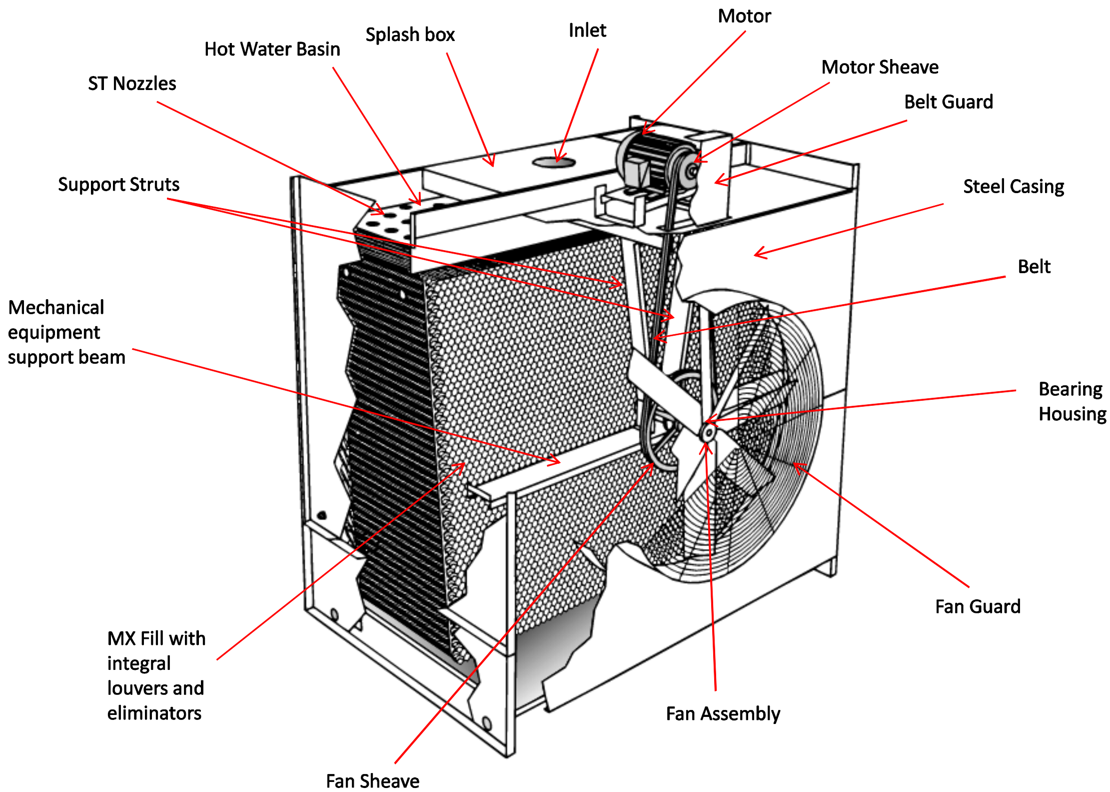
MARLEY



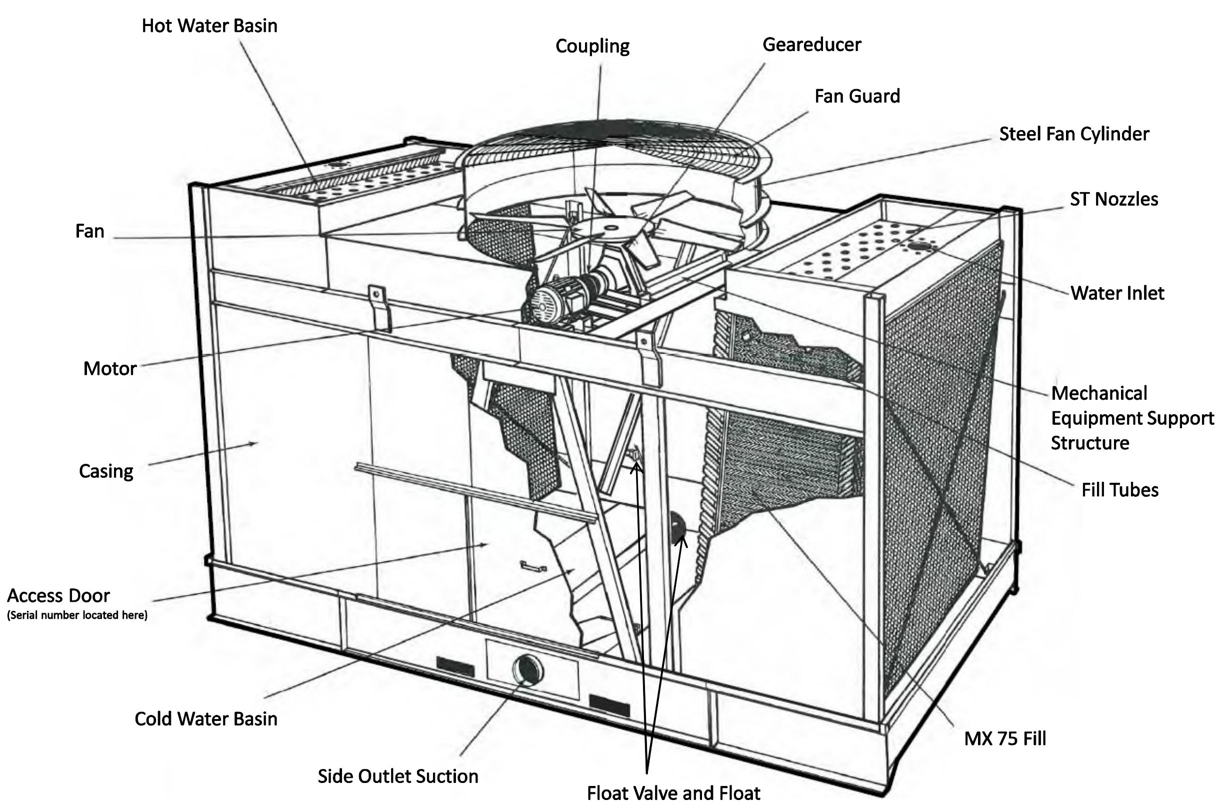
4700 Aquatower



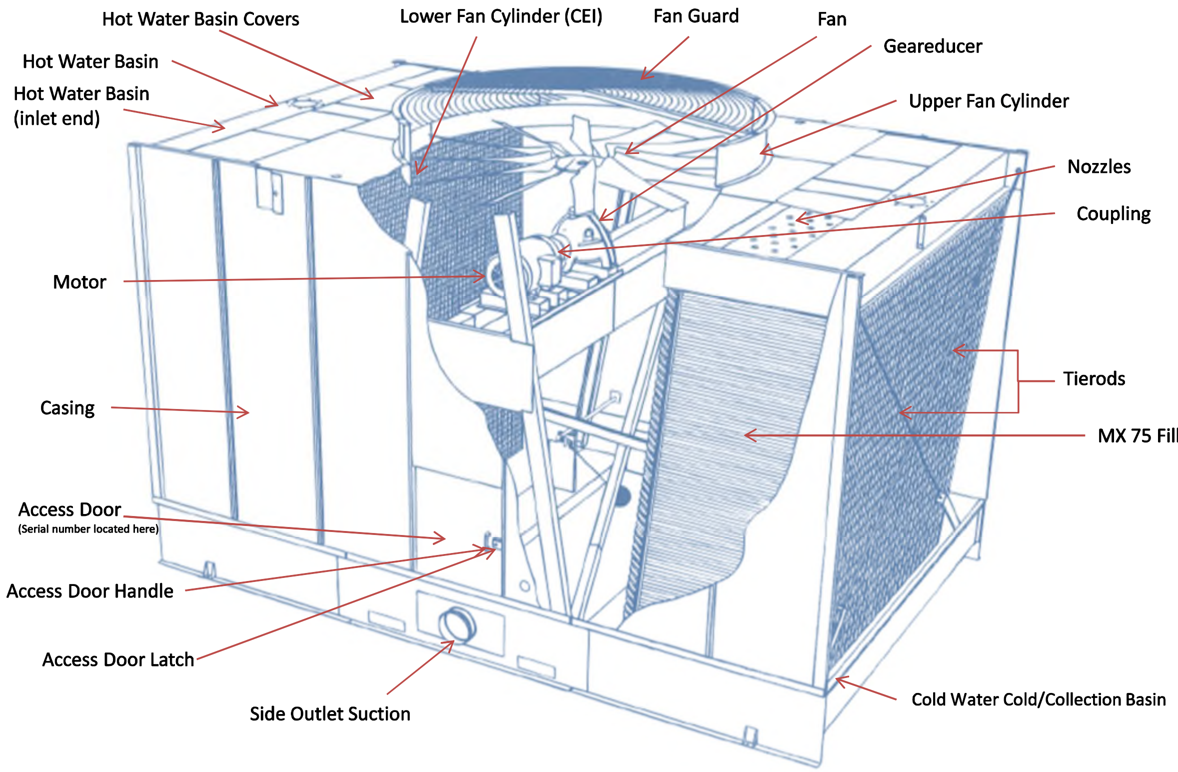
3800 Aquatower (Fiberglass)



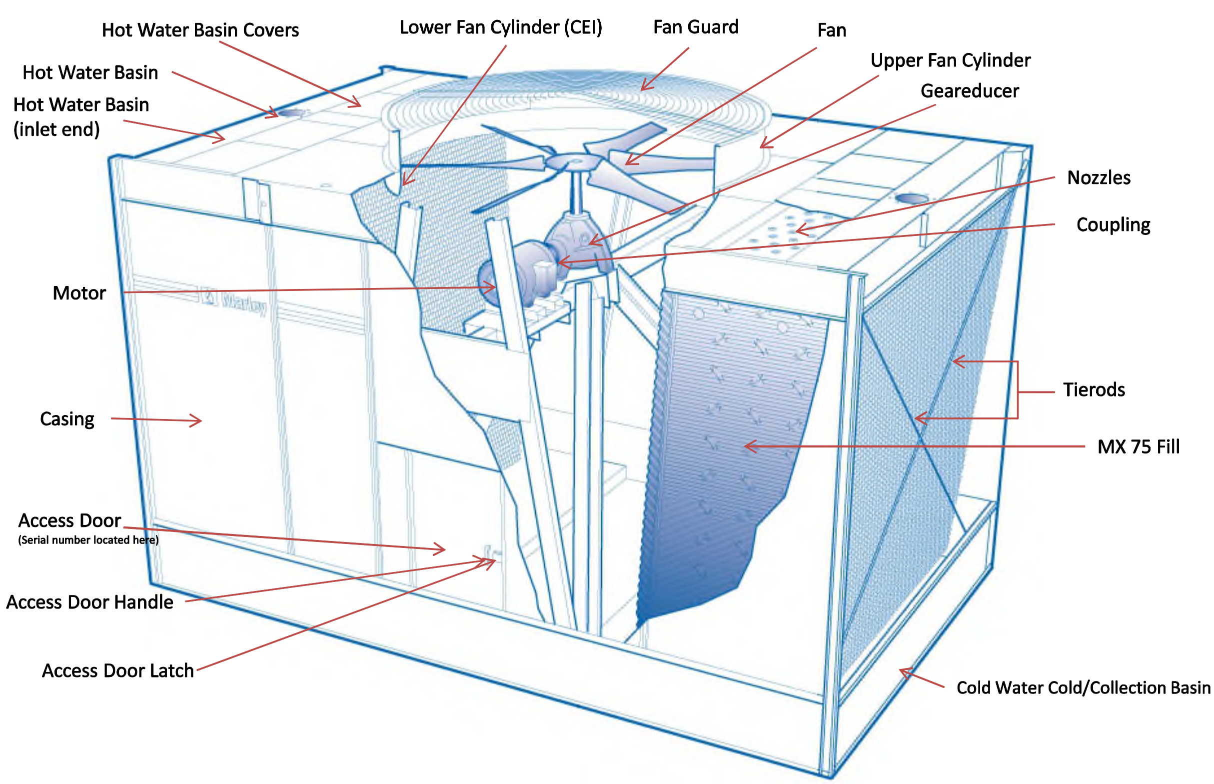
4800 & 4900 Aquatower



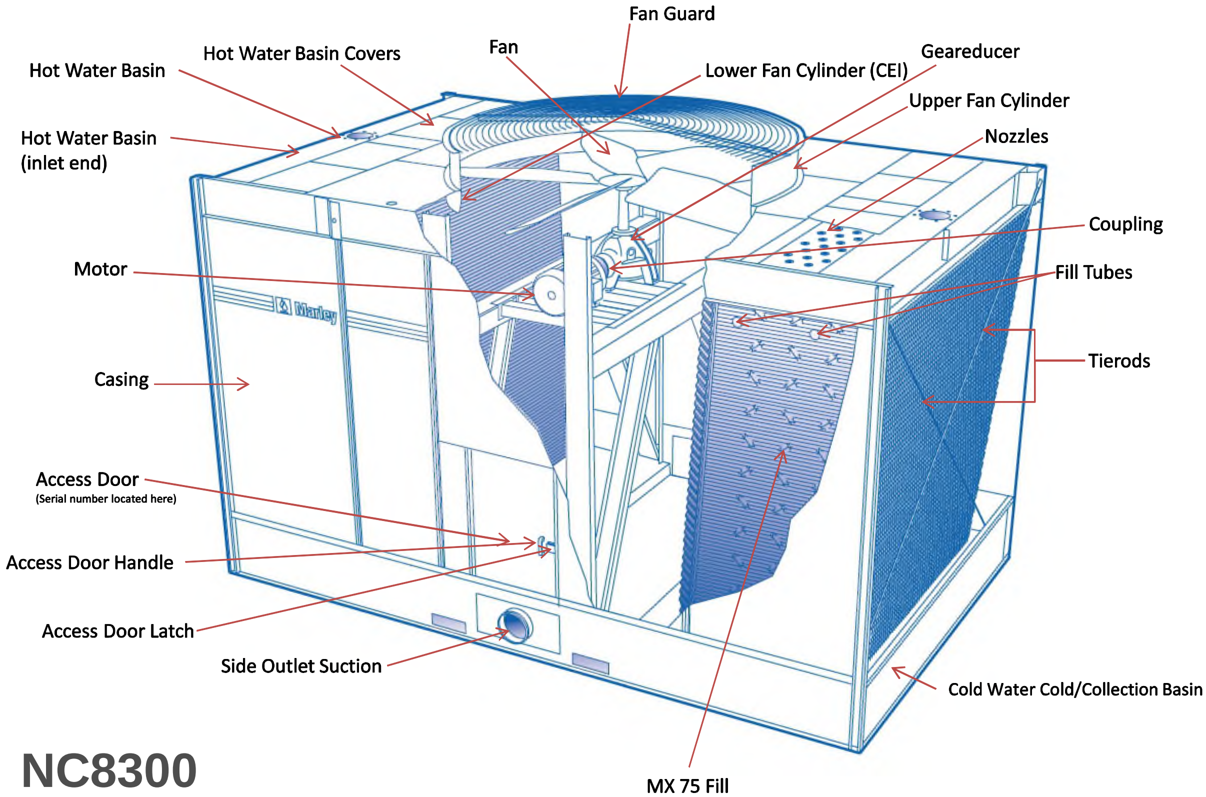
NC 220



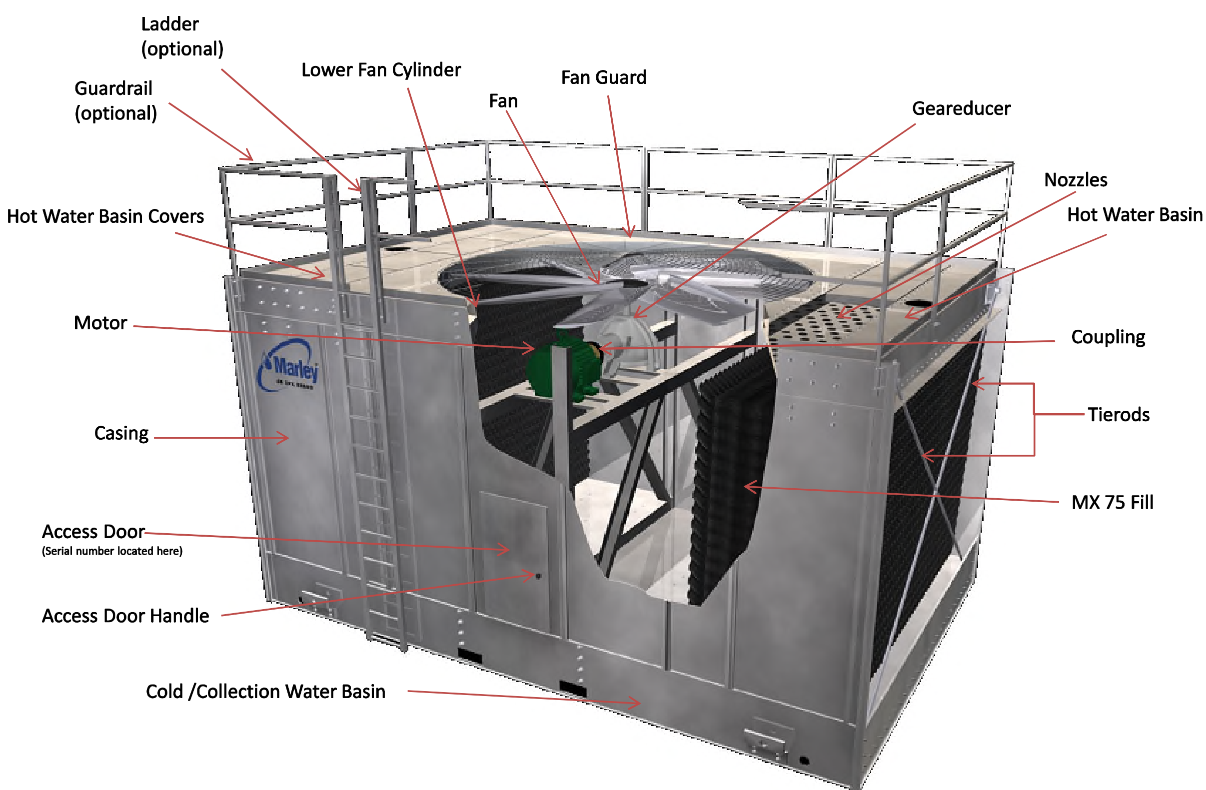
NC100/NC1000/NC1100



NC1200

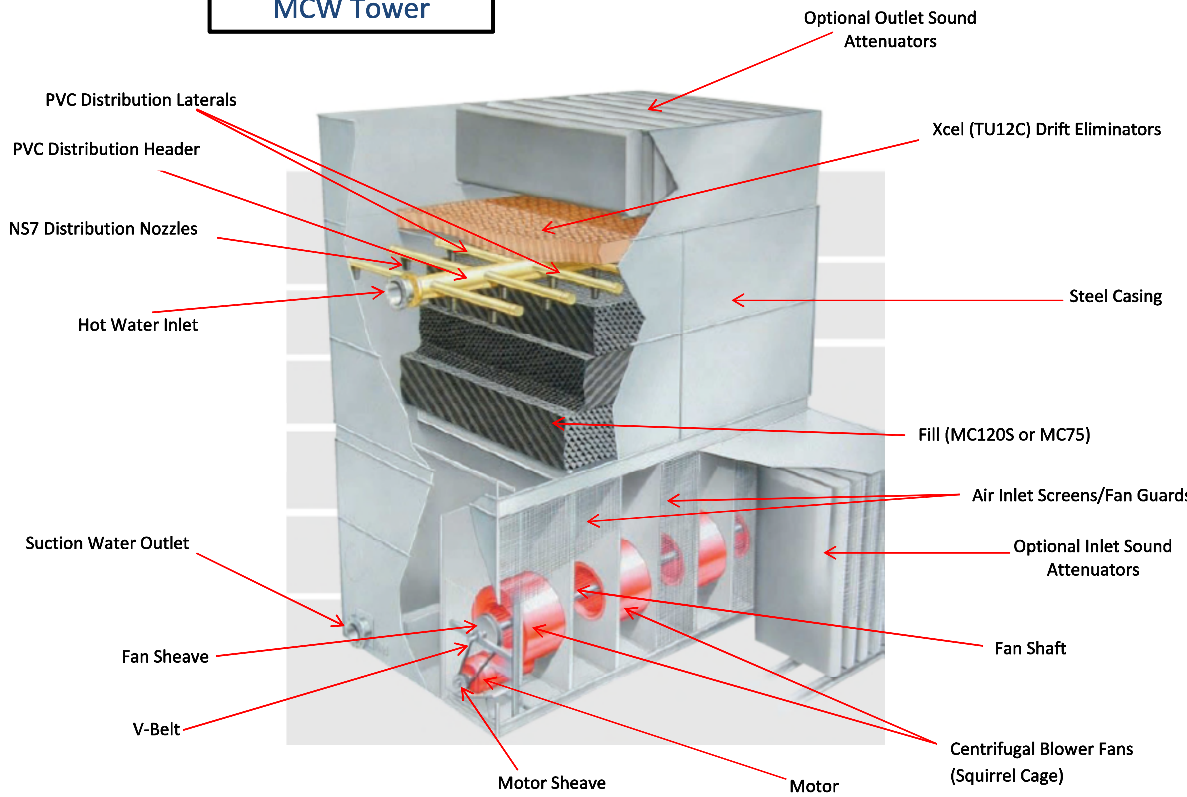


NC8300



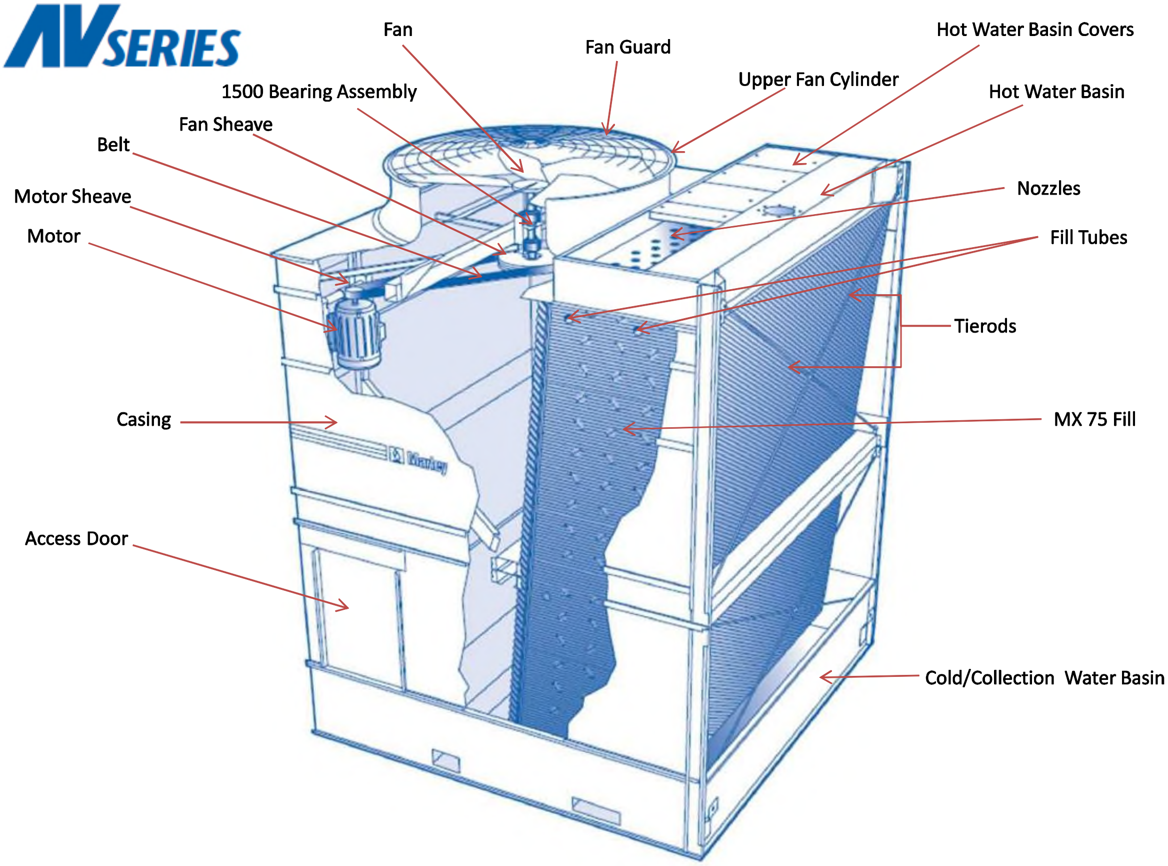
NC8400

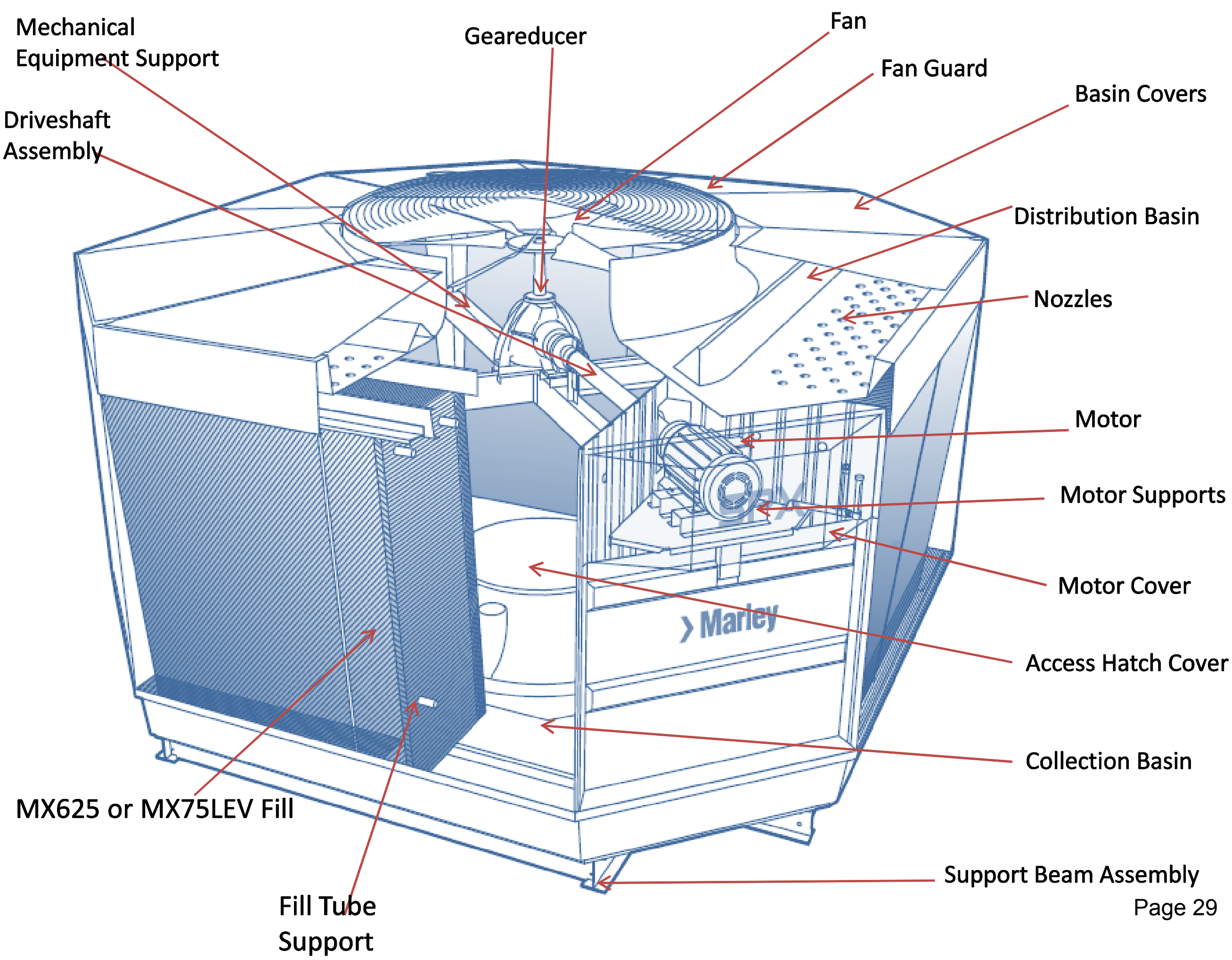
MCW Tower



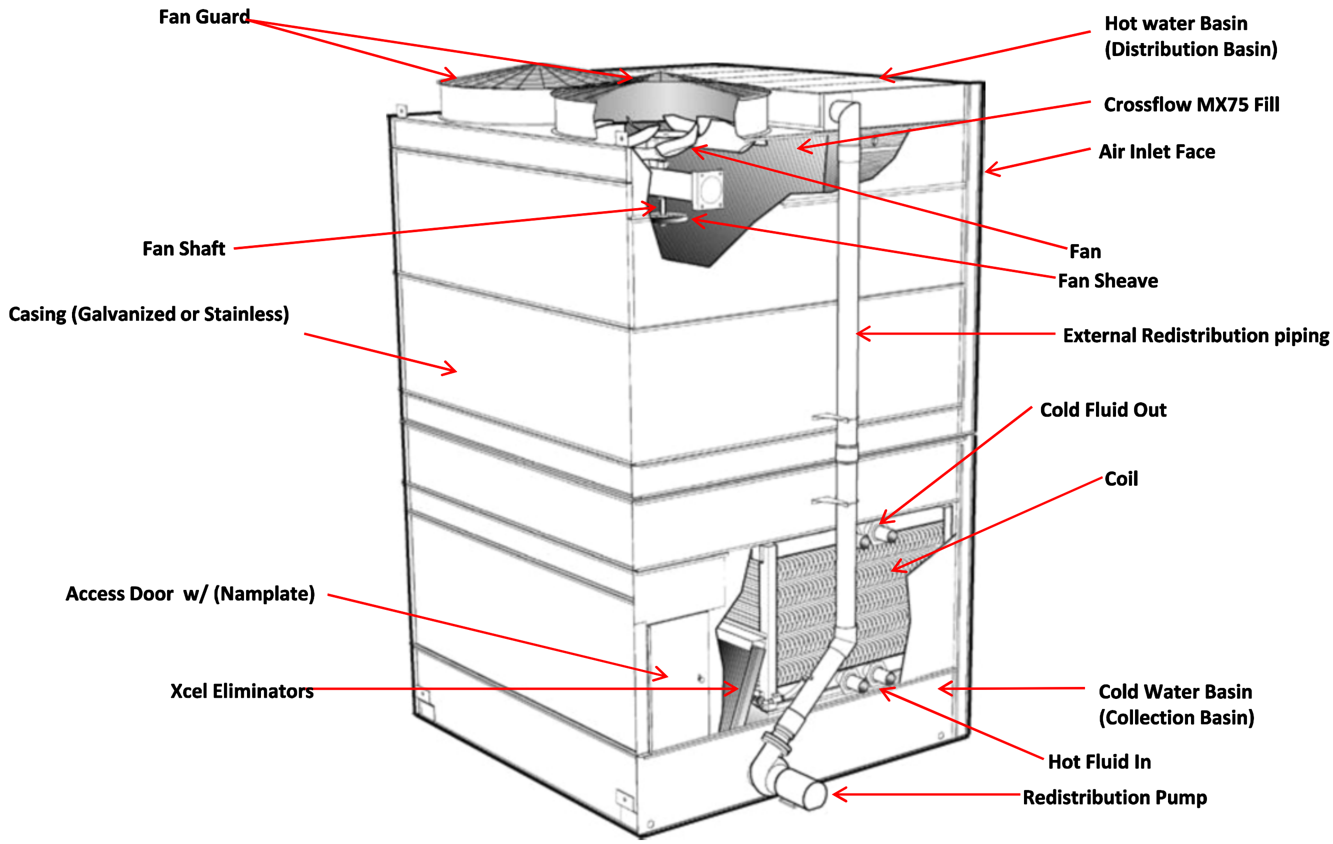
MD Tower Model

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
Marley
Access Door
Cold/Collection Water Basin

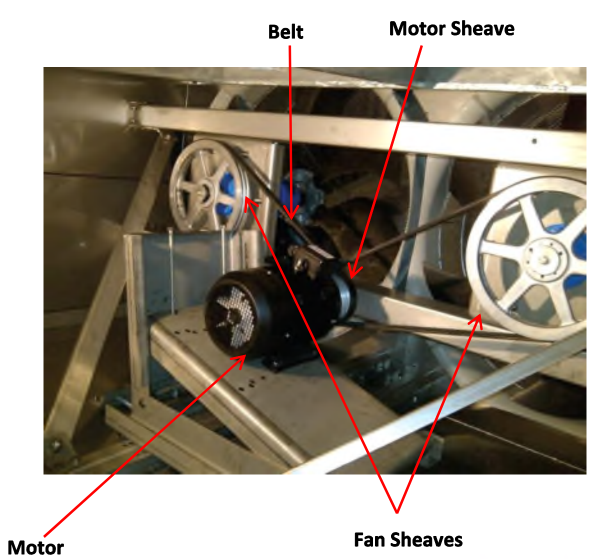

Mechanical
Equipment Support
Geareducer
Fan
Fan Guard
Basin Covers
Driveshaft
Assembly
Distribution Basin
Nozzles
Motor
Motor Supports
Motor Cover
Marley
Access Hatch Cover
Collection Basin
MX625 or MX75LEV Fill
Support Beam Assembly
Fill Tube
Support

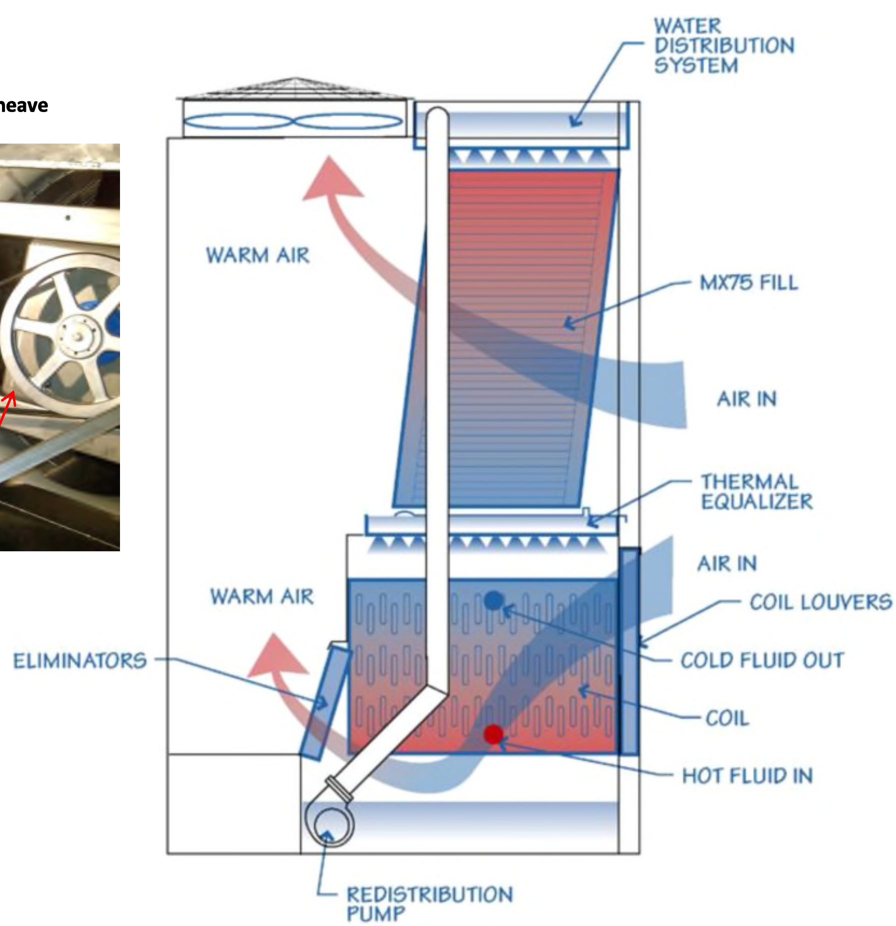
Marley MH Fluid Cooler



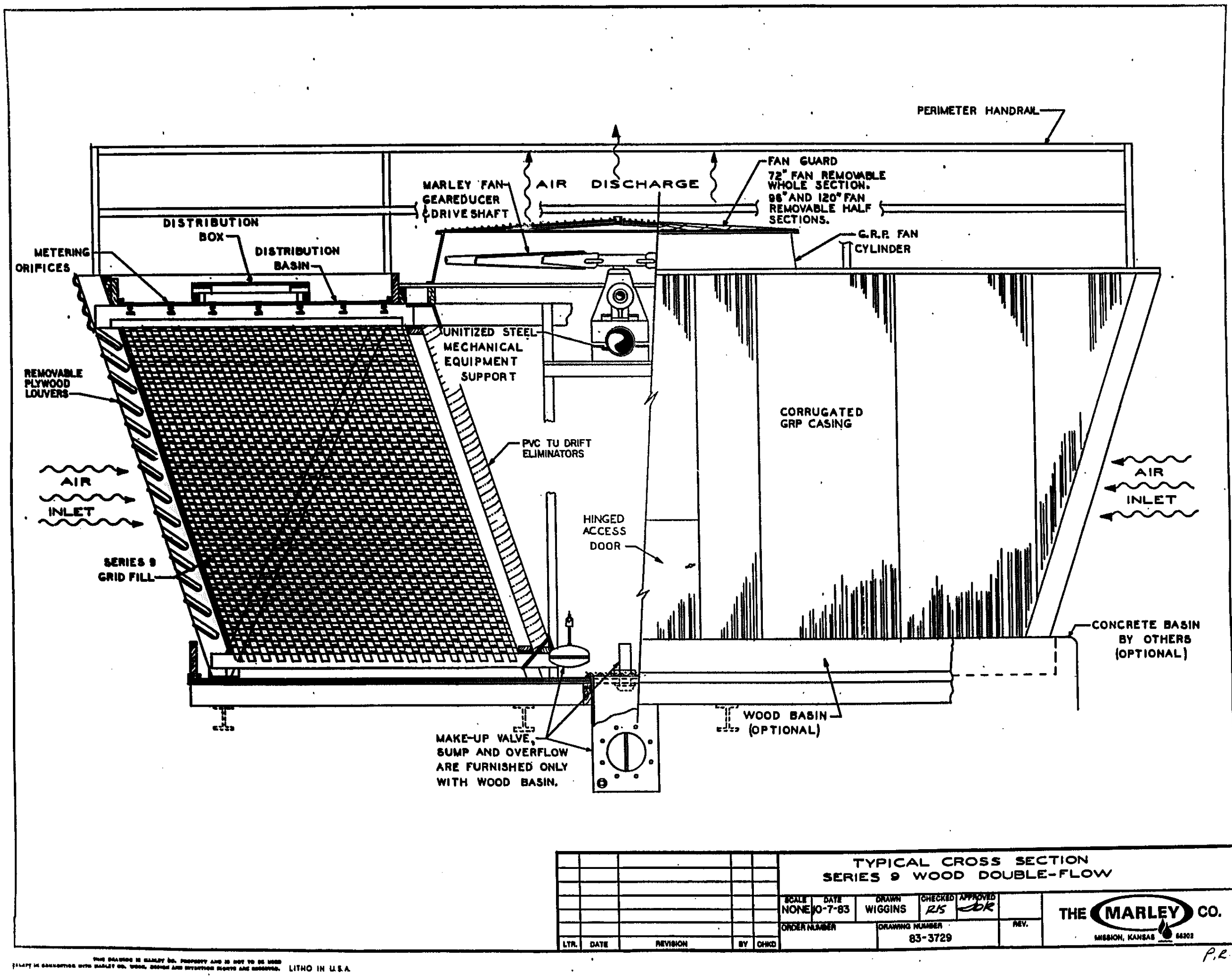
SPX Cooling Technologies
Balcke | Hamon Dry Cooling | Marley

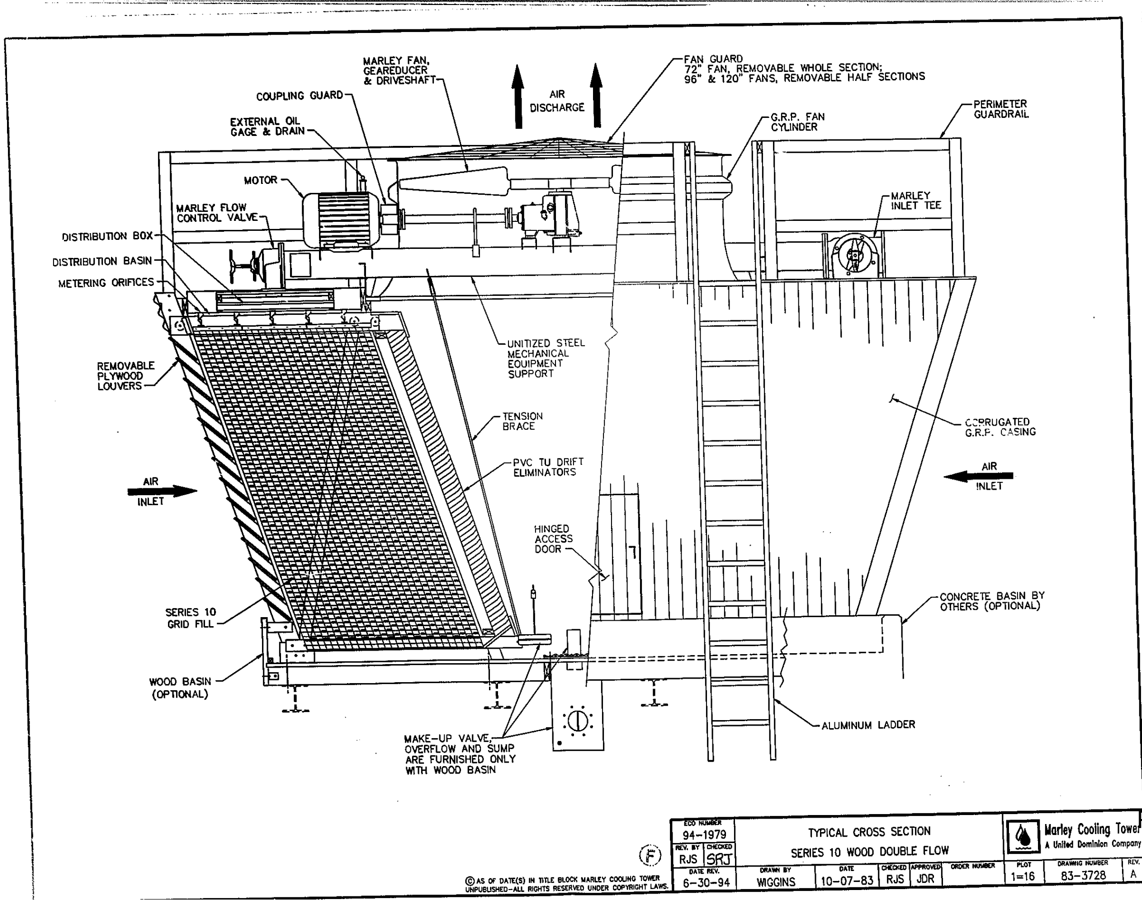
Marley MH Fluid Cooler

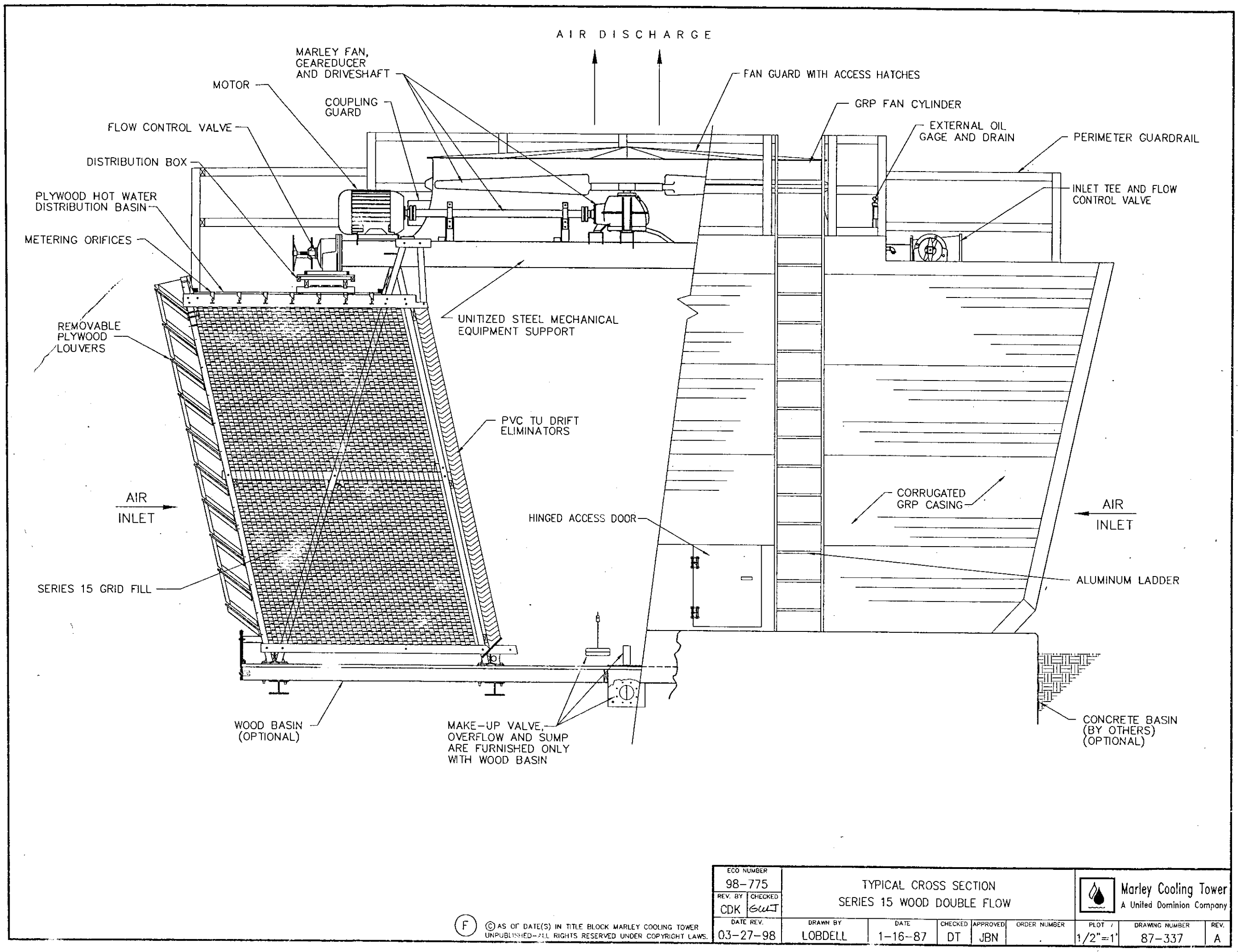


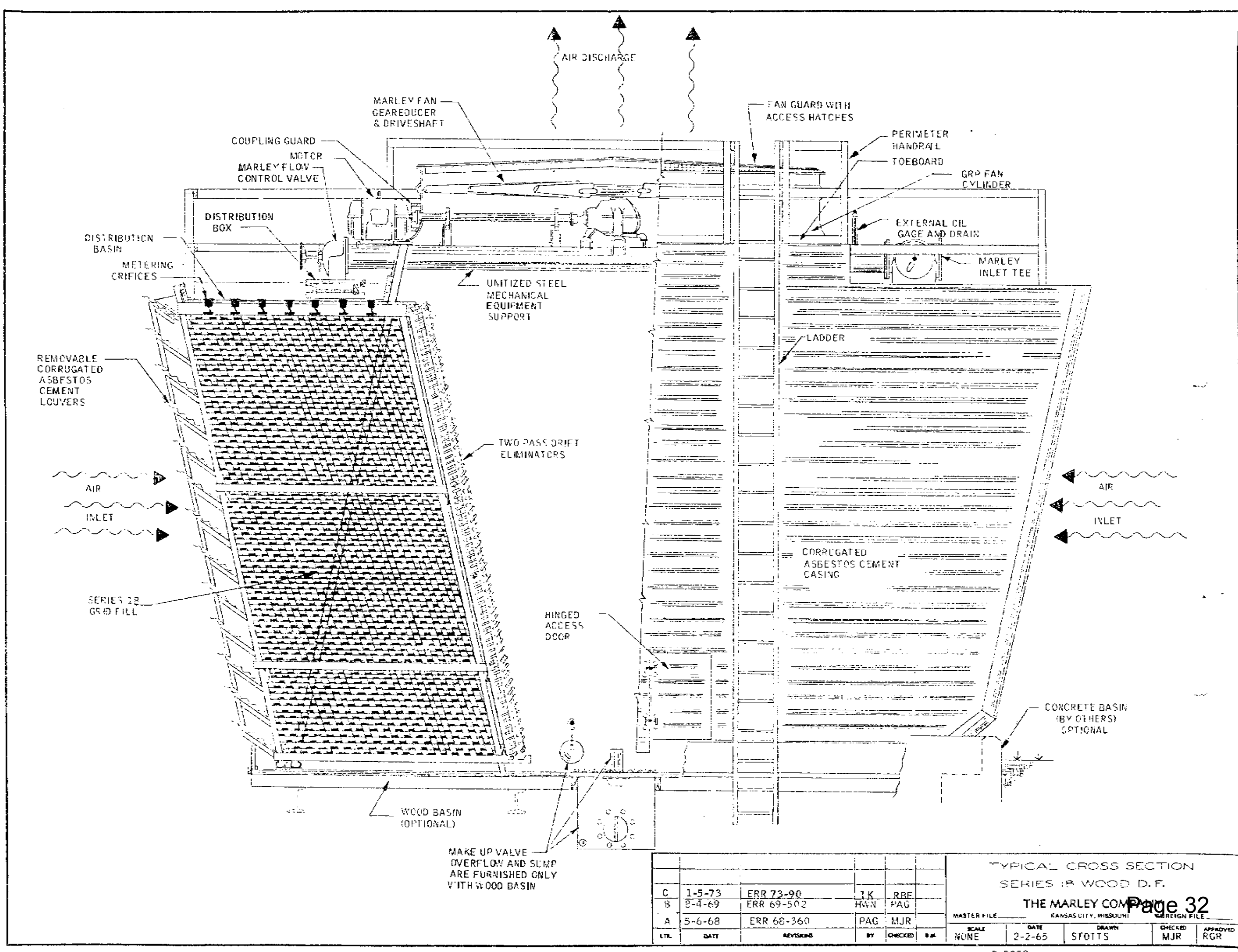


SPX Cooling Technologies
Balcke | Hamon Dry Cooling | Marley


PERIMETER HANDRAIL
FAN GUARD
72" FAN REMOVABLE WHOLE SECTION.
96" AND 120" FAN REMOVABLE HALF SECTIONS.
MARLEY FAN GEAREDUCER DRIVE SHAFT
AIR DISCHARGE
G.R.P. FAN CYLINDER
DISTRIBUTION BOX
METERING ORIFICES
DISTRIBUTION BASIN
UNITIZED STEEL MECHANICAL EQUIPMENT SUPPORT
REMOVABLE PLYWOOD LOUVERS
PVC TU DRIFT ELIMINATORS
CORRUGATED GRP CASING
AIR INLET
AIR INLET
HINGED ACCESS DOOR
SERIES 9 GRID FILL
CONCRETE BASIN BY OTHERS (OPTIONAL)
WOOD BASIN (OPTIONAL)
MAKE-UP VALVE, SUMP AND OVERFLOW ARE FURNISHED ONLY WITH WOOD BASIN.
TYPICAL CROSS SECTION
SERIES 9 WOOD DOUBLE-FLOW
SCALE NONE
DATE 10-7-83
DRAWN WIGGINS
CHECKED RJS
APPROVED JDR
ORDER NUMBER
DRAWING NUMBER 83-3729
REV.
THE MARLEY CO.
MISSION, KANSAS
LTR. DATE REVISION BY CHKD
LITHO IN U.S.A.
Drawing No. 83-3729
P.R.


MARLEY FAN, GEAREDUCER & DRIVESHAFT
AIR DISCHARGE
FAN GUARD
72" FAN, REMOVABLE WHOLE SECTION;
96" & 120" FANS, REMOVABLE HALF SECTIONS
COUPLING GUARD
EXTERNAL OIL GAGE & DRAIN
G.R.P. FAN CYLINDER
PERIMETER GUARDRAIL
MOTOR
MARLEY FLOW CONTROL VALVE
MARLEY INLET TEE
DISTRIBUTION BOX
DISTRIBUTION BASIN
METERING ORIFICES
UNITIZED STEEL MECHANICAL EQUIPMENT SUPPORT
REMOVABLE PLYWOOD LOUVERS
CORRUGATED G.R.P. CASING
TENSION BRACE
PVC TU DRIFT ELIMINATORS
AIR INLET
AIR INLET
HINGED ACCESS DOOR
SERIES 10 GRID FILL
CONCRETE BASIN BY OTHERS (OPTIONAL)
WOOD BASIN (OPTIONAL)
ALUMINUM LADDER
MAKE-UP VALVE, OVERFLOW AND SUMP ARE FURNISHED ONLY WITH WOOD BASIN
ECO NUMBER 94-1979
REV. BY RJS
CHECKED SRJ
DATE REV. 6-30-94
TYPICAL CROSS SECTION
SERIES 10 WOOD DOUBLE FLOW
DRAWN BY WIGGINS
DATE 10-07-83
CHECKED RJS
APPROVED JDR
ORDER NUMBER
Marley Cooling Tower
A United Dominion Company
PLOT 1=16
DRAWING NUMBER 83-3728
REV. A
© AS OF DATE(S) IN TITLE BLOCK MARLEY COOLING TOWER UNPUBLISHED—ALL RIGHTS RESERVED UNDER COPYRIGHT LAWS.





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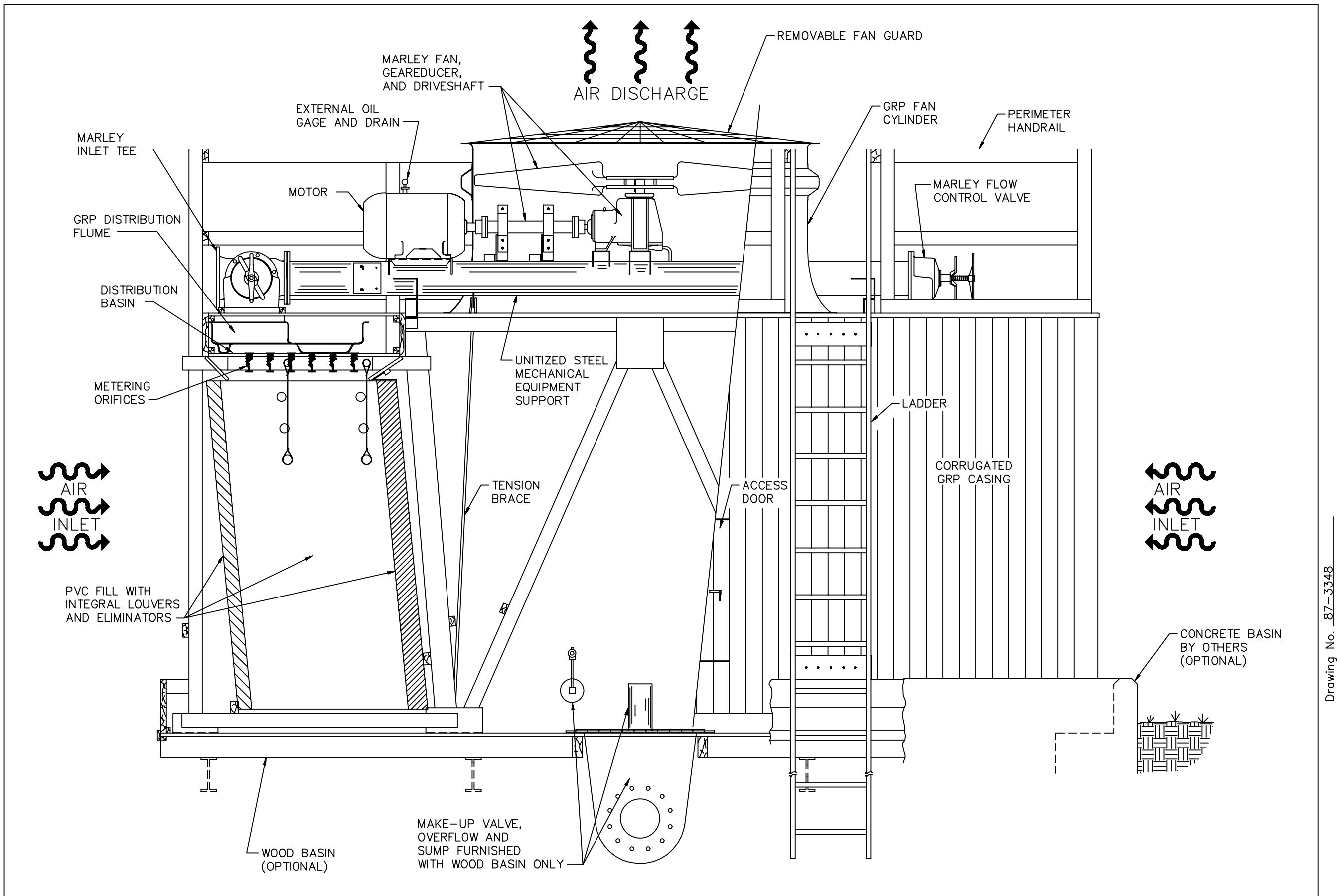
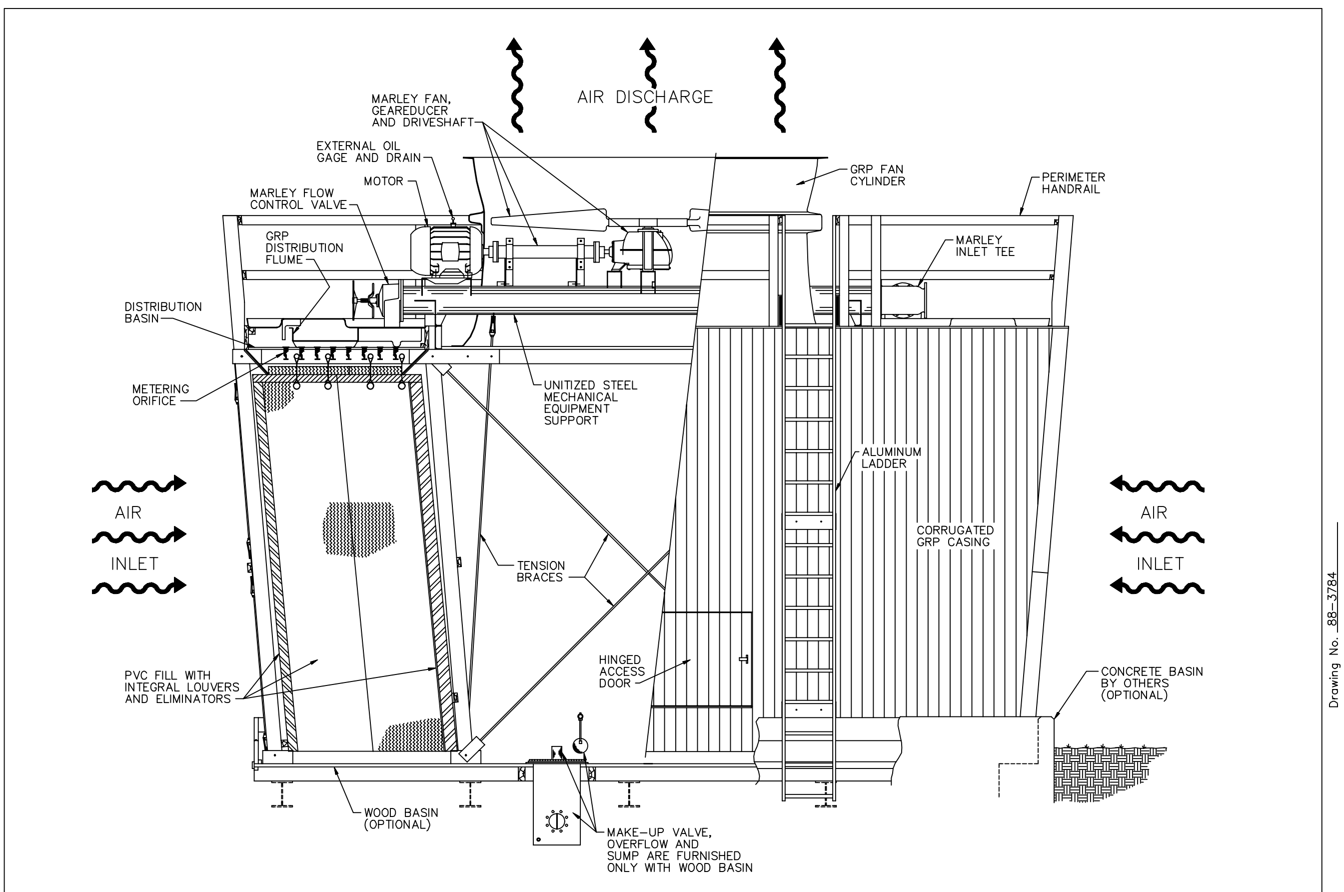


LTR	DATE	REVISION	BY	CHKD

TYPICAL CROSS SECTION
SIGMA 100 WOOD DOUBLE-FLOW

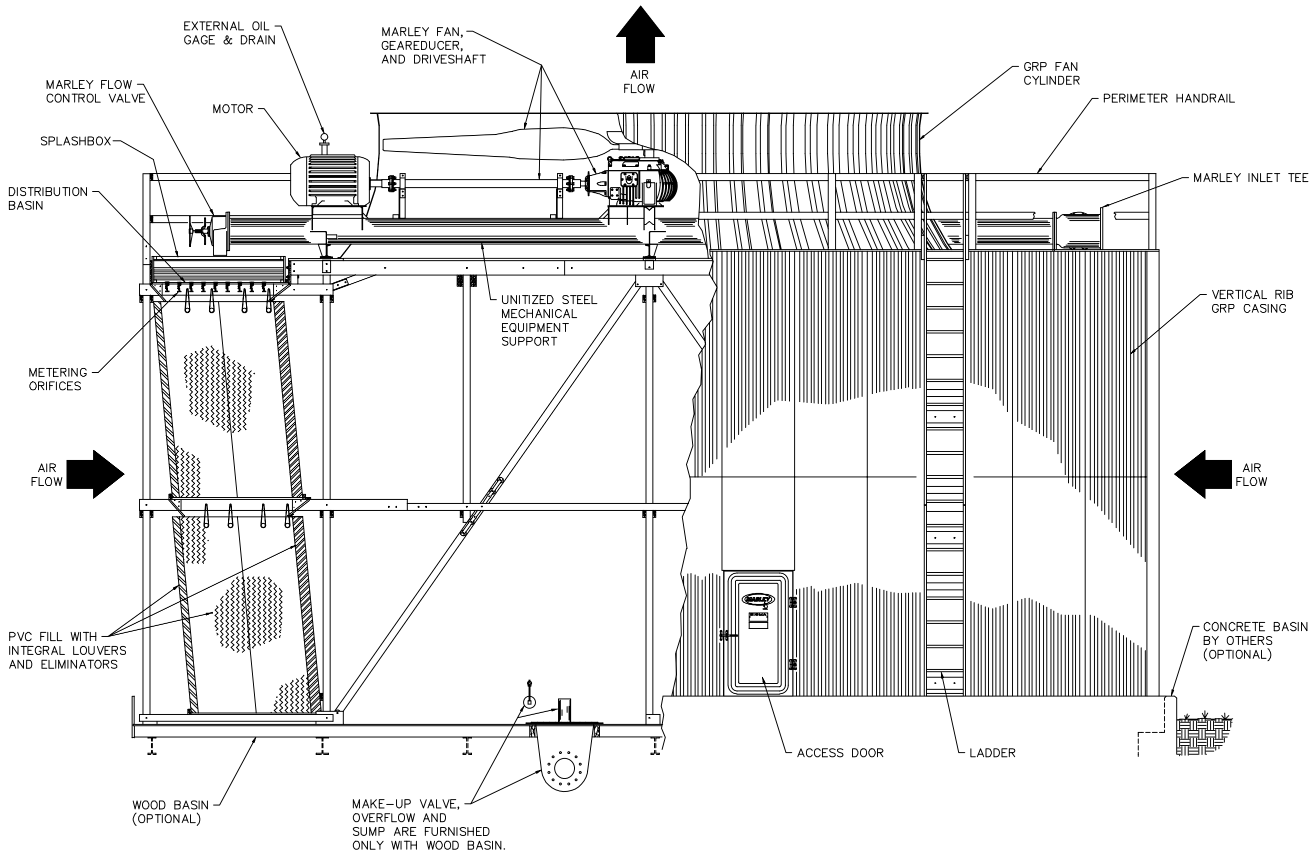
PLOT	DATE	DRAWN	CHECKED	APPROVED		
3/4"=1'	4/6/87	CLEVELAND			CAD	THE MARLEY COOLING TOWER CO.
ORDER NUMBER		DRAWING NUMBER 87-3348			REV	MISSION, KANSAS 66202



LTR	DATE	REVISION	BY	CHKD

TYPICAL CROSS-SECTION
SIGMA SERIES 120 WOOD DOUBLE-FLOW

PLOT	DATE	DRAWN	CHECKED	APPROVED		
1/2"=1'	11-23-88	CLEVELAND			CAD	THE MARLEY COOLING TOWER CO.
ORDER NUMBER		DRAWING NUMBER 88-3784			REV	MISSION, KANSAS 66202



Drawing No. 90-3220

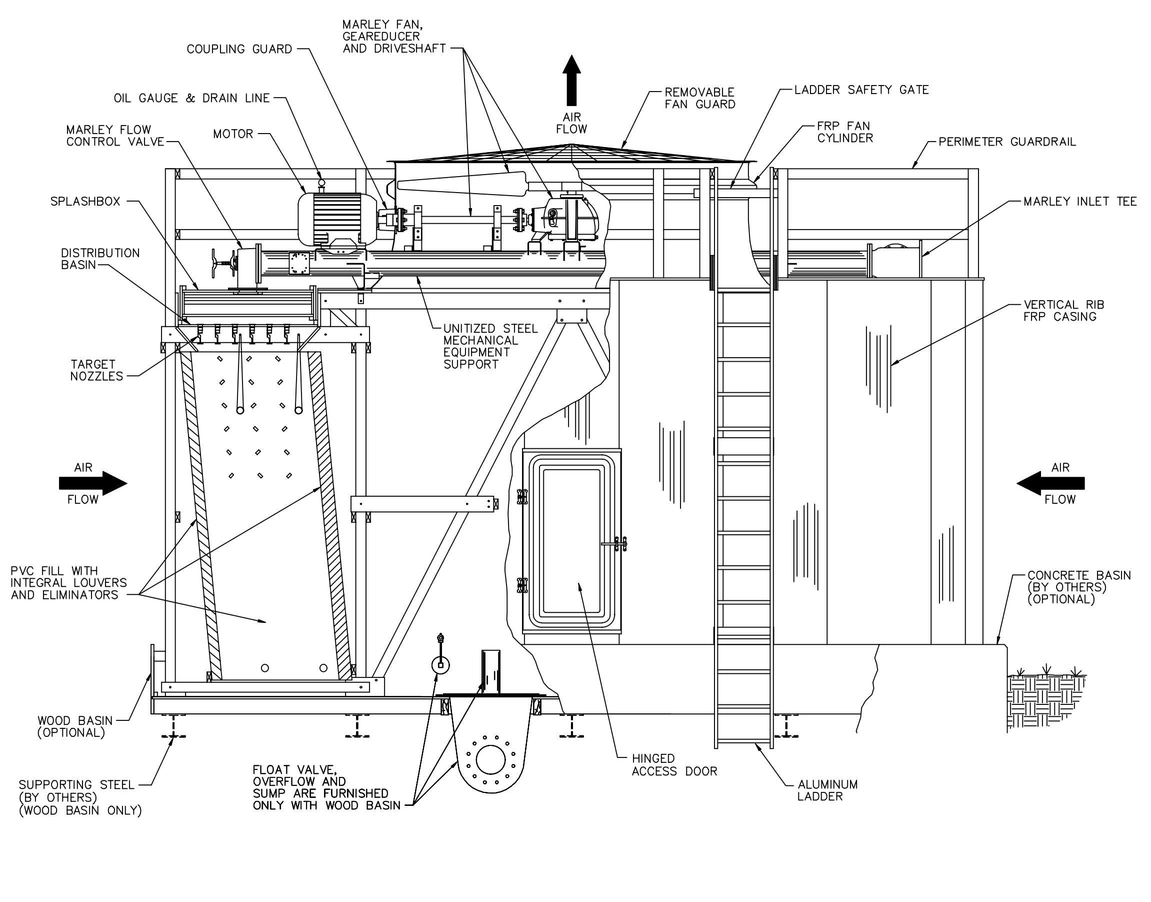
TYPICAL CROSS SECTION
SIGMA SERIES 160 WOOD DOUBLE-FLOW

PLOT	DATE	DRAWN	CHECKED	APPROVED	
3/8"=1'	03-01-90	NEWBOLD	RHR	SRJ	CAD

ORDER NUMBER	DRAWING NUMBER	REV
	90-3220	A

THE MARLEY COOLING TOWER CO.
MISSION, KANSAS 66202

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

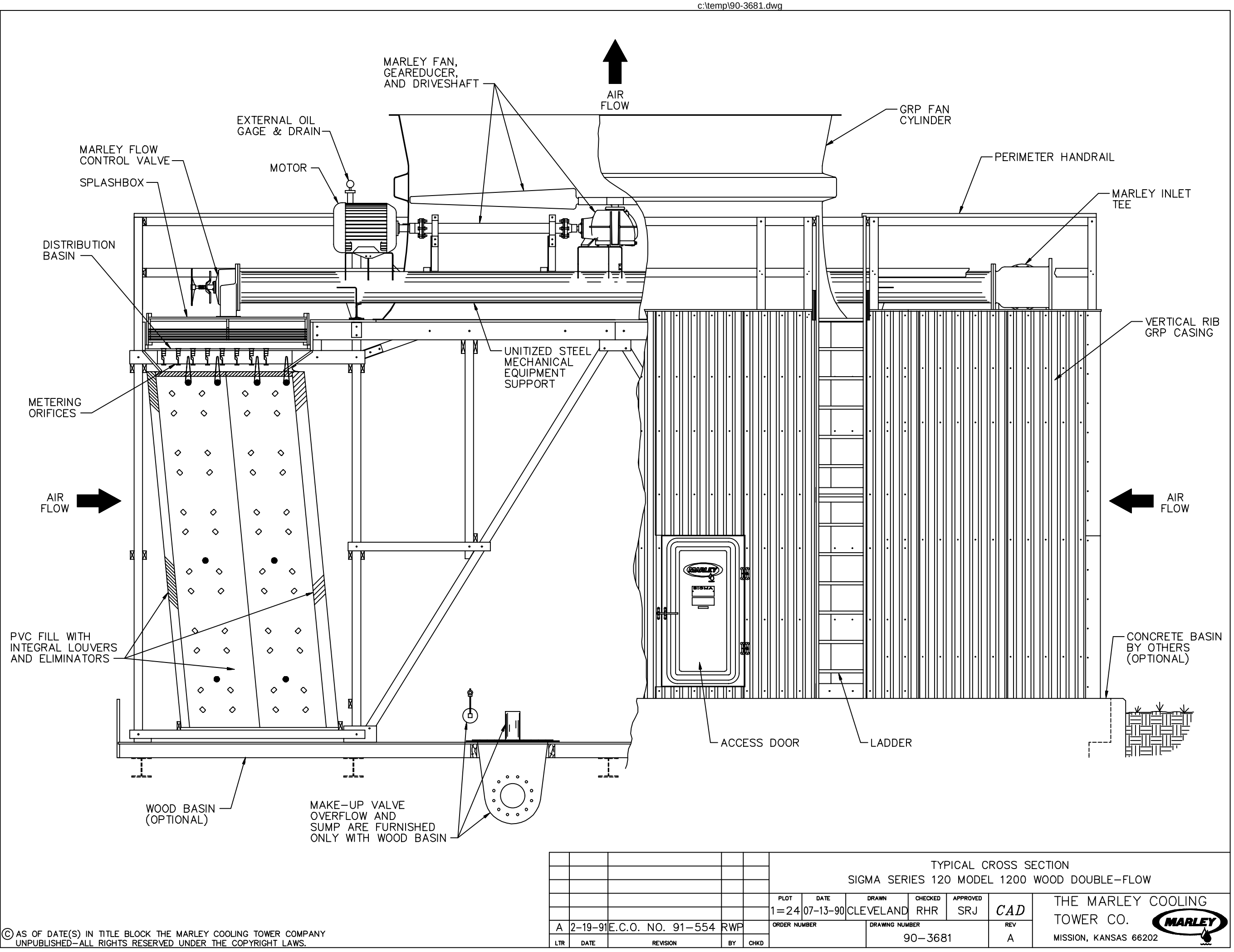


ECO NUMBER	REV. BY	CHECKED	REV. DATE
99–1296	AU		07/09/1999

TYPICAL CROSS SECTION
SIGMA 100 WOOD DOUBLE FLOW MODEL 1000

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

Marley Cooling Tower
A United Dominion Company


MARLEY FAN, GEAREDUCER, AND DRIVESHAFT
AIR FLOW
GRP FAN CYLINDER
EXTERNAL OIL GAGE & DRAIN
MARLEY FLOW CONTROL VALVE
MOTOR
SPLASHBOX
PERIMETER HANDRAIL
MARLEY INLET TEE
DISTRIBUTION BASIN
VERTICAL RIB GRP CASING
UNITIZED STEEL MECHANICAL EQUIPMENT SUPPORT
METERING ORIFICES
AIR FLOW
AIR FLOW
Drawing No. 90-3681
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
PLOT 1=24
DATE 07-13-90
DRAWN CLEVELAND
CHECKED RHR
APPROVED SRJ
CAD
THE MARLEY COOLING TOWER CO.
MISSION, KANSAS 66202
ORDER NUMBER
DRAWING NUMBER 90-3681
REV A
A 2-19-91 E.C.O. NO. 91-554 RWP
LTR DATE REVISION BY CHKD
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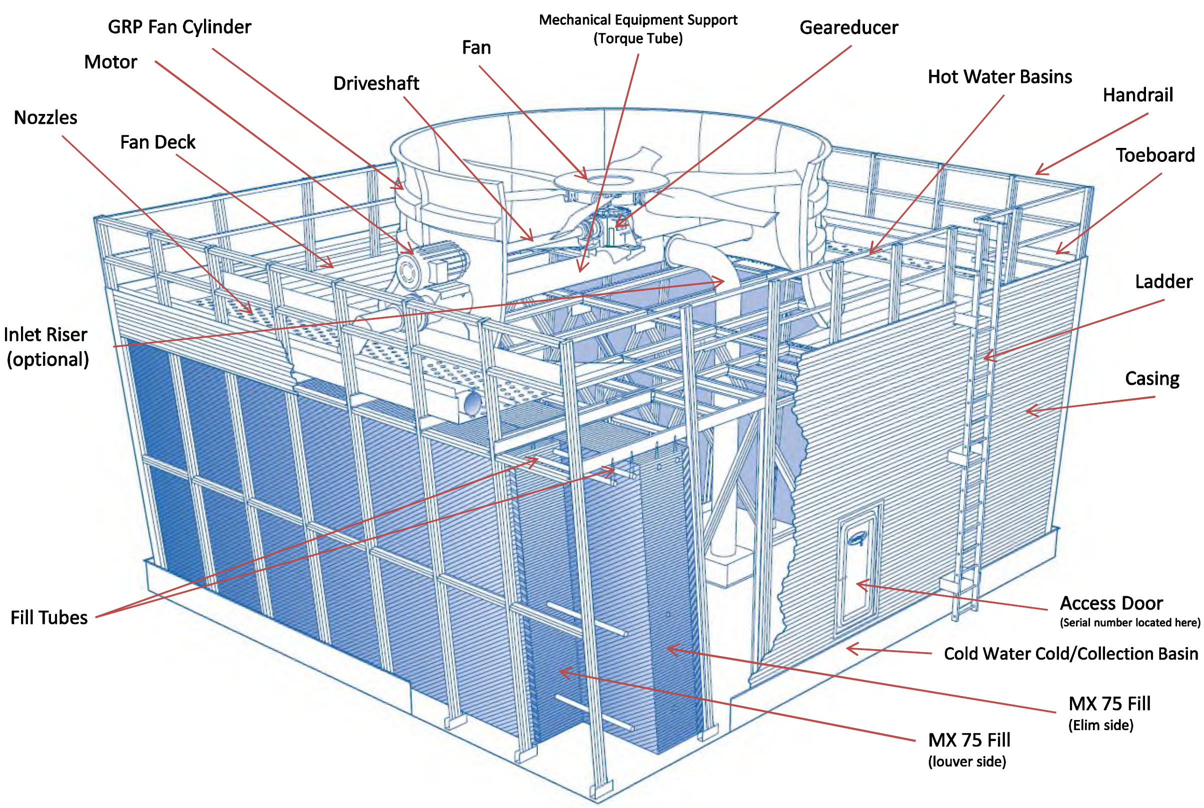
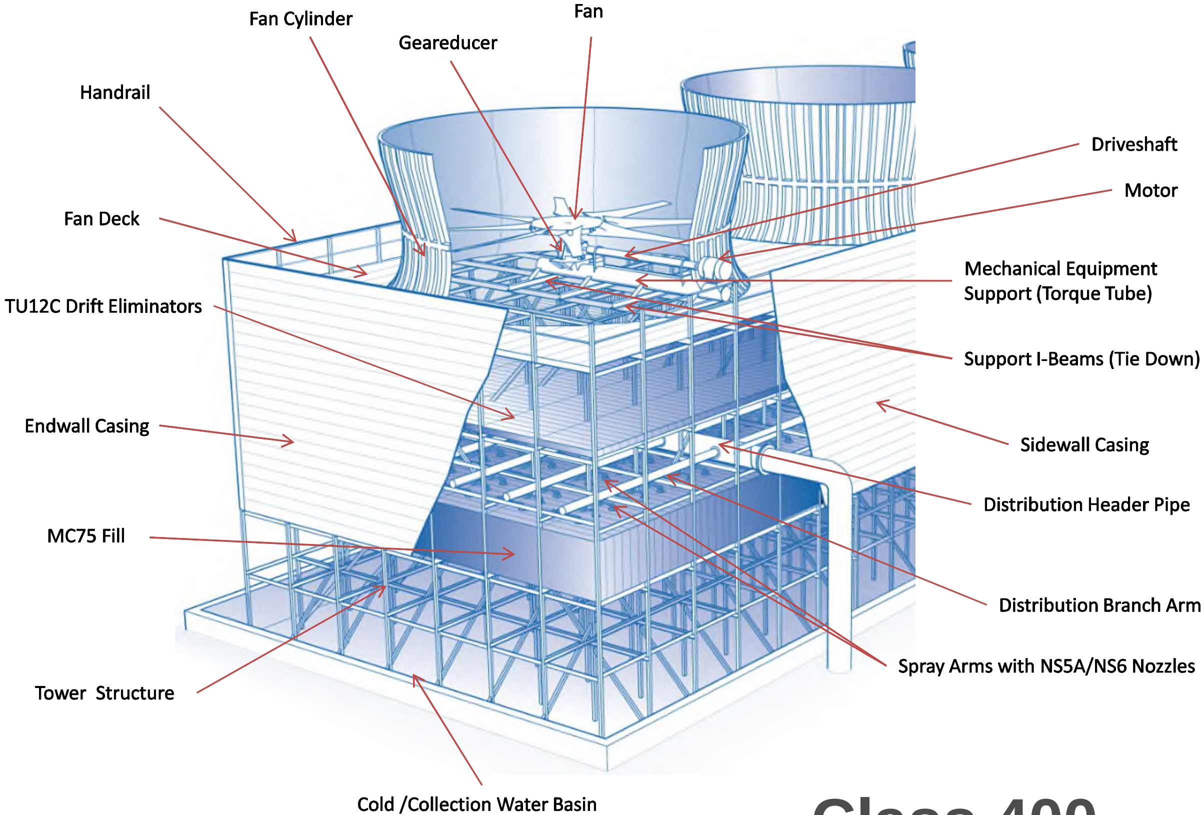
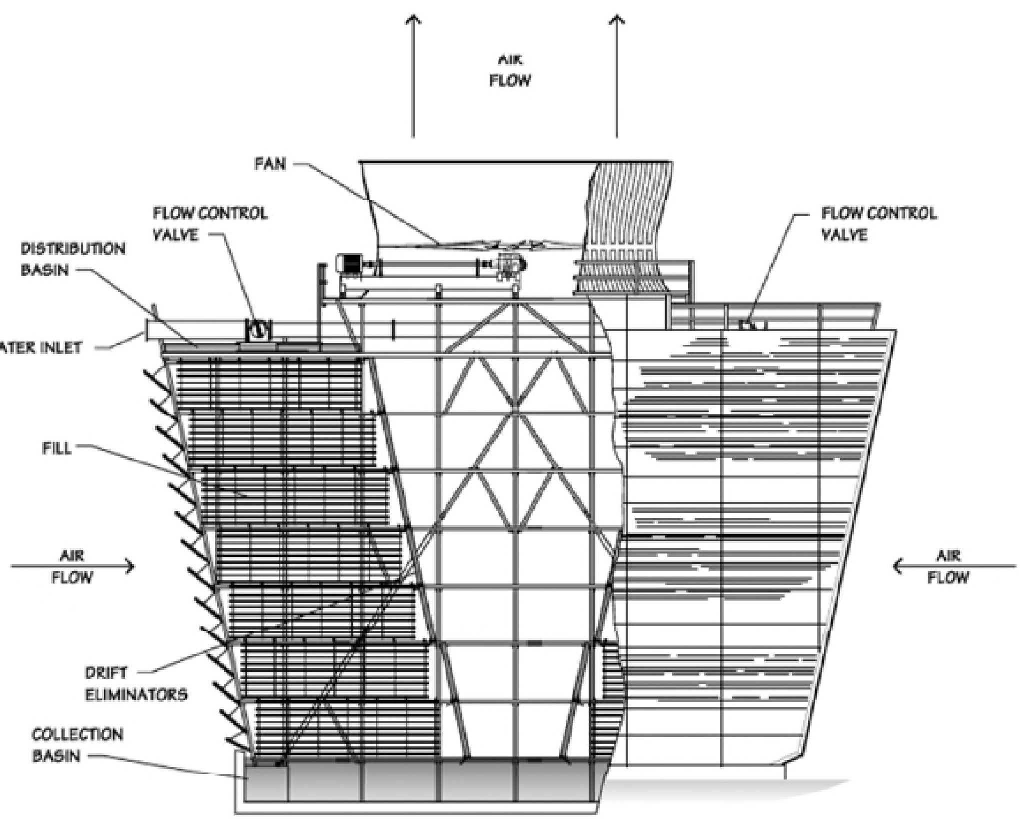

GRP Fan Cylinder
Motor
Fan
Mechanical Equipment Support (Torque Tube)
Geareducer
Driveshaft
Hot Water Basins
Handrail
Nozzles
Fan Deck
Toeboard
Ladder
Inlet Riser (optional)
Casing
Fill Tubes
Access Door (Serial number located here)
Cold Water Cold/Collection Basin
MX 75 Fill (Elim side)
MX 75 Fill (louver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

FSigma



Class 400



Class 600

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MARLEY®

user manual

cooling tower **Downtime Instructions**

Z0238848_B ISSUED 06/2016

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

instructions for downtime

Mechanical Draft Cooling Towers

Preface

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

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

⚠ Warning

Never start motor on fan drive without first making sure that there will be no interference with free rotation of the fan, 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 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 Service Manual for instructions on changing oil. Allow freedom for fan to windmill.
2. Each month, drain any water condensate from the lowest point of the Geareducer and its oil system. Check the oil level and add oil if necessary. Operate the Geareducer a minimum of 20 minutes to recoat the interior surfaces with oil.
3. To return to operation, drain off any condensate, check oil level and add oil as necessary to establish required oil level. Change oil at normal recommended interval, accounting for downtime as operating time.

Bearing Housing, Oil Lubricated Type

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

Electric Motors

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

Note

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

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

3. Enclose motors or cover 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.

Drive Train Backstop

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

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.

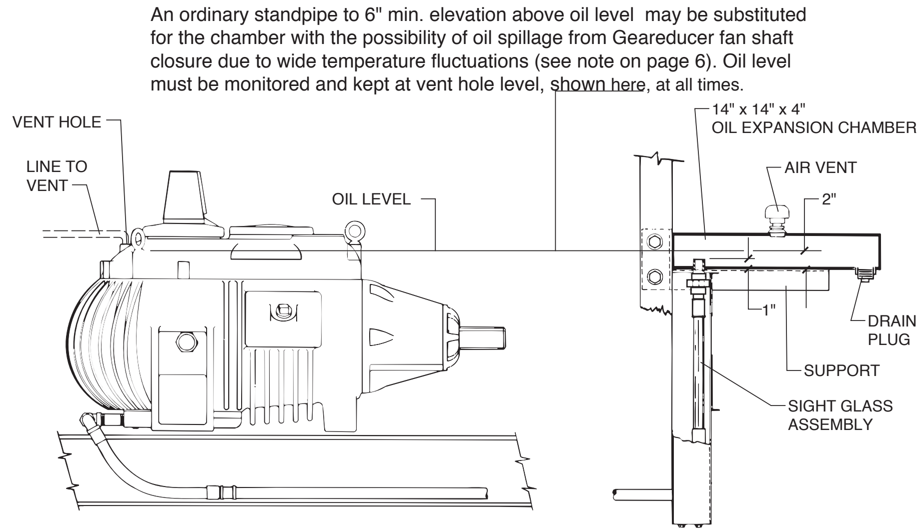

Figure 1

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.

Electric Motors

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

Note

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

Drive Train Backstop

Fill to top with oil recommended in the Drive Train Backstop Service Manual.

Drain and refill to top each two-year period. To start up, drain oil to operating level.

General

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

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

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

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

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

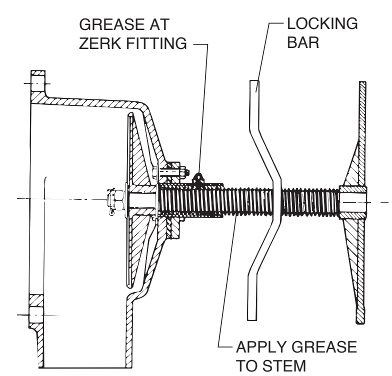

Figure 2

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

Note

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

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Plant Tour

Notes / Take Away Points:

<u>**Plant Tour Quiz** - (circle the correct answer)</u>

1. SPX is this only company that has a 5' thermoformer in the industry.

   True or False

2. Marley towers only use "Bolts" in Galvanized cold water basins.

   True or False

3. Geareducer run in machine simulates actual tower operations with motor and fan torque.

   True or False

4. Is S301L stainless steel higher strength material than 304?

   Yes or No

5. With Integral Louvers ice is more likely to form on the outside of the tower because the water is not immediately exposed to the ambient air.

   True or False

6. New Markey drift eliminator achieves the lowest available drift from a crossflow cooling tower compared to other leading manufacturers.

   True or False

7. What is the warranty for Marley Geardrive on NC towers?

   3 years or 5 years.

8. SPX Marley designed the X7 Fan using U-bolts that will not come loose or depitch over time.

   True or False

9. Marley is the second company to have an independent consultant validating our published sound values.

   True or False

10. Does each crate include a packing list?

    Yes or No

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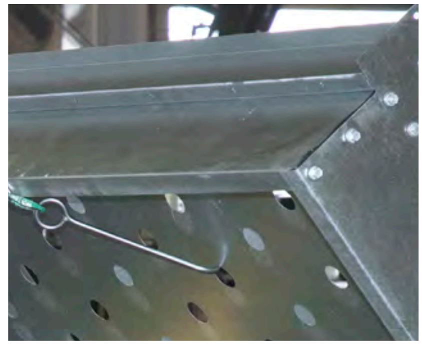
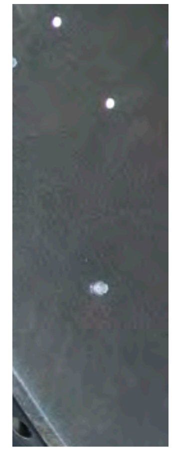
12
JLG










PVC
7
HOT

THERN

54308-A1


AS A LEADING COOLING TOWER MANUFACTURER, SPX DESIGNS AND PRODUCES ALL CRITICAL COOLING TOWER COMPONENTS. THE OLATHE FACTORY IS THE HUB OF PERFORMANCE, EFFICIENCY AND QUALITY.


20MVL
15MVL


Miller

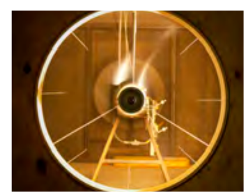
Development Center Tour

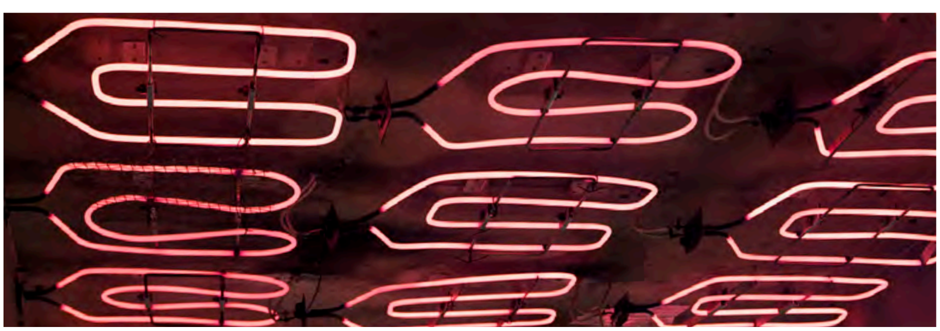
From its inception, The Marley Company, now SPX Cooling Technologies, Inc., has been committed to a strong research and development program that has, over the years, produced industry-leading technologies and innovations. The Research and Development Center, located in Kansas City has been the global technology hub for SPX product brands since its foundation in 1957.

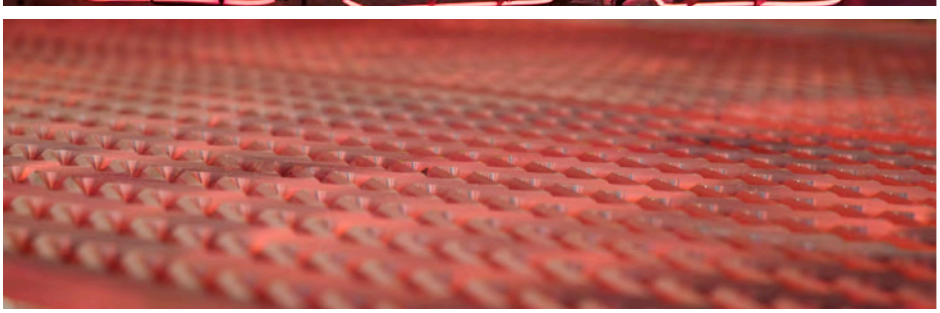
The Research and Development Center, constructed on the site of a former limestone mine, provides an ideal year-round scientific environment. Inside the Research and Development Center's three underground acres, 70 feet below the surface, experiments are performed under controlled laboratory conditions. Above ground, seven acres provide ample space to conduct prototype testing under ambient conditions.

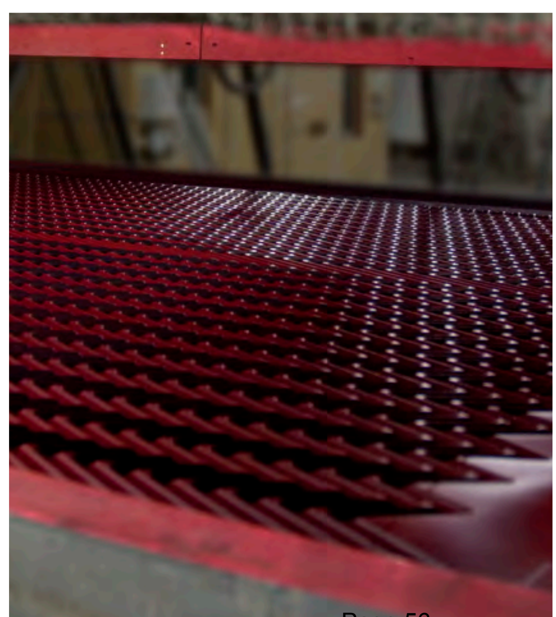
Notes / Take away Points:

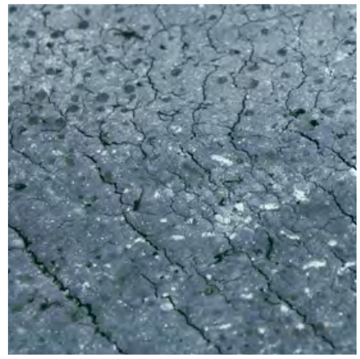

CAUTION

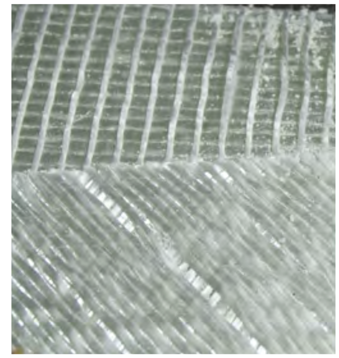










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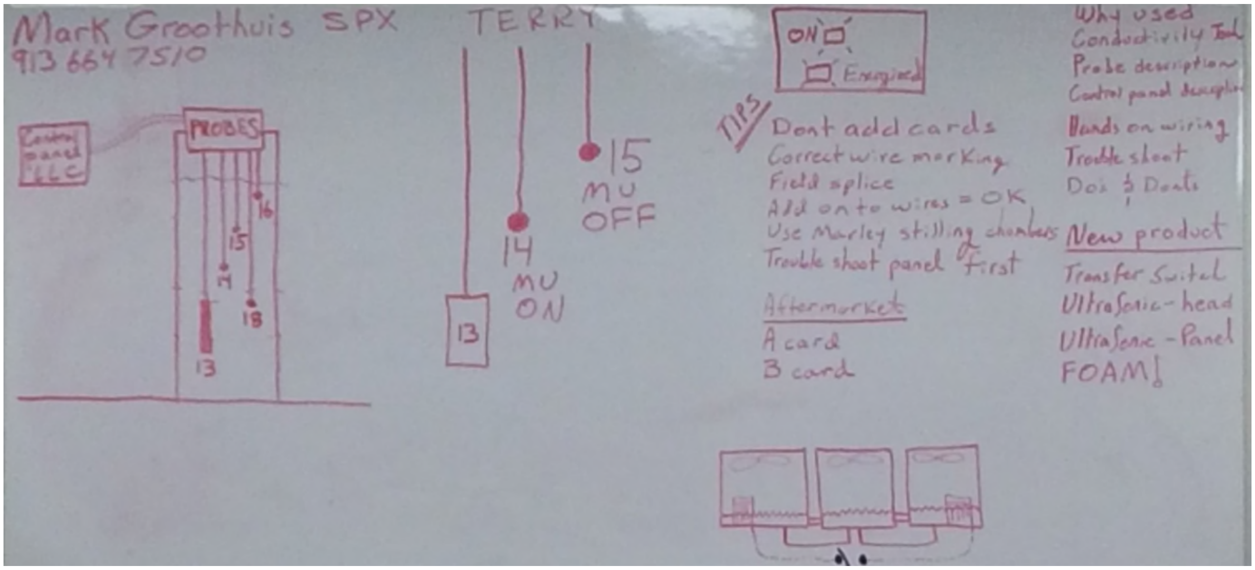
Water Monitoring Systems (Marley Liquid Level Controls LLC)

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:

MARLEY®

user manual

LLC water level control

INSTALLATION - OPERATION - MAINTENANCE

Z0628617_B ISSUED 07/2018

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 controls. Carefully read the manual before installation or operation and follow all instructions. Save this manual for future reference.

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.

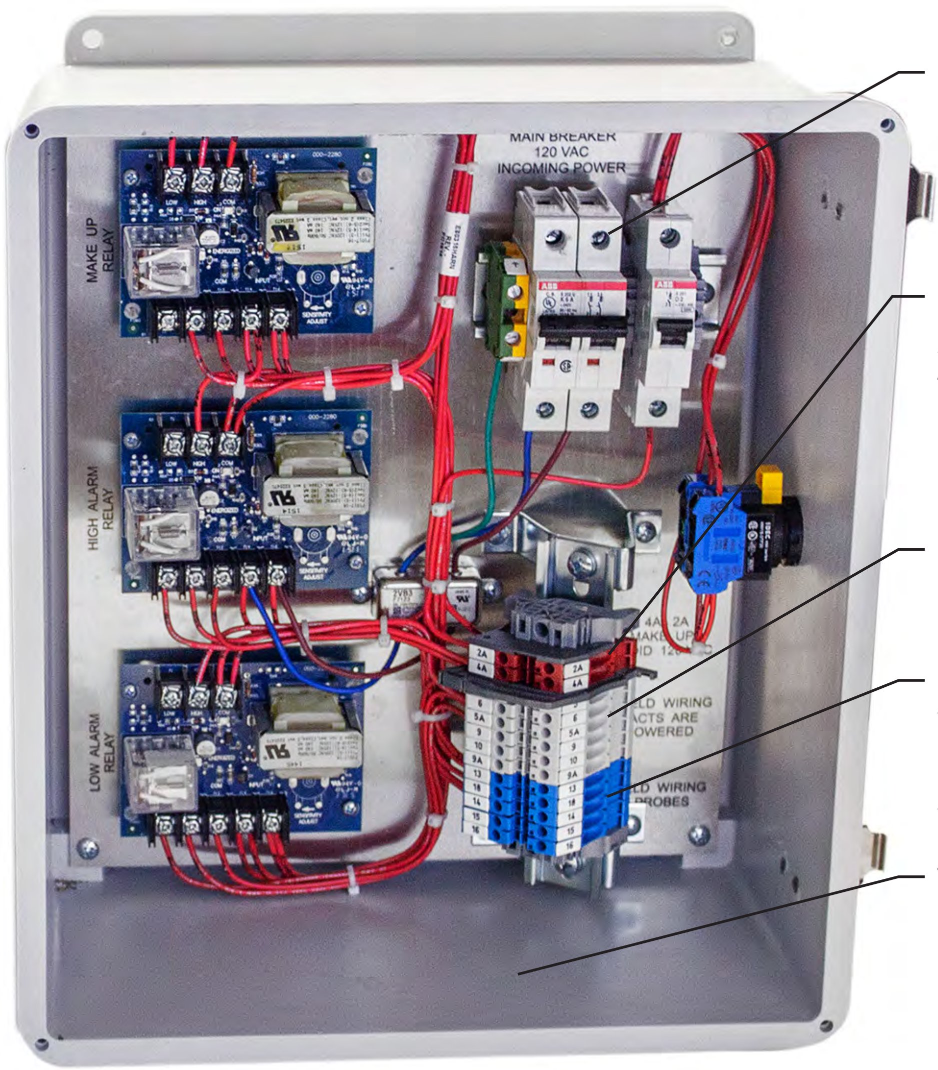
⚠ Warning

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.

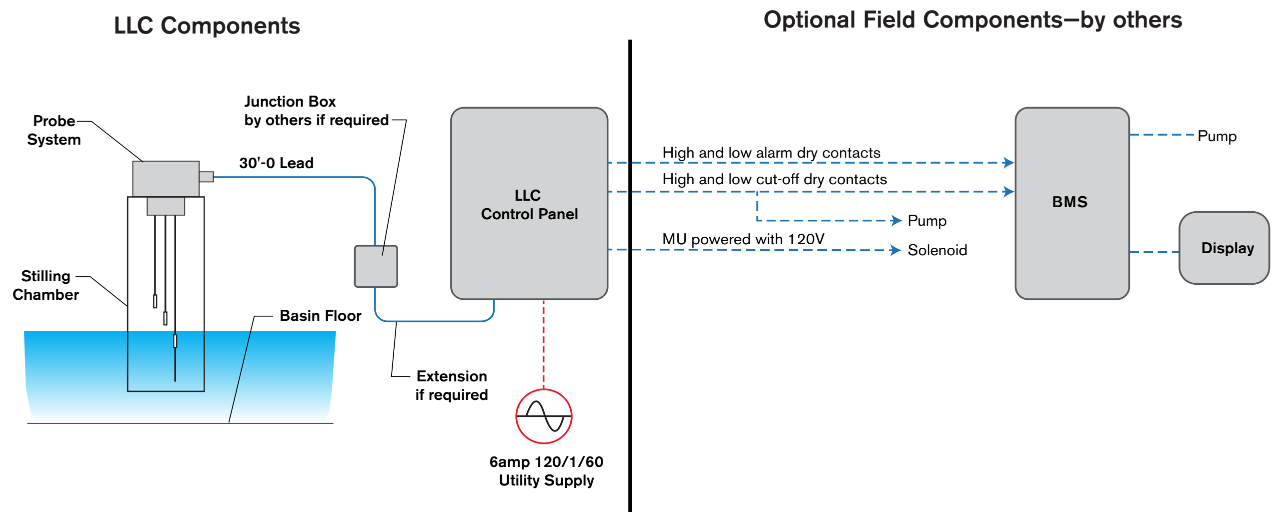
To avoid water getting into the control panel, all conduit entries should be into the bottom of the enclosure.

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.

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.

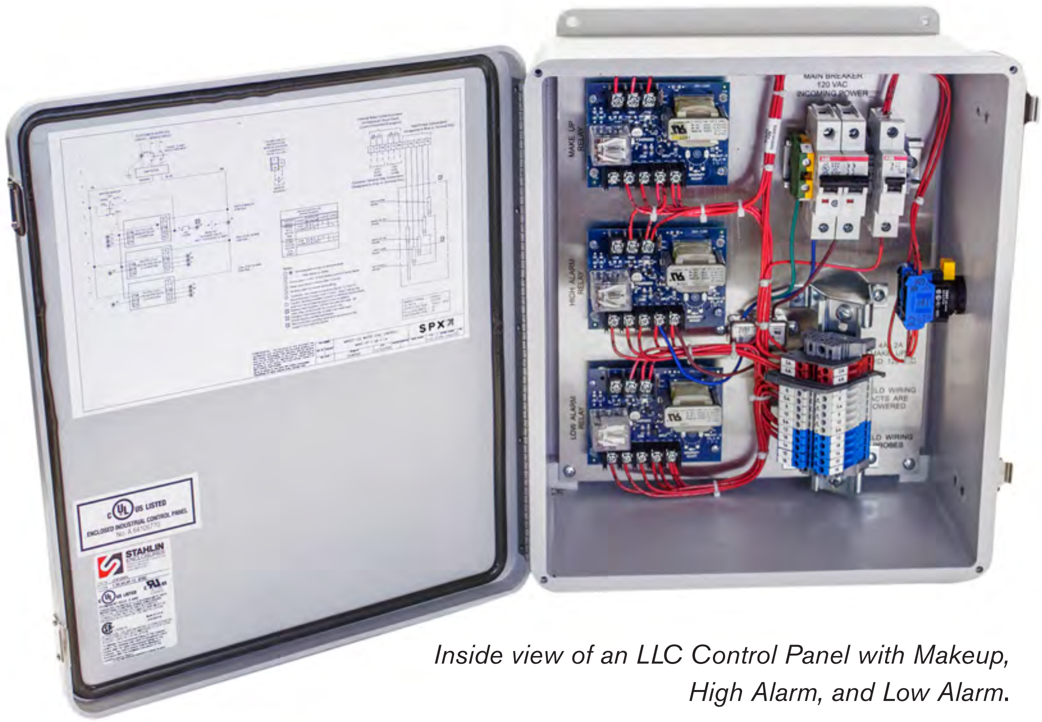
Water Makeup Function

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.

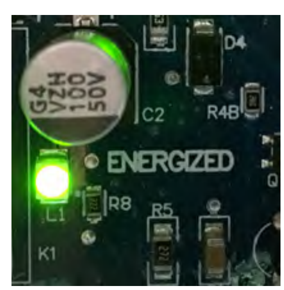
Illustrations Describing Operation Sequence

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

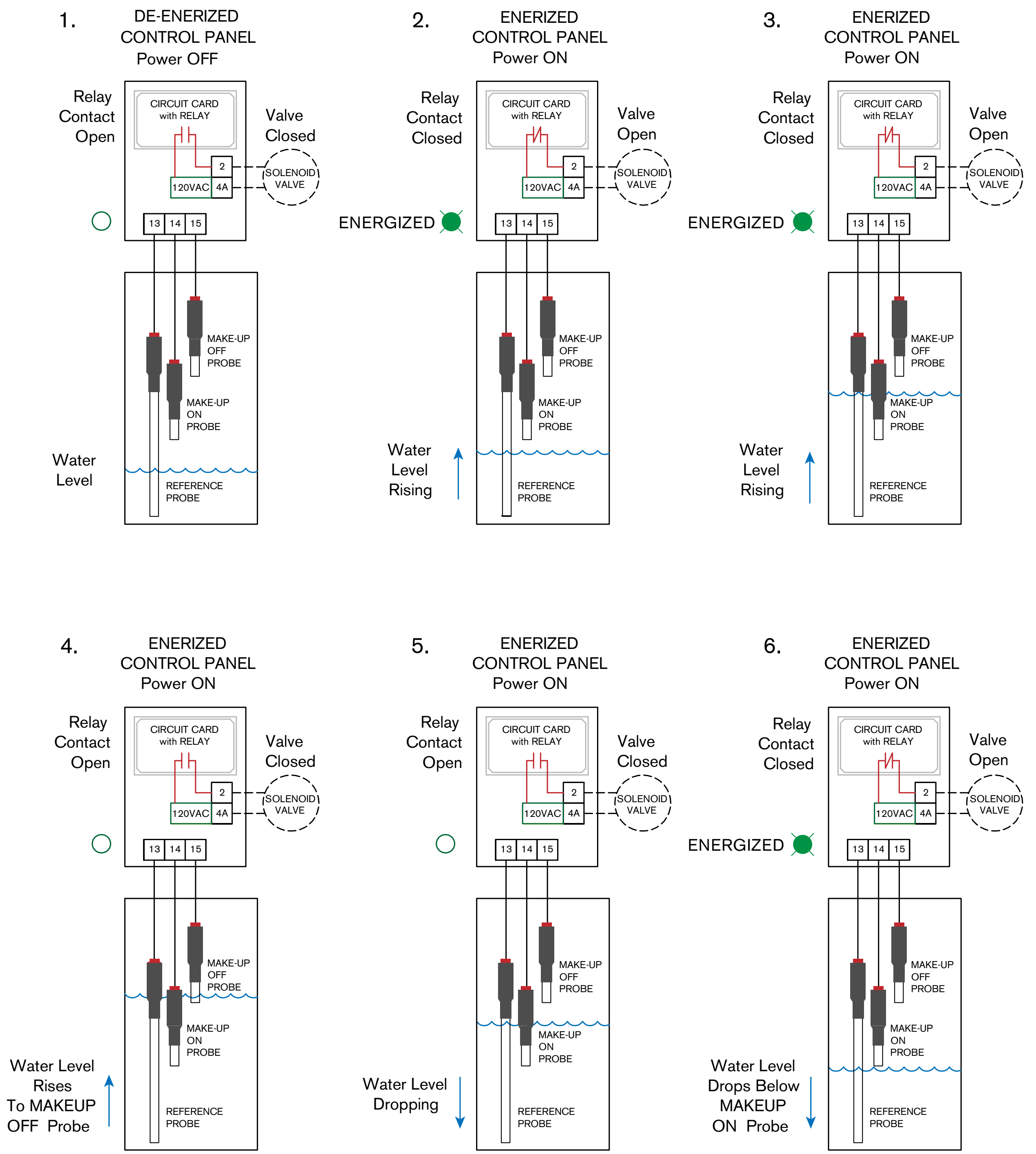
Page 12 – Low Alarm – Low Cutoff



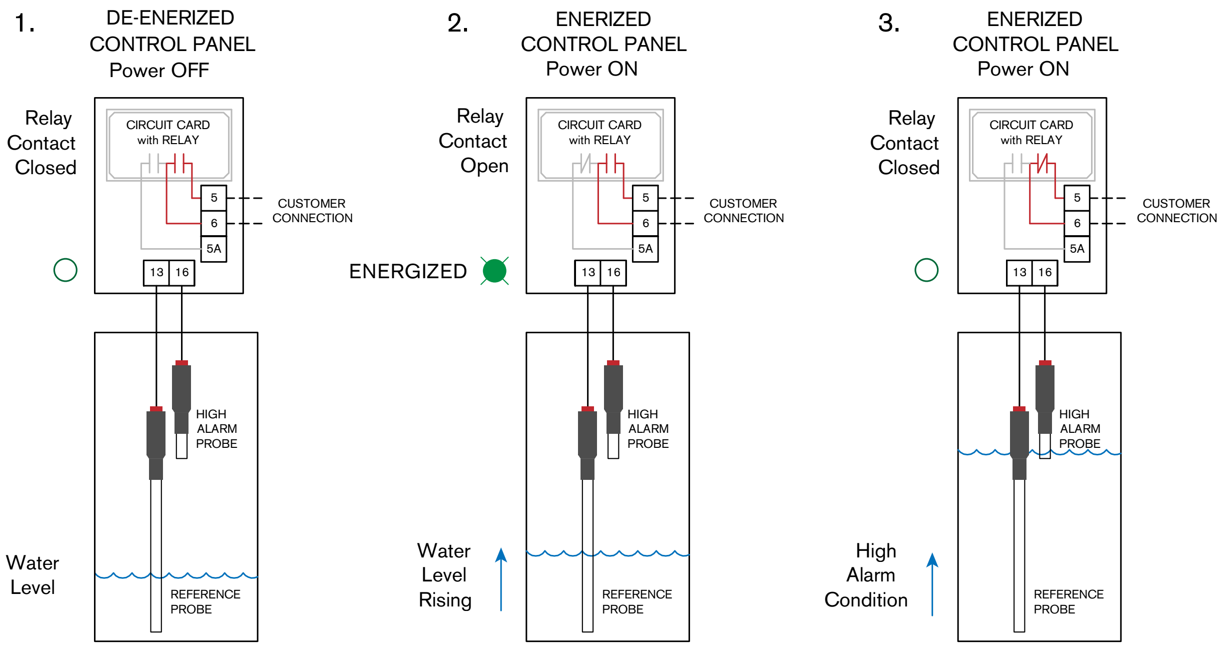
Each relay circuit card has two green indicator lights. The ON light indicates the card is powered and ready to function. The ENERGIZED light indiates when the probe system is functioning and should be used when troubleshooting.

Water Makeup Control – Sequence of Operation – B Card

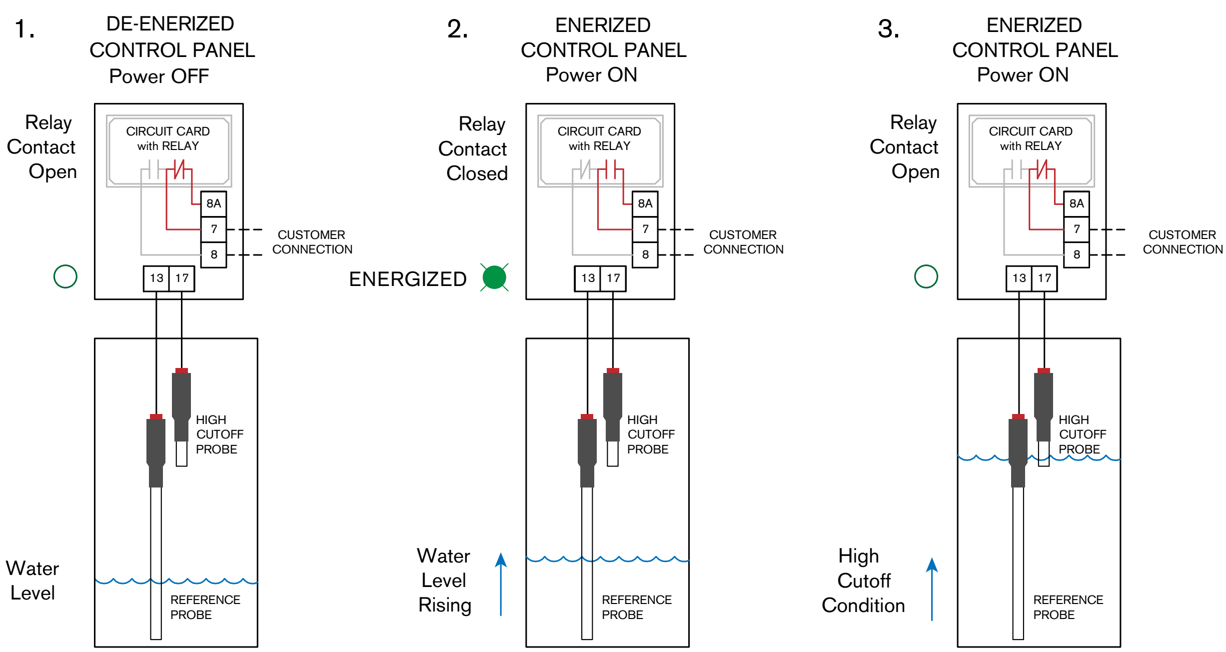
Selector Switch in AUTO Position



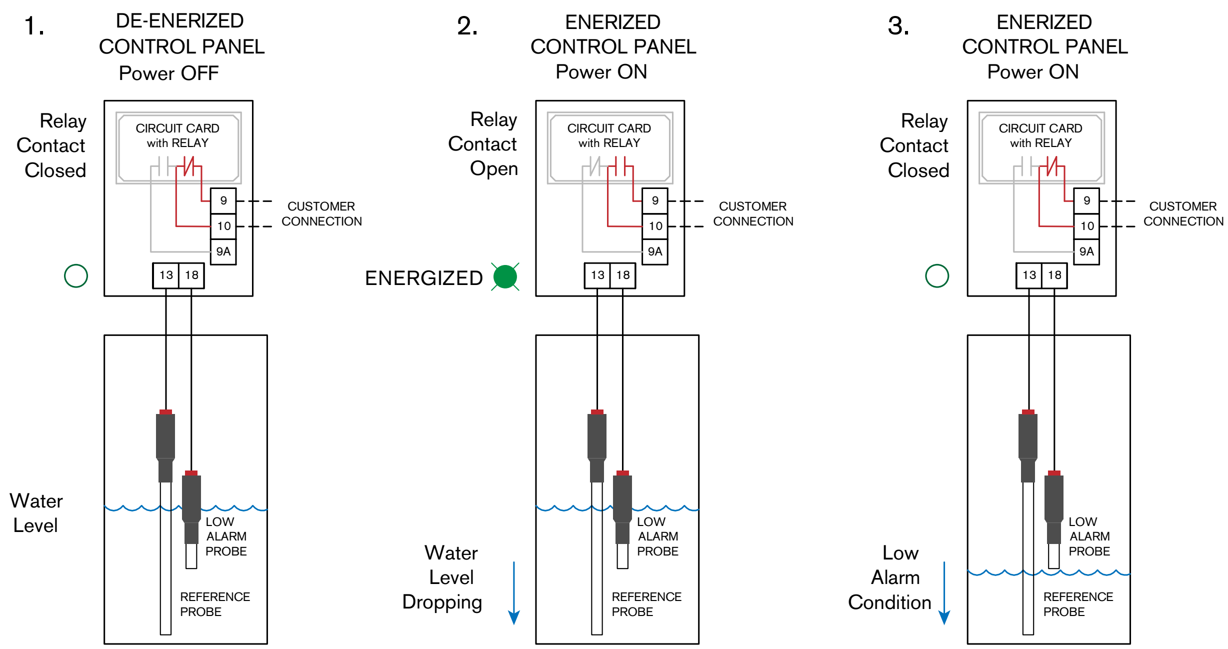
High Level Alarm – Sequence of Operation – B Card



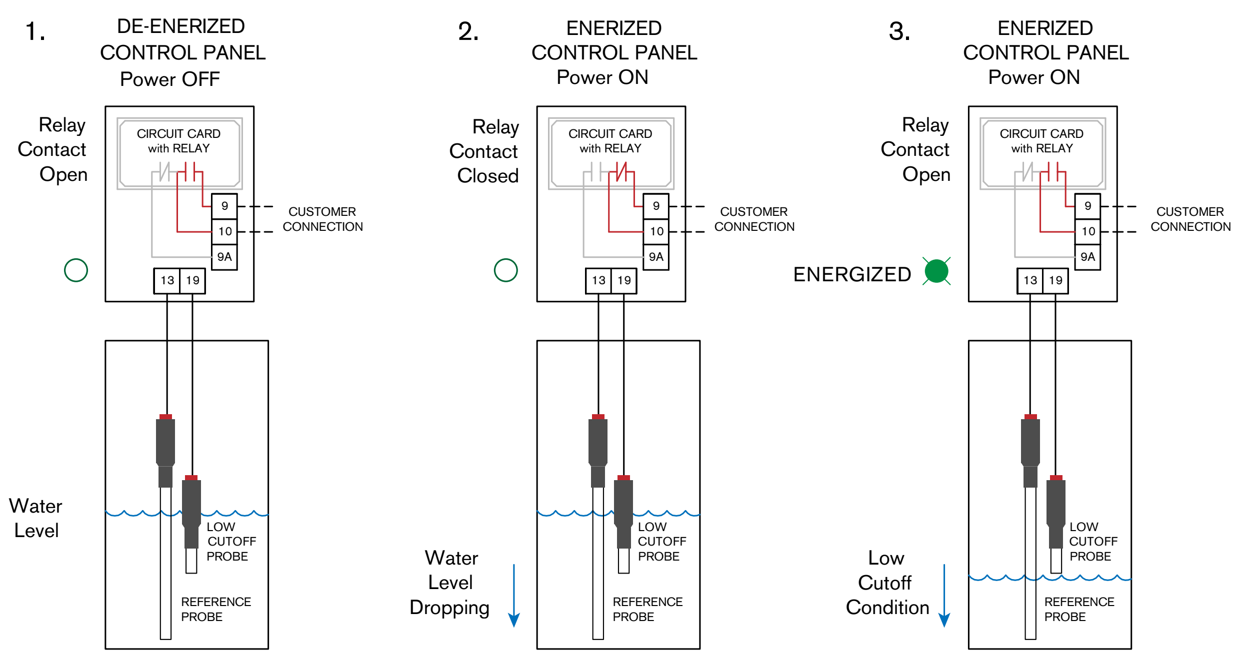
High Level Cutoff – Sequence of Operation – B Card



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:

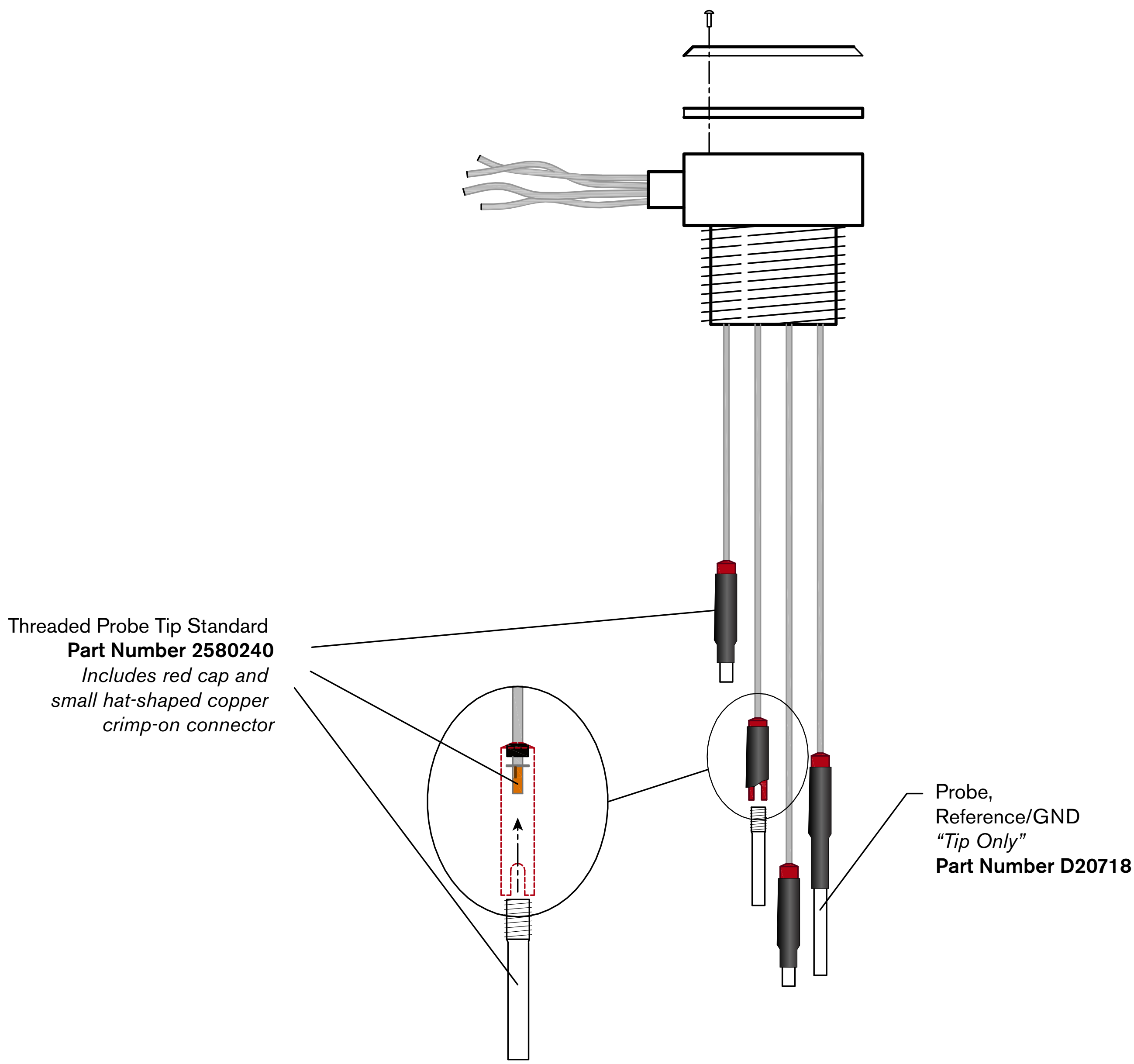
- Check probe heights in the stilling chamber. The levels may be factory set but if in question contact your Marley sales representative for level height information. Probe wire height is secured using an adjustable cord grip located inside the conduit box located on top of the stilling chamber.
- Check 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.

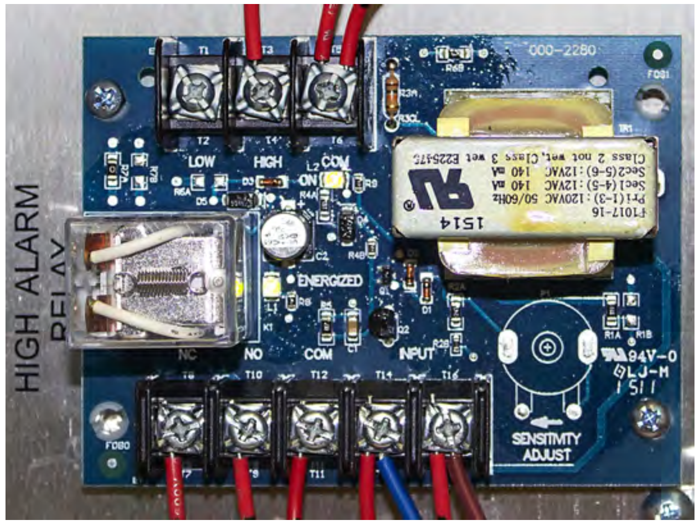
Checking control panel functionality

- 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.



Electrode Probe Assembly

Additional part numbers can be found on the next page



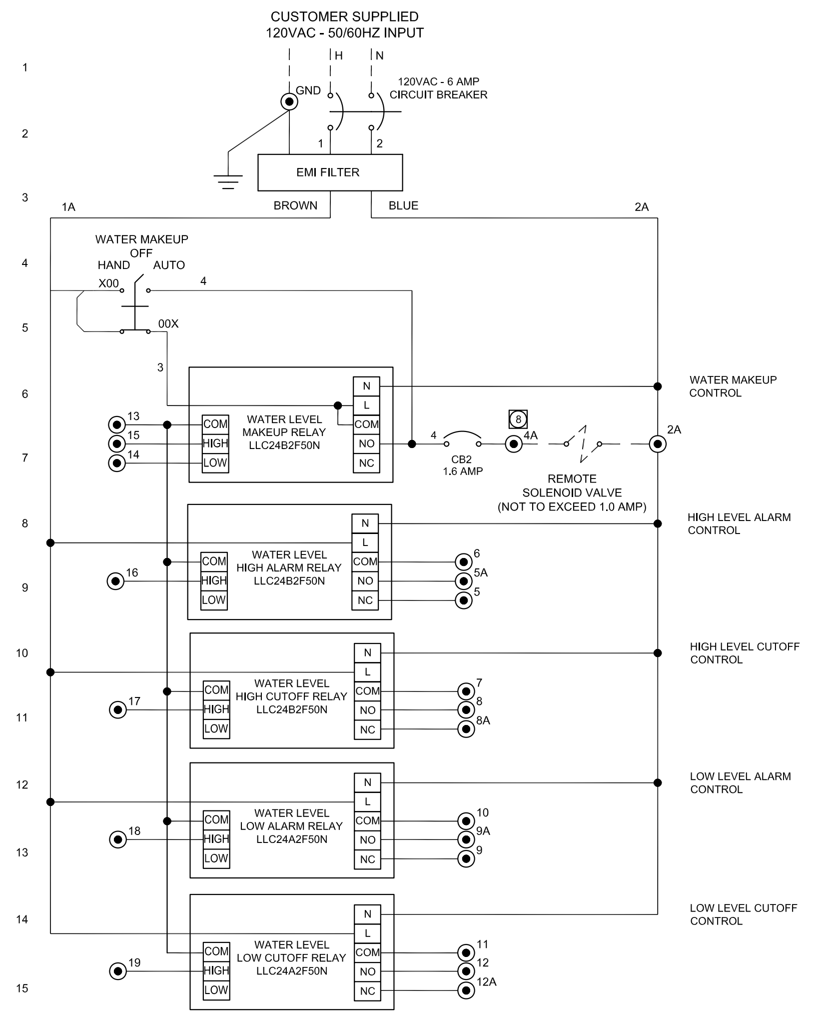
Relay Circuit Card

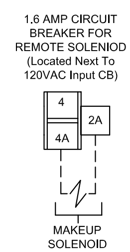
Item number **D55194 –** Used for Makeup, High Alarm and High Cutoff (LLC24B2F50N)

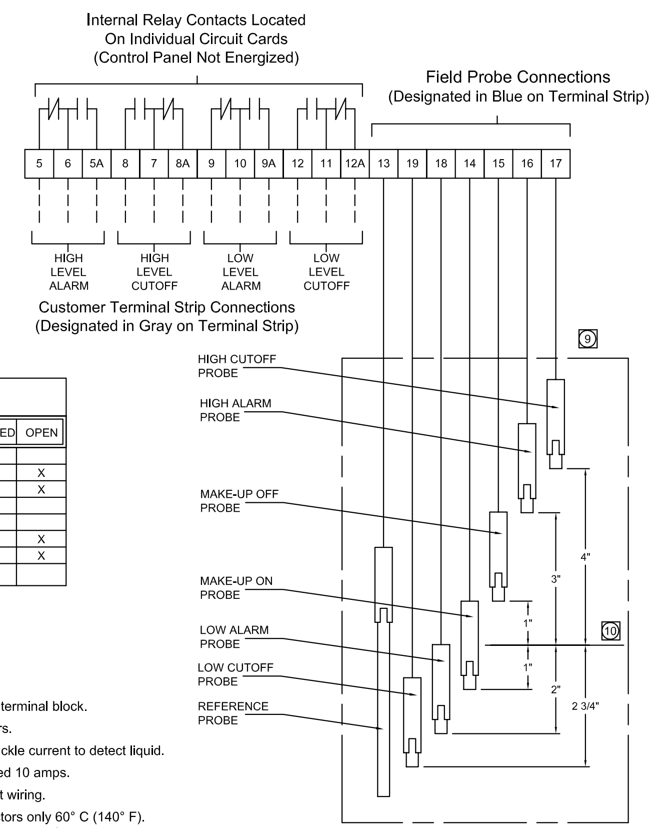
Item number **D55195 –** Used for Low Alarm and Low Cutoff (LLC24A2F50N)

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 6" Stainless Steel Tip
D20718	Reference / GND Probe Sensor 1.5" 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







OPERATION STATUS
(Panel Energized)

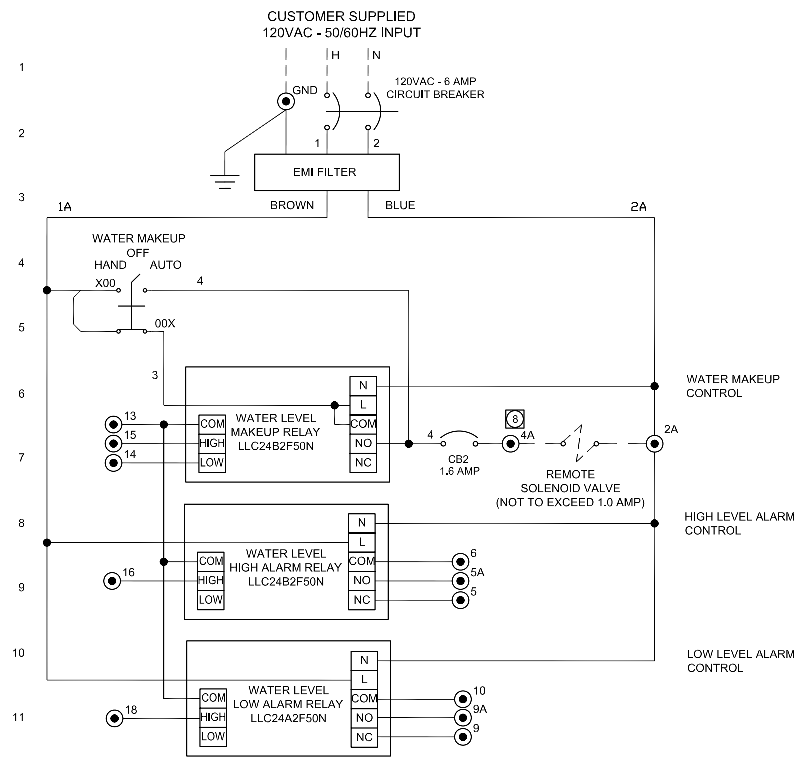
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

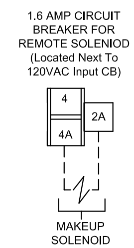
Notes:

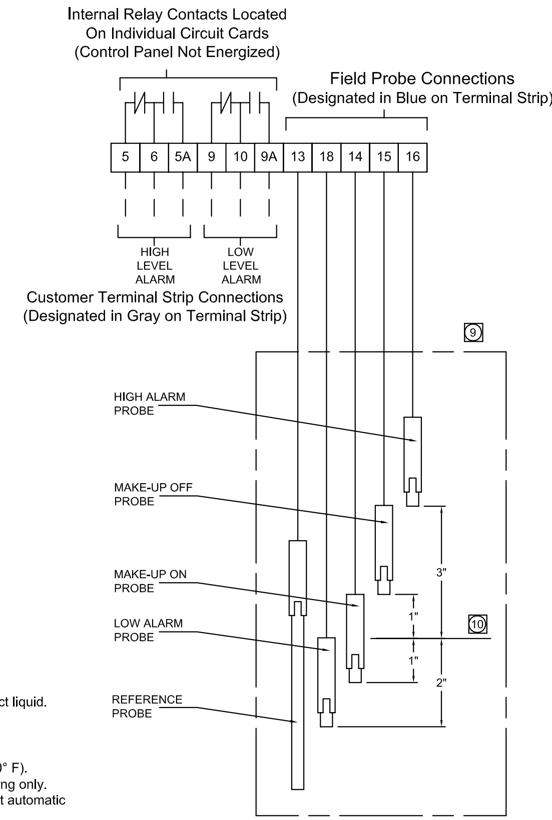
1. ◉ Terminal point number on terminal block.
2. — — Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 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 #: E80330
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

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

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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + HA + LA				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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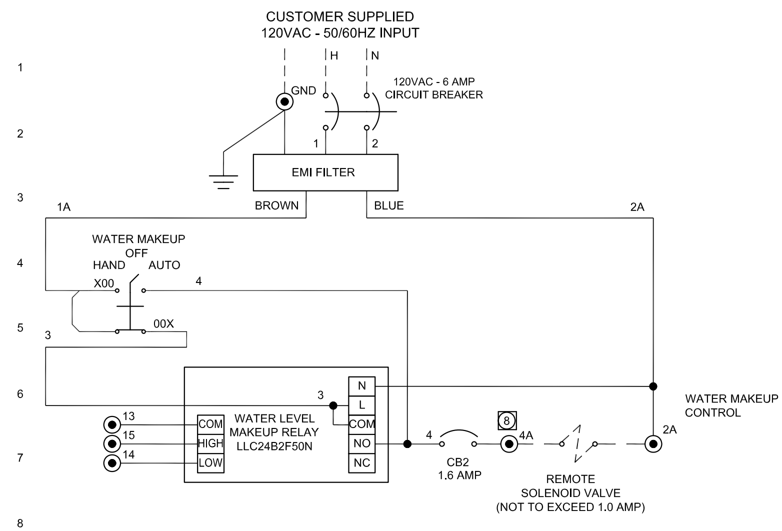
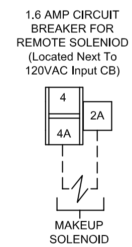
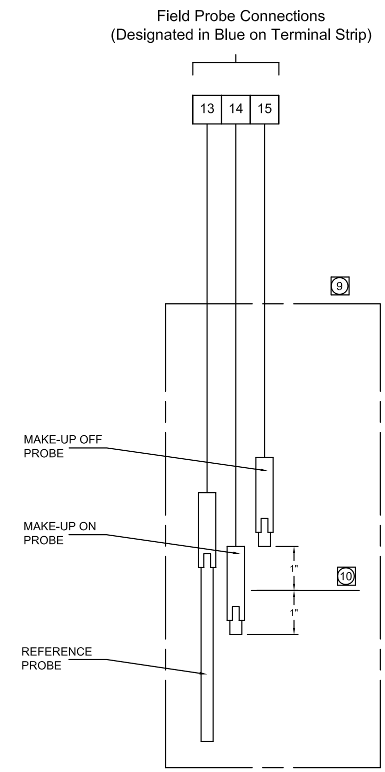






Notes:

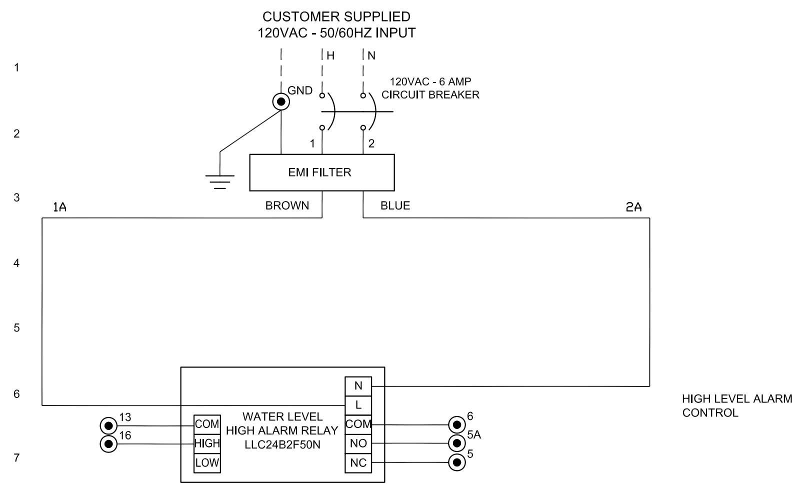
1. Terminal point number on terminal block.
2. Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 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

MARLEY LLC WATER LEVEL CONTROLS
MAKE-UP

SPX COOLING TECHNOLOGIES

ECO NUMBER	REV. BY	CHECKED	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

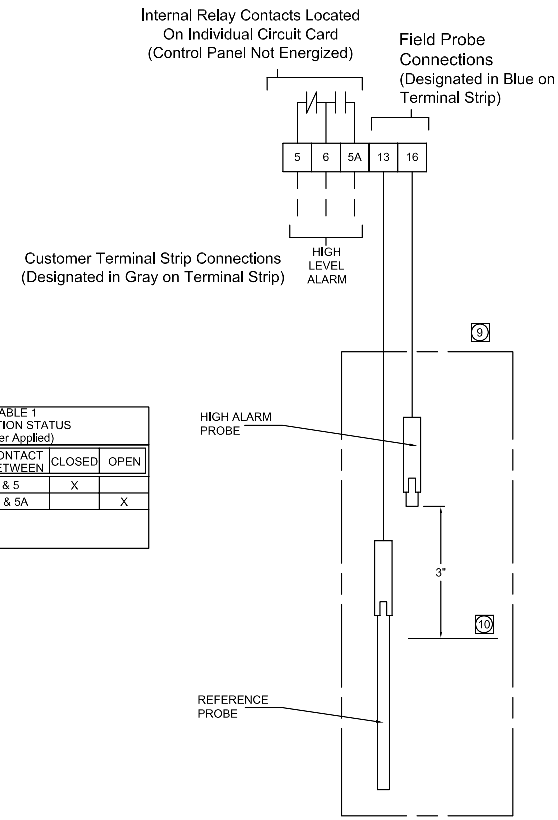


TABLE 1
OPERATION STATUS
(Power Applied)

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.

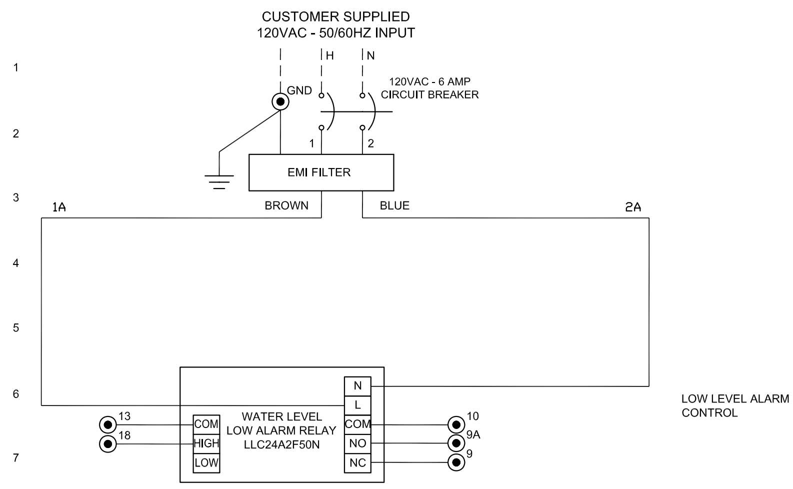
MARLEY ITEM #:	E80301
UL FILE #:	E312361
SUPPLY VOLTAGE: ..	120vAC - 60HZ
FULL LOAD AMPS:	2A
ENCLOSURE TYPE: ..	4X

ECO NUMBER | REV. BY | CHECKED | REV. DATE

MARLEY LLC WATER LEVEL CONTROLS
HIGH LEVEL ALARM

SPX COOLING TECHNOLOGIES

DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
DGWOOD	11/25/2008				1=5.2	08-24219	



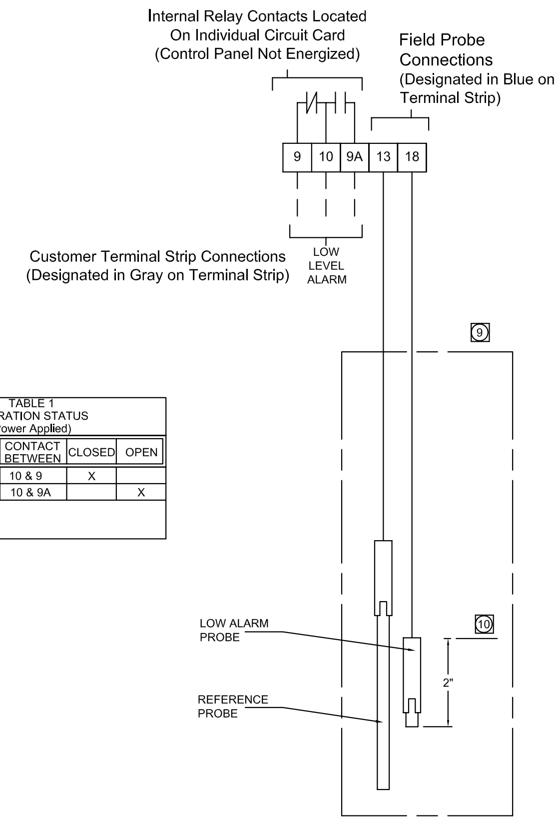


TABLE 1
OPERATION STATUS
(Power Applied)

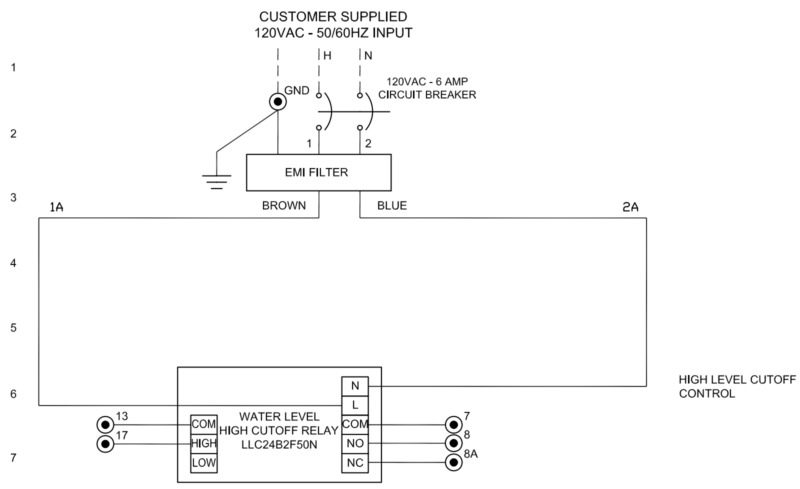
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

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

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



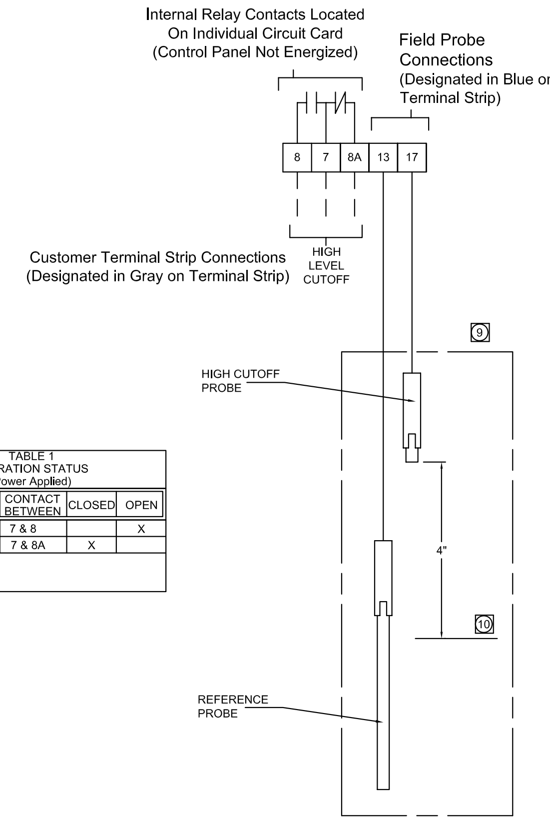


TABLE 1
OPERATION STATUS
(Power Applied)

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

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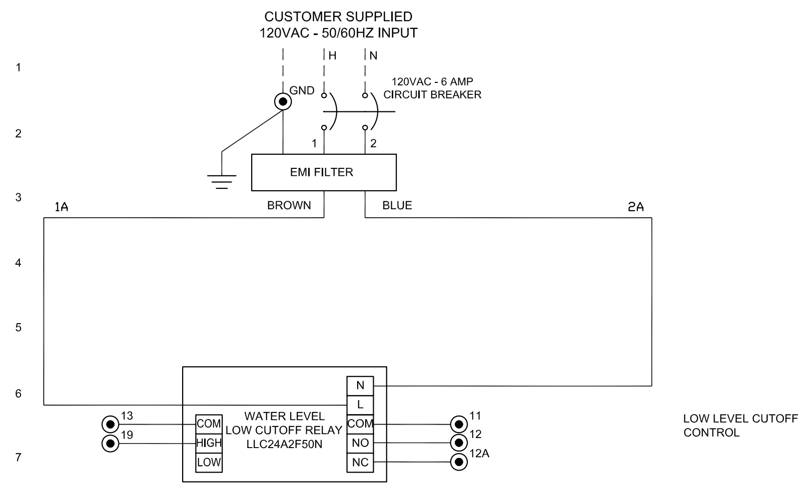
	DGWOOD	11/28/2008				1=5.2	08-24221	



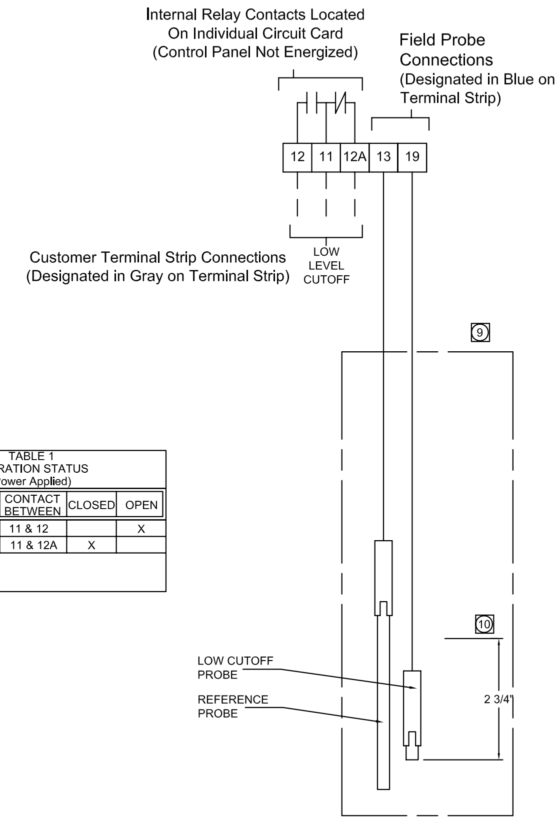


TABLE 1
OPERATION STATUS
(Power Applied)

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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS LOW LEVEL CUTOFF				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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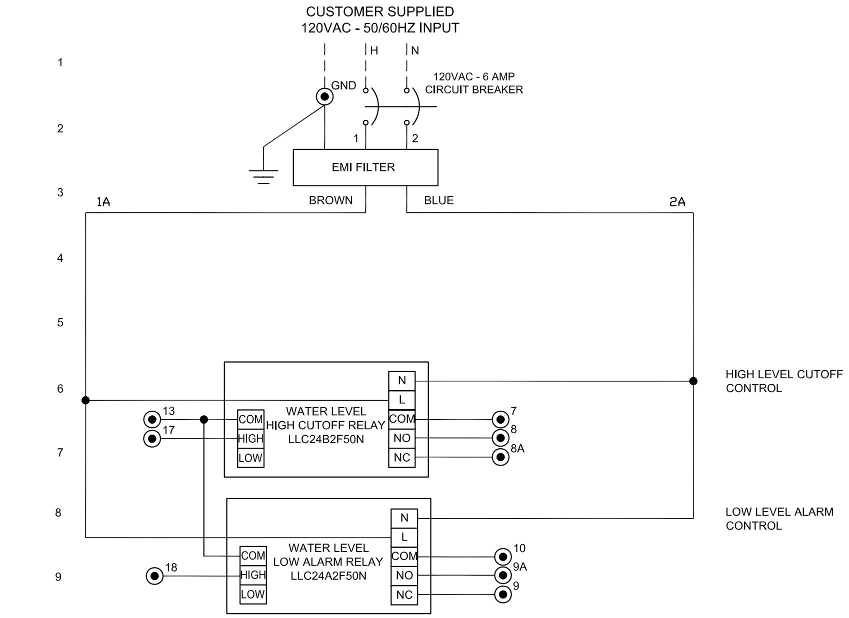


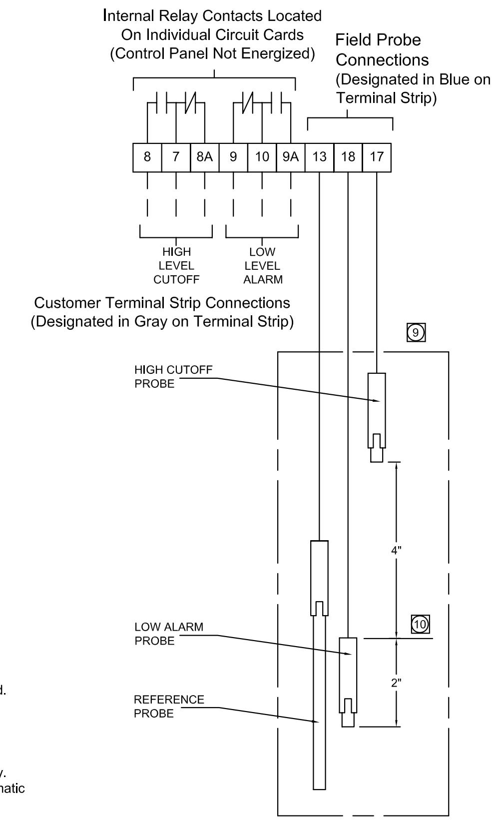


TABLE 1
OPERATION STATUS
(Power Applied)

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.

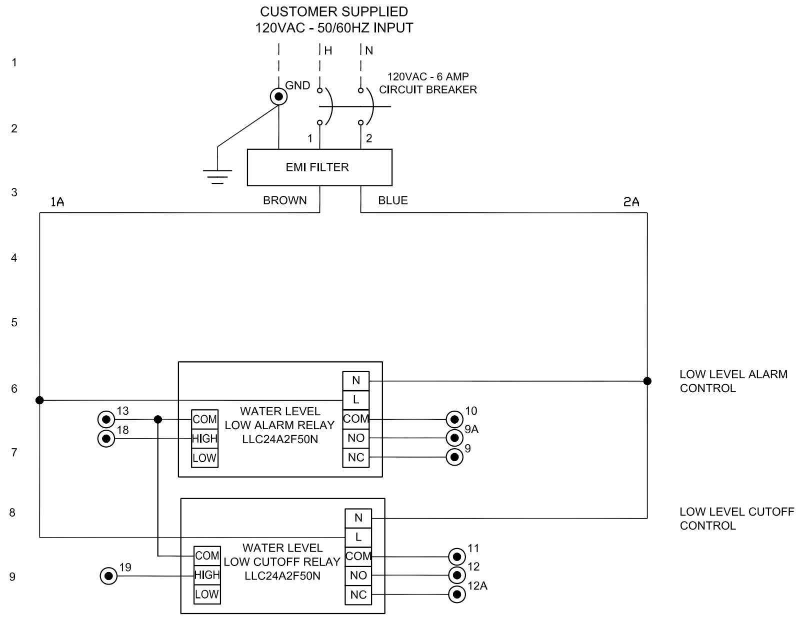
MARLEY ITEM #: E80312
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

ECO NUMBER	REV. BY	CHECKED	REV. DATE

MARLEY LLC WATER LEVEL CONTROLS
LA + HCO

SPX COOLING TECHNOLOGIES

DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
DGWOOD	11/26/2008				1=5.2	08-24230	



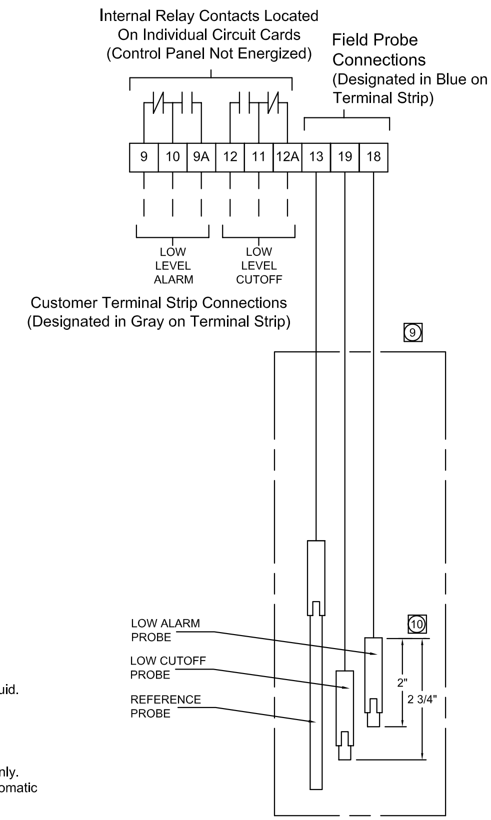


TABLE 1
OPERATION STATUS
(Power Applied)

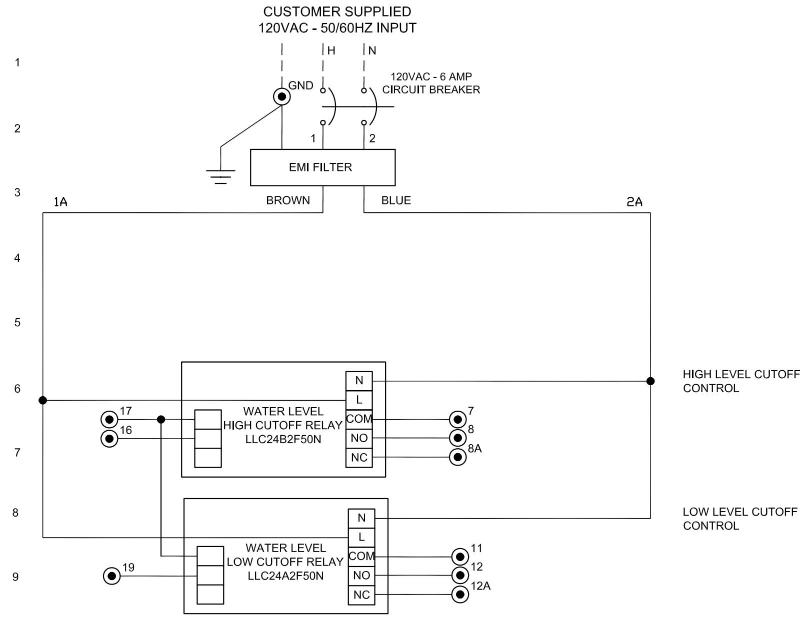
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

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

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	



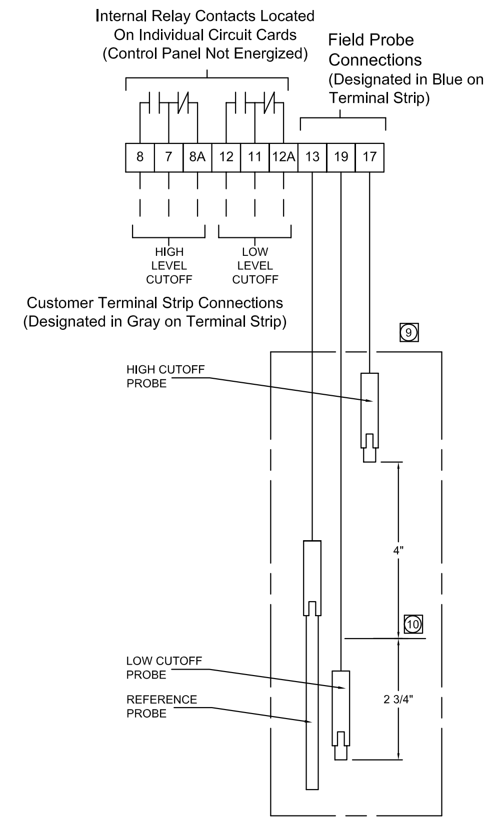


TABLE 1
OPERATION STATUS
(Power Applied)

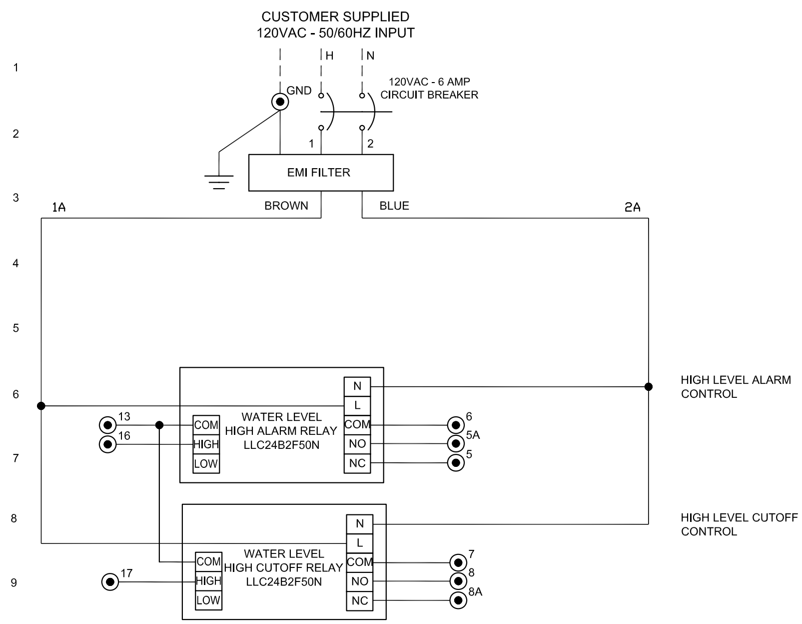
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

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

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	



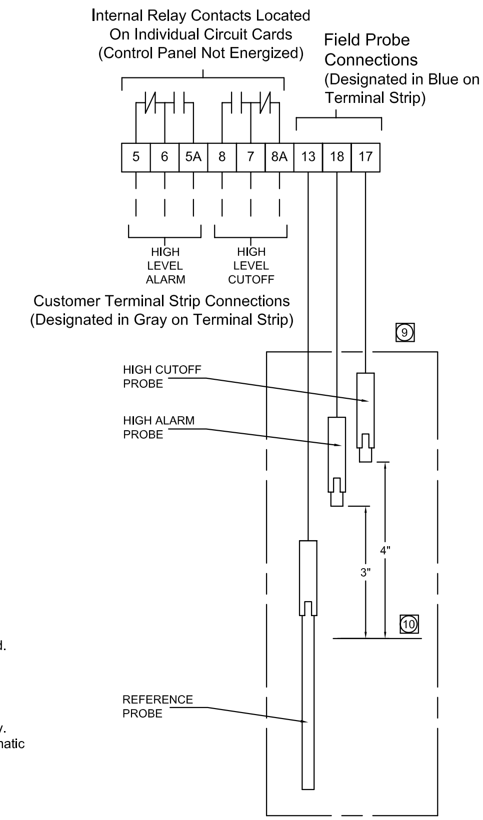


TABLE 1
OPERATION STATUS
(Power Applied)

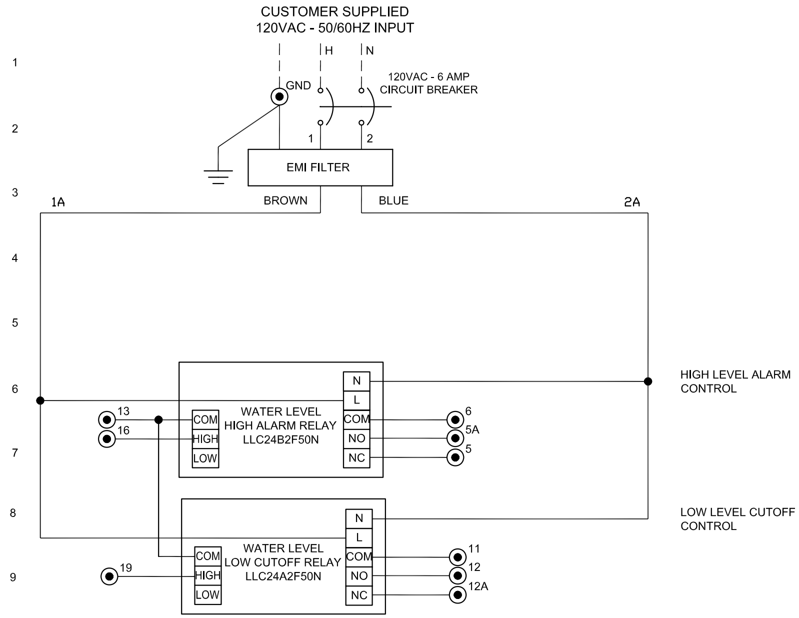
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	

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

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	



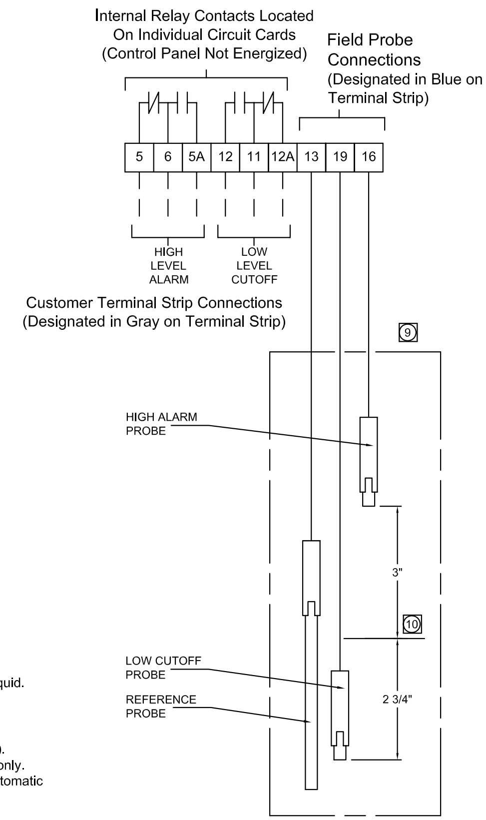


TABLE 1
OPERATION STATUS
(Power Applied)

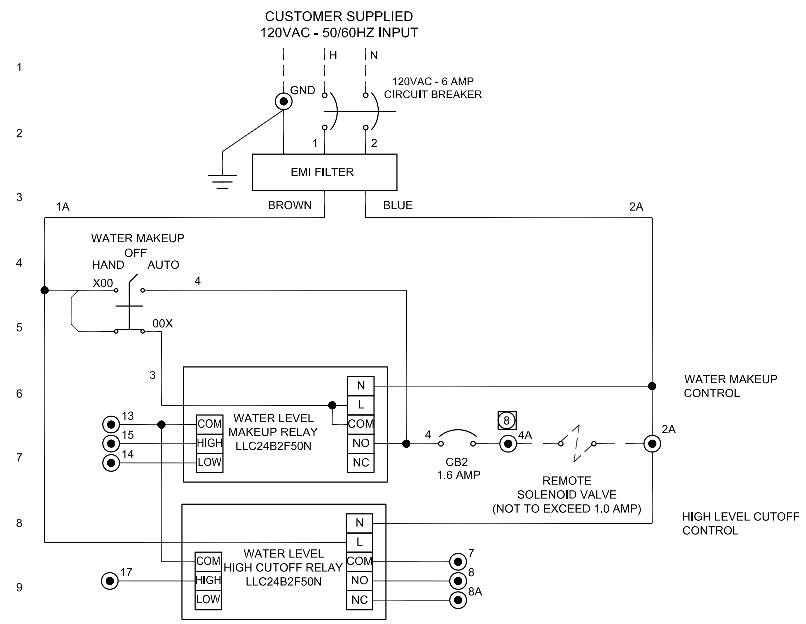
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

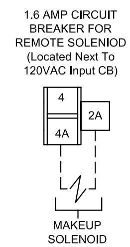
Notes:

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

ECO NUMBER		WATER LEVEL CONTROL SYSTEM HA + 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	08-24229	





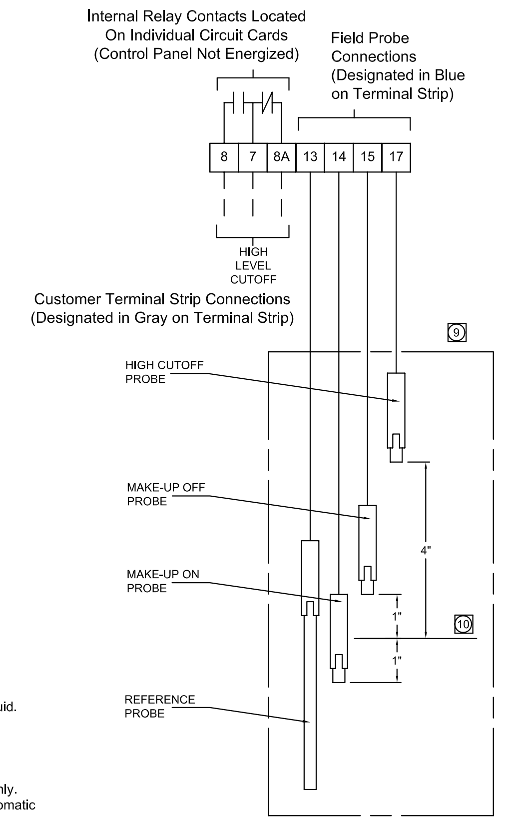


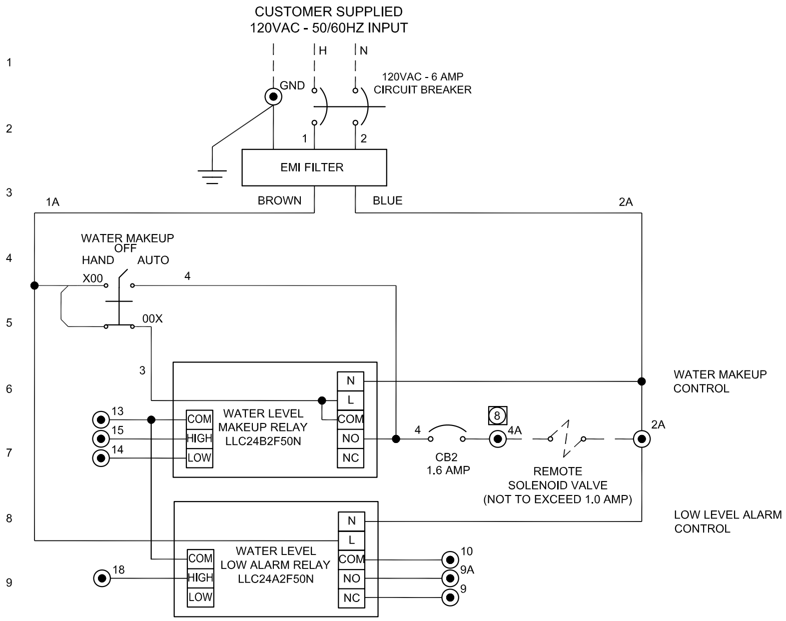
TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	

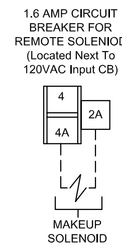
Notes:

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. 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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + 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	08-24225	





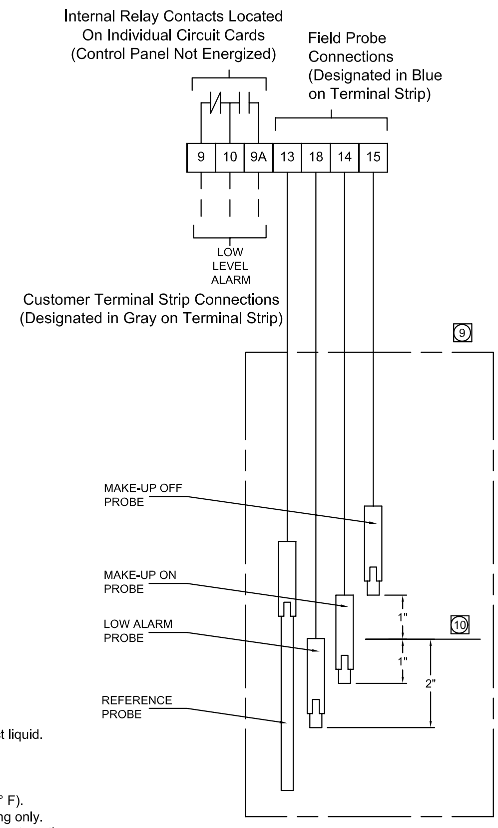


TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

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

ECO NUMBER		MARLEY LLC WATER CONTROLS MAKE-UP + LA				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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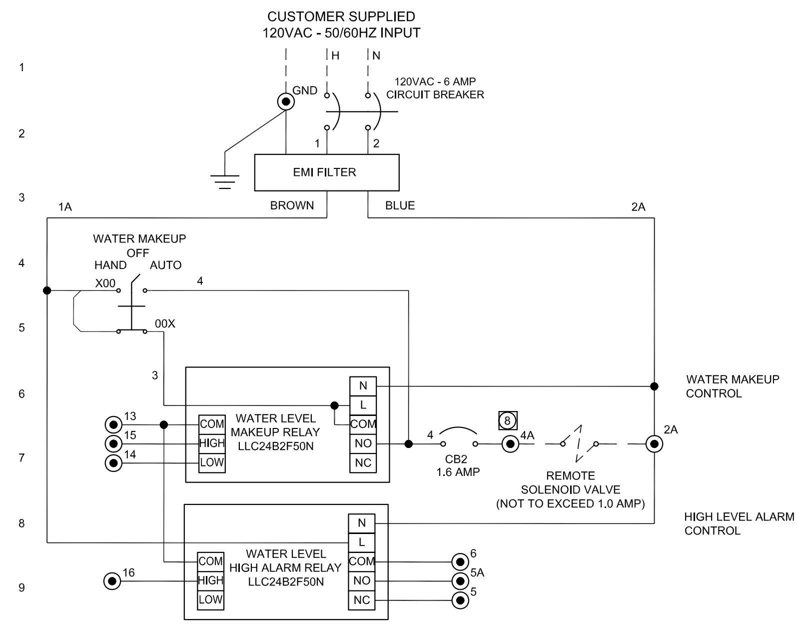

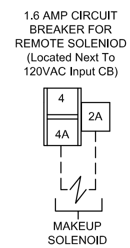

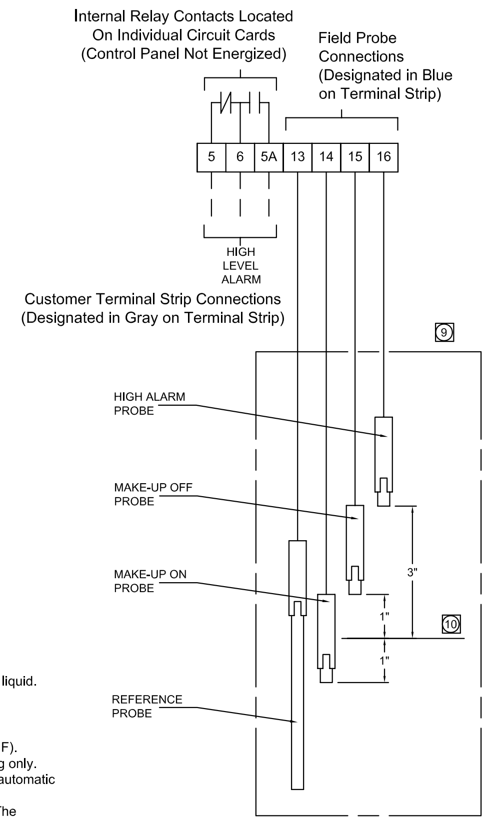

TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X

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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + HA	SPX COOLING TECHNOLOGIES
REV. BY	CHECKED		

REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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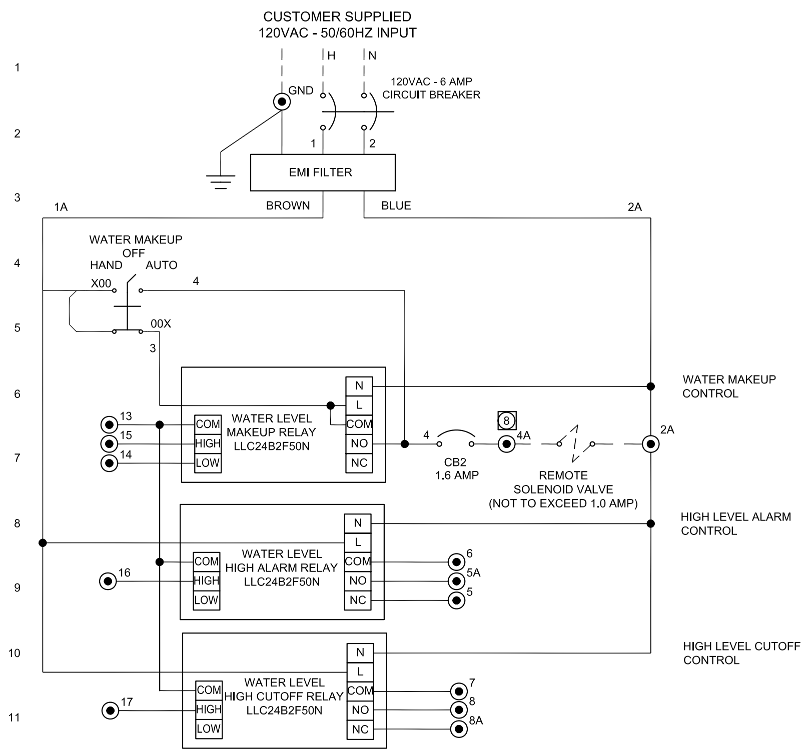


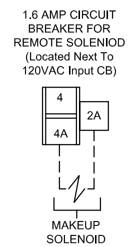
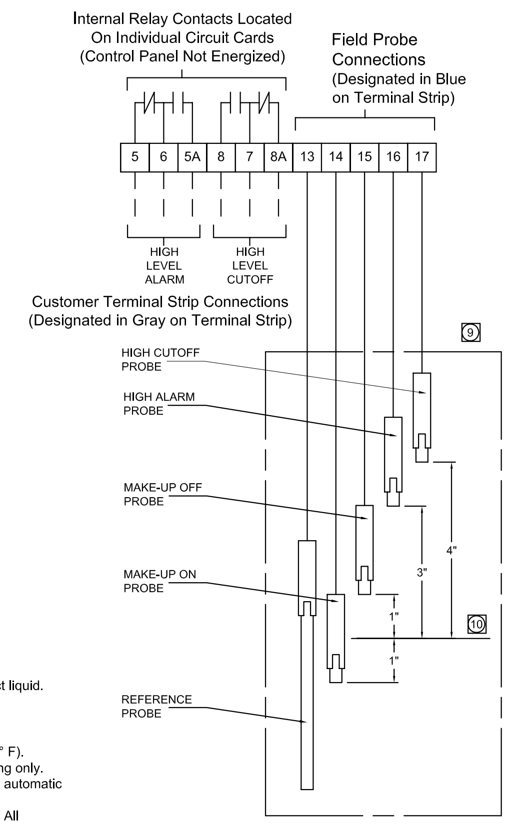


TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	



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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + HA + HCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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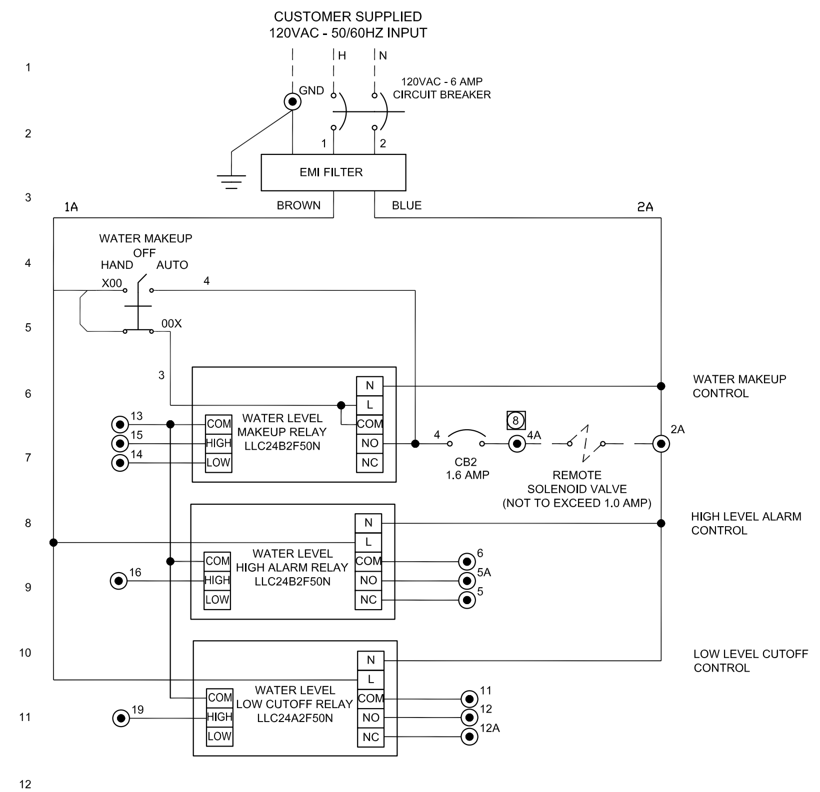
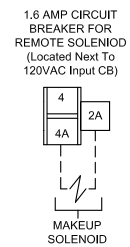




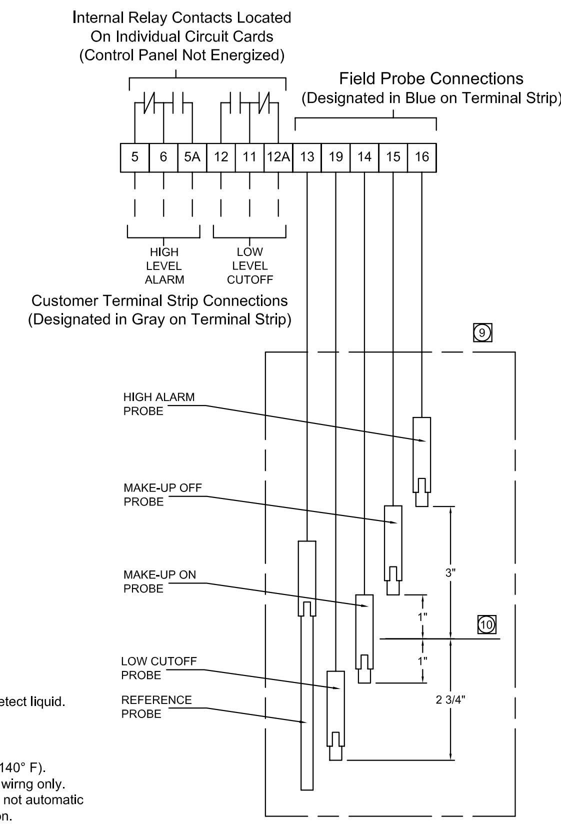


TABLE 1
OPERATION STATUS
(Power Applied)

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:

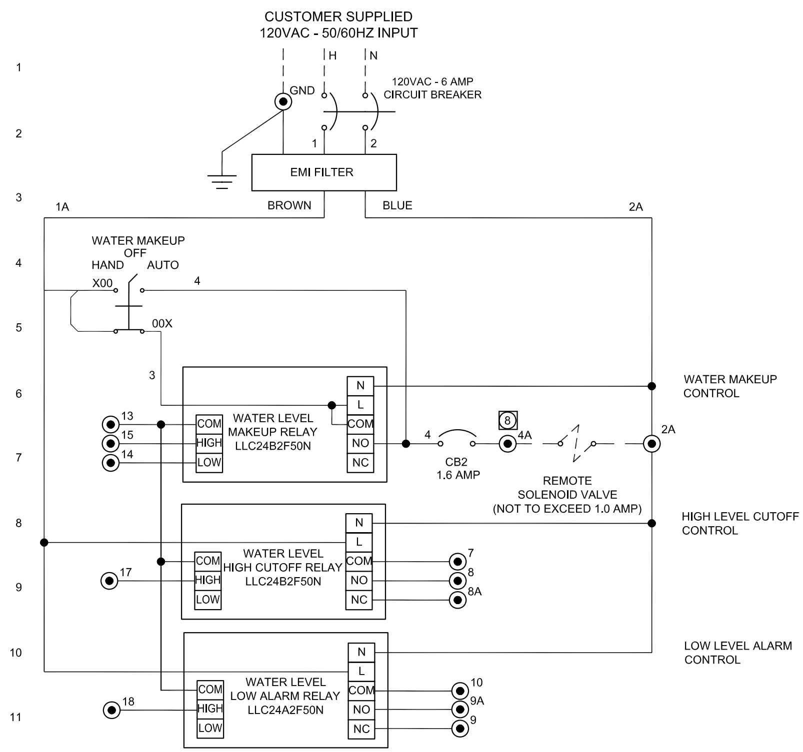
1. ◉ Terminal point number on terminal block.
2. —— —— Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 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.

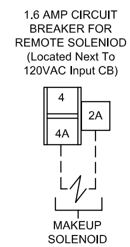
MARLEY ITEM #: E80317
UL FILE #: E312361
SUPPLY VOLTAGE: .. 120vAC - 60HZ
FULL LOAD AMPS: 2A
ENCLOSURE TYPE: .. 4X

MARLEY LLC WATER LEVEL CONTROLS
MAKE-UP + HA + LCO

SPX COOLING TECHNOLOGIES

ECO NUMBER	REV. BY	CHECKED	REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
				DGWOOD	11/26/2008				1=5.2	08-24235	





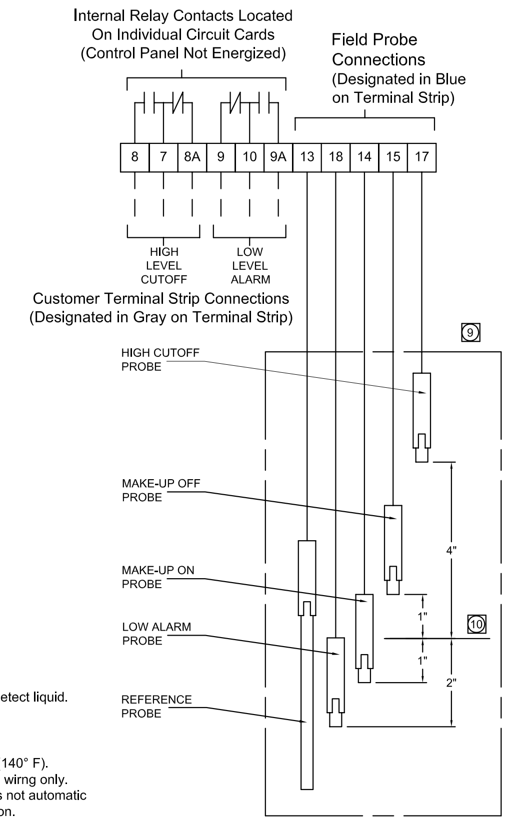


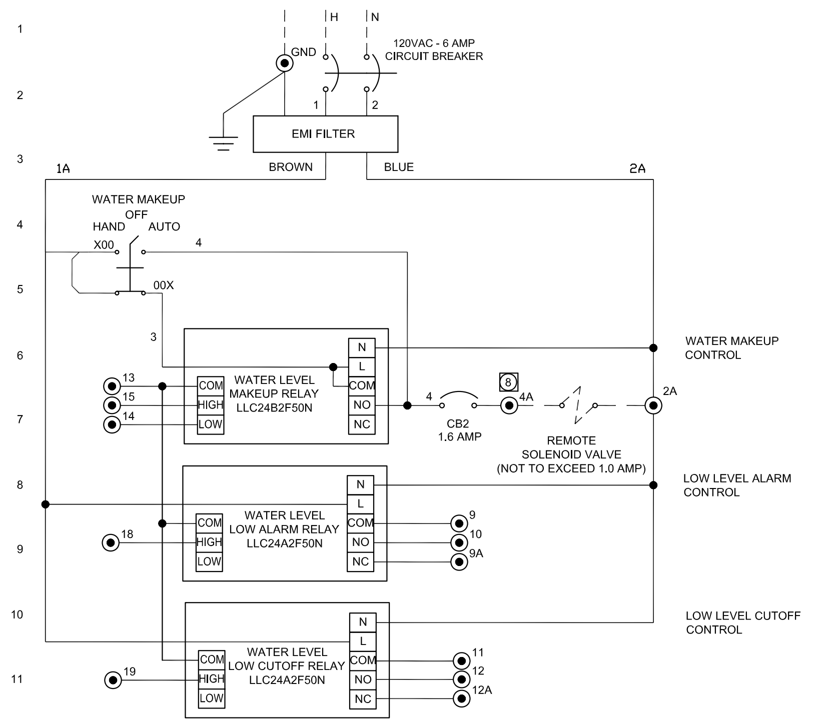
TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

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

ECO NUMBER	MARLEY LLC WATER LEVEL CONTROLS MAKE-UP 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	08-24236	



1.6 AMP CIRCUIT BREAKER FOR REMOTE SOLENIOD (Located Next To 120VAC Input CB)

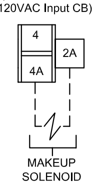
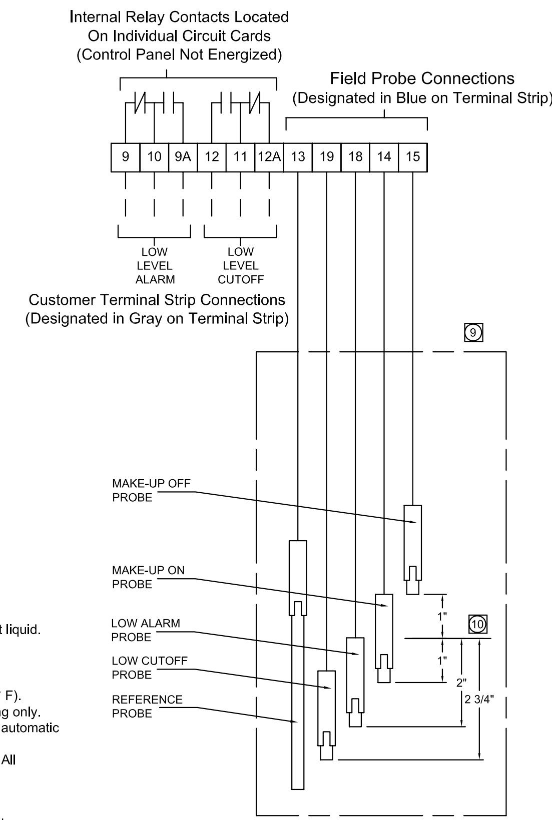


TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

Notes:

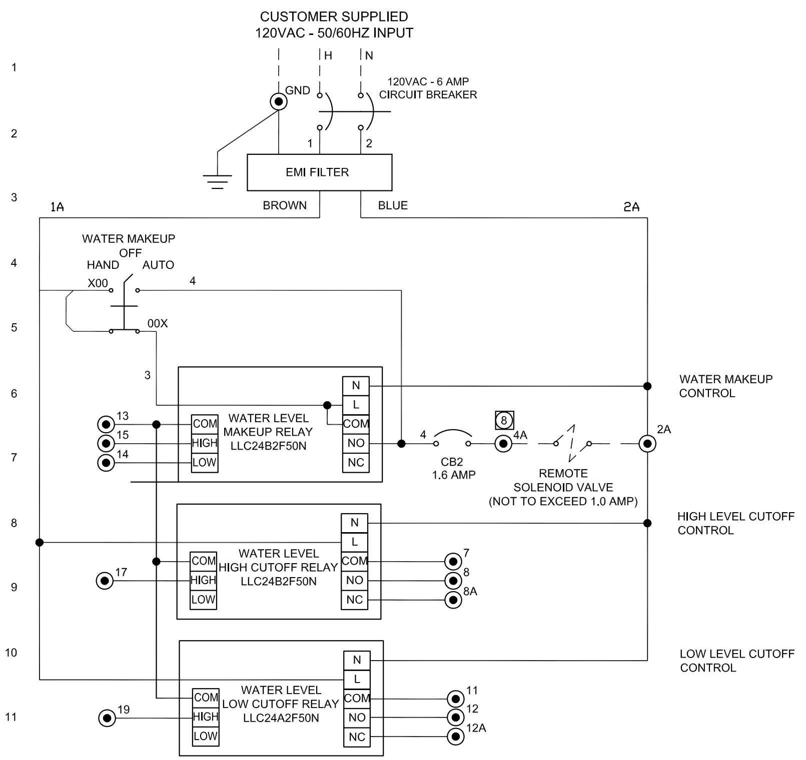
1. Terminal point number on terminal block.
2. Field wiring by others.
3. Probe uses < 1 mA, 12 VAC trickle current to detect liquid.
4. Relay card output contacts rated 10 amps.
5. 18 AWG used for control circuit wiring.
6. Terminals: Use copper conductors only 60° C (140° F). Recommended Torque = 4.4-7.1 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. 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

ECO NUMBER	MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + LA + LCO							
REV. BY / CHECKED								
REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
	DGWOOD	11/25/2008				1=5.2	08-24237	

SPX
COOLING TECHNOLOGIES



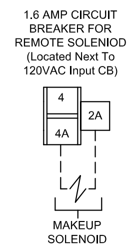
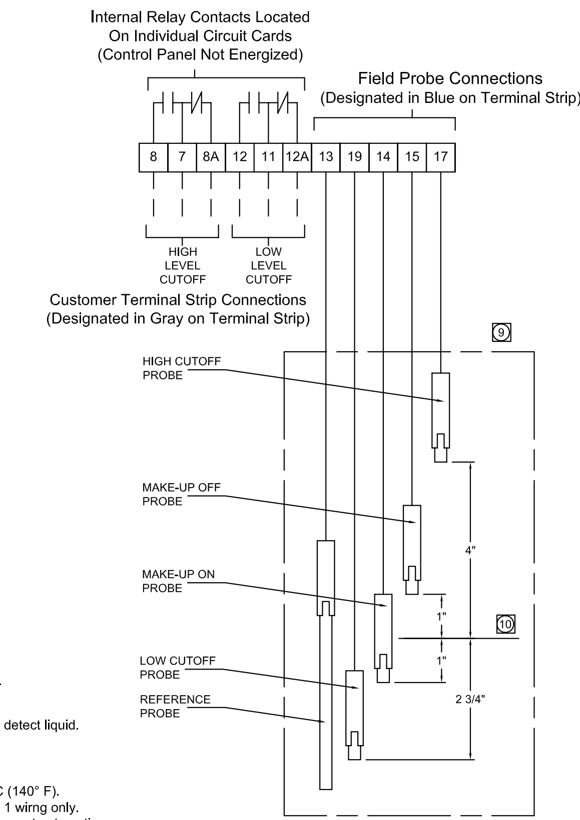


TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

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

ECO NUMBER	MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + 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	08-24238	

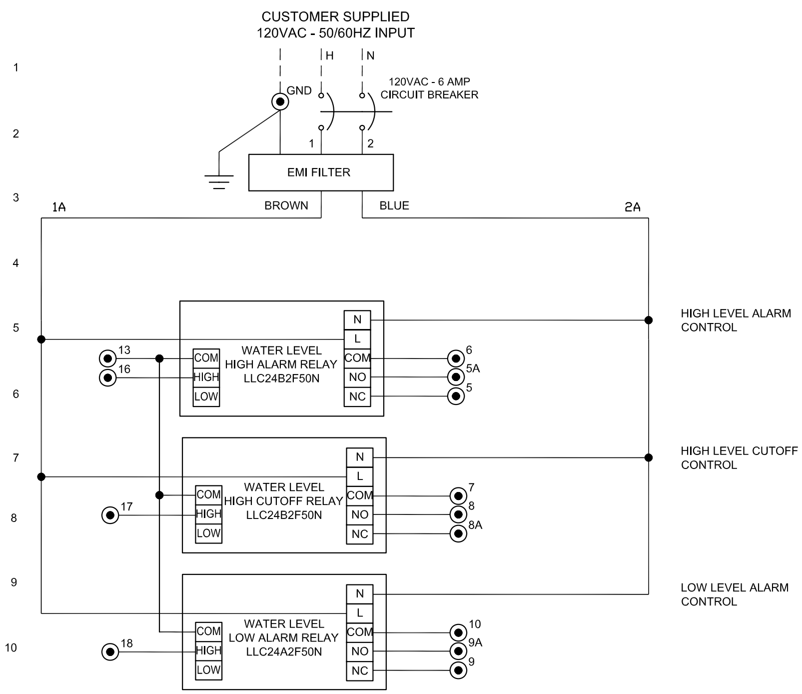
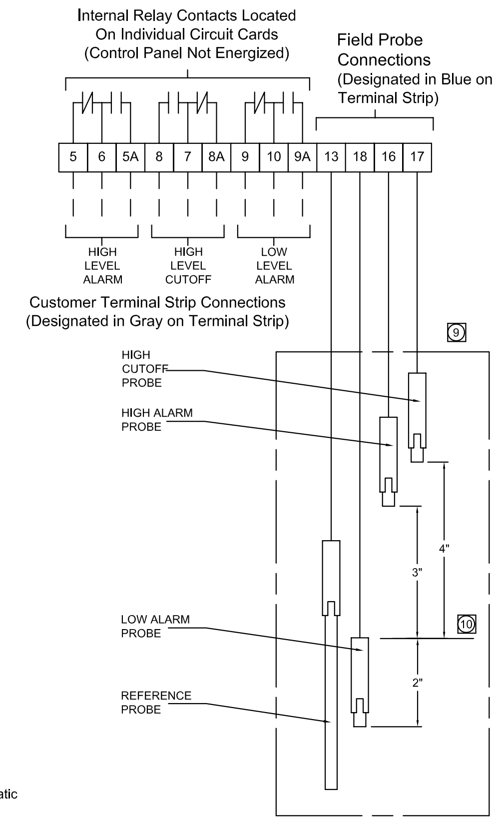


TABLE 1
OPERATION STATUS
(Power Applied)

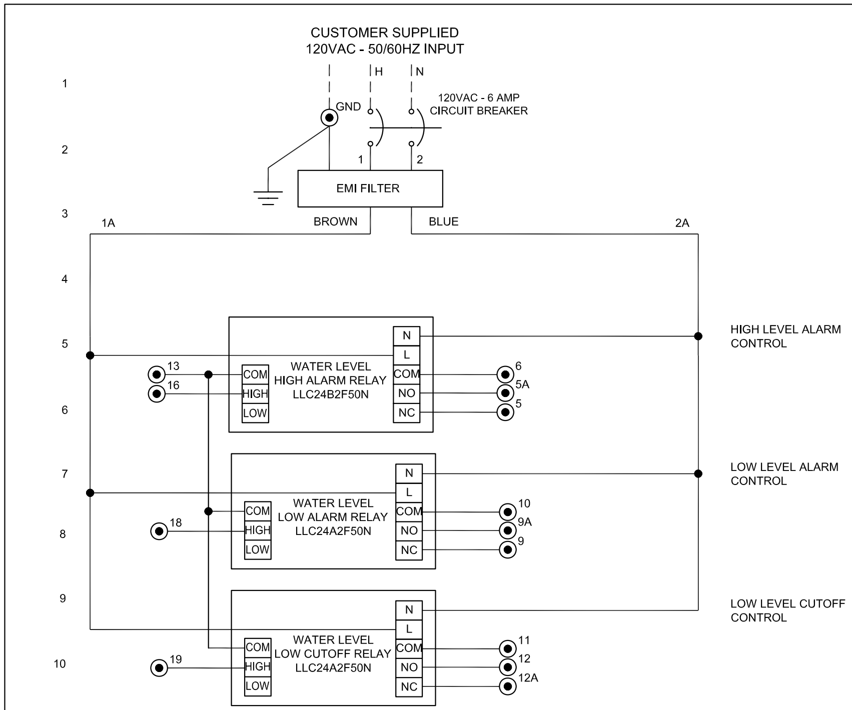
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X

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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS HA + 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	08-24239	



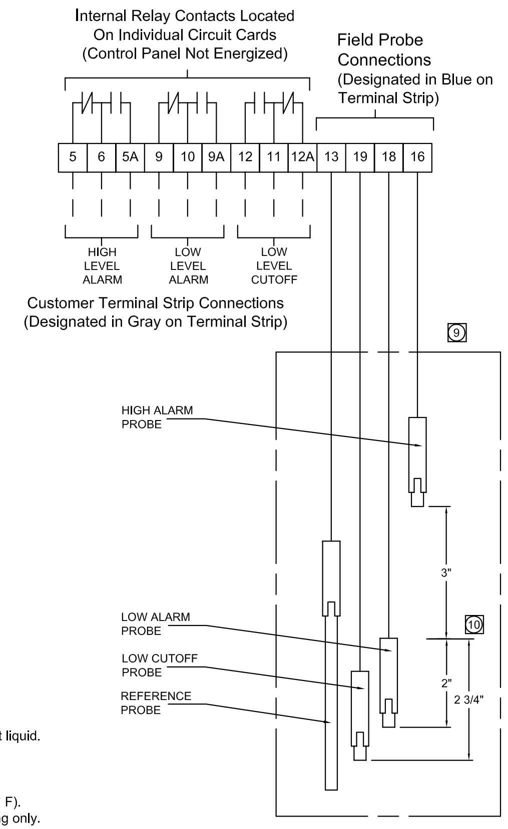


TABLE 1
OPERATION STATUS
(Power Applied)

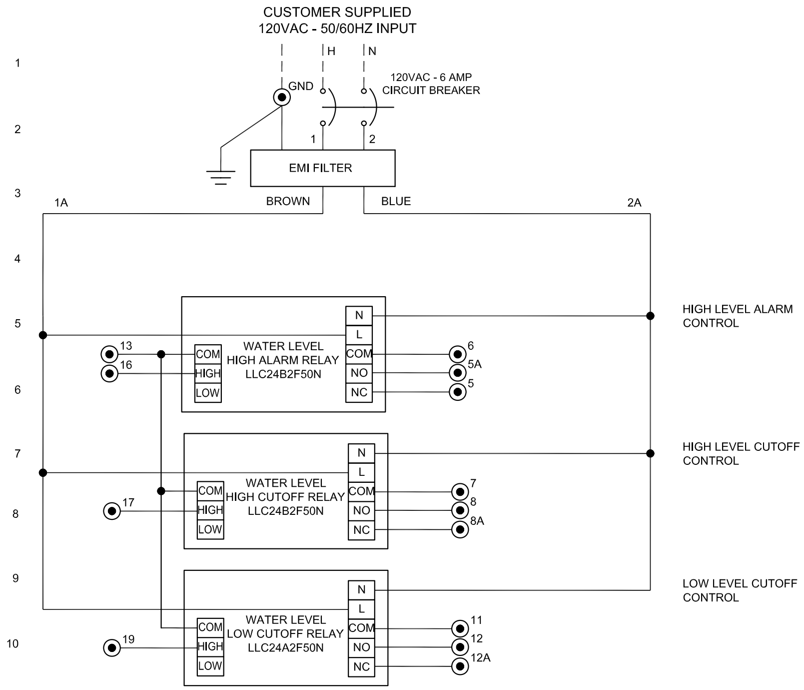
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

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

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	



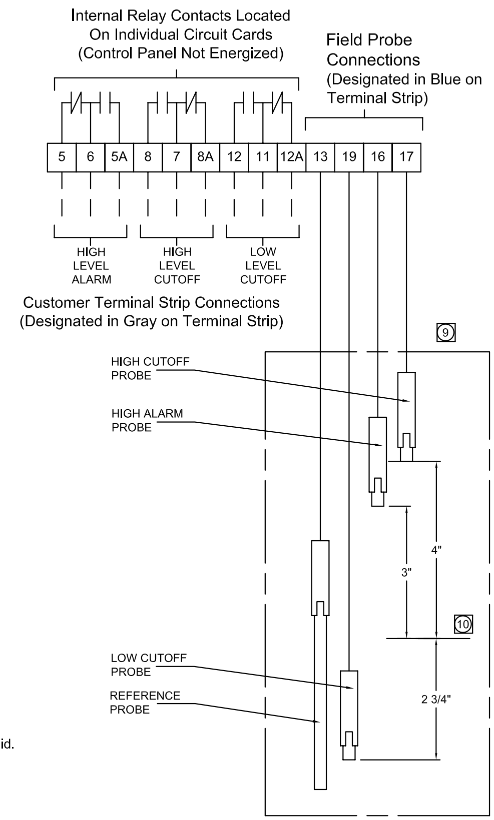


TABLE 1
OPERATION STATUS
(Power Applied)

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	

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

ECO NUMBER	MARLEY LLC WATER LEVEL CONTROLS HA + HCO + LCO				SPX COOLING TECHNOLOGIES			
REV. BY / CHECKED								
REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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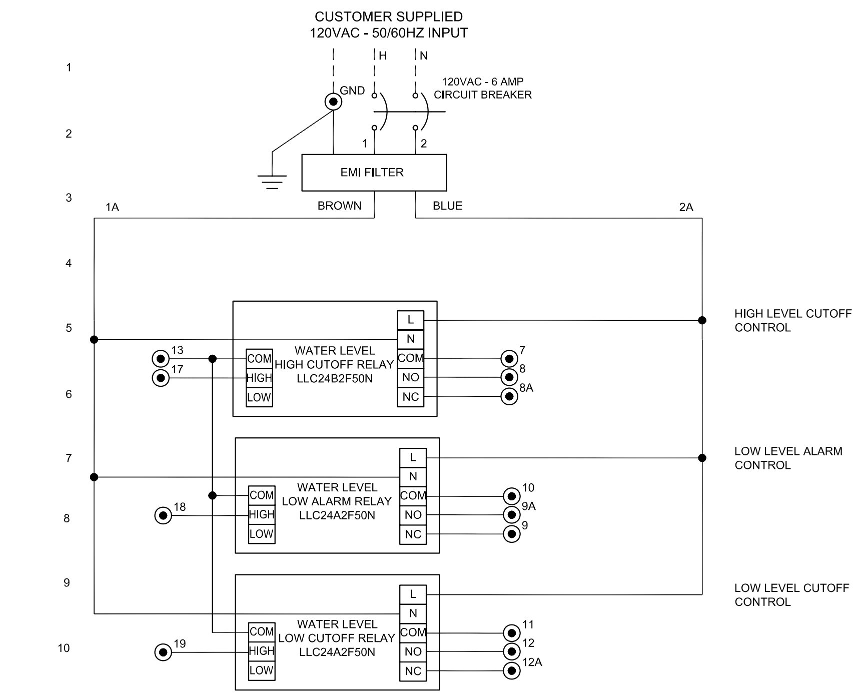

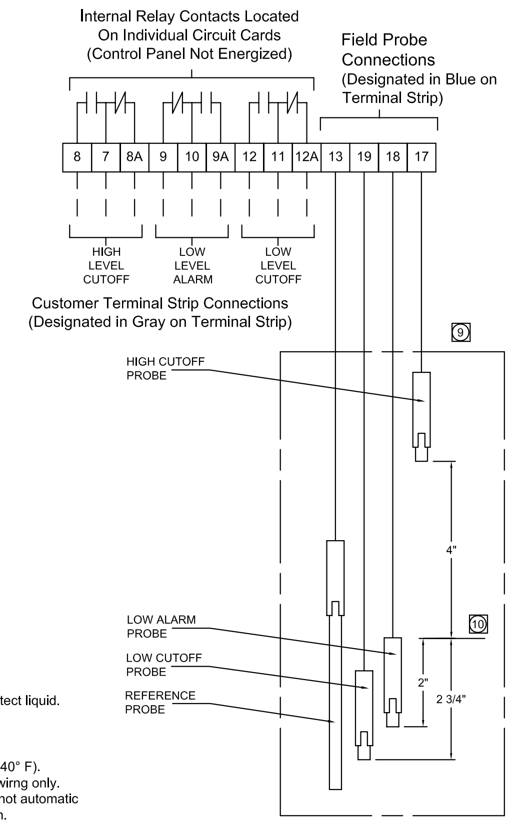

TABLE 1
OPERATION STATUS
(Power Applied)

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	

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

MARLEY LLC WATERE LEVEL CONTROLS
LA + HCO + LCO

SPX
COOLING TECHNOLOGIES

ECO NUMBER	REV. BY	CHECKED	REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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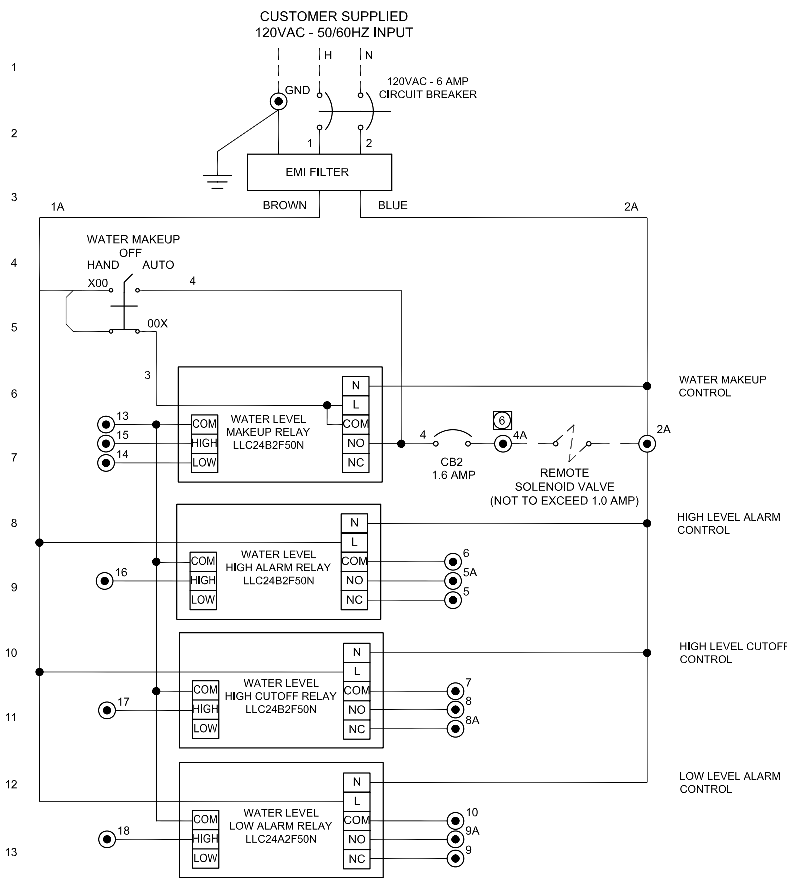

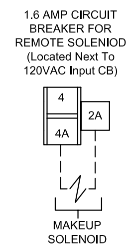

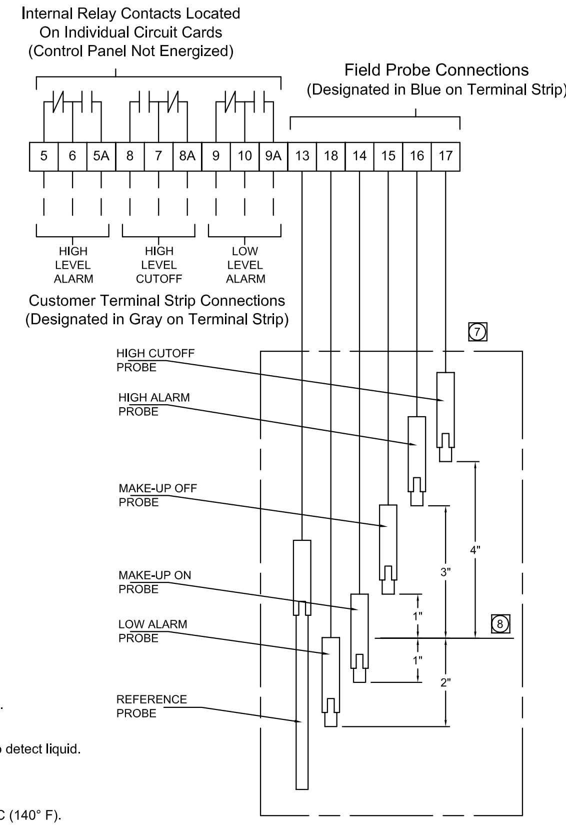

TABLE 1
OPERATION STATUS
(Power Applied)

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

MARLEY LLC WATER LEVEL CONTROLS
MAKE-UP + HA + LA + HCO

ECO NUMBER	REV. BY	CHECKED	REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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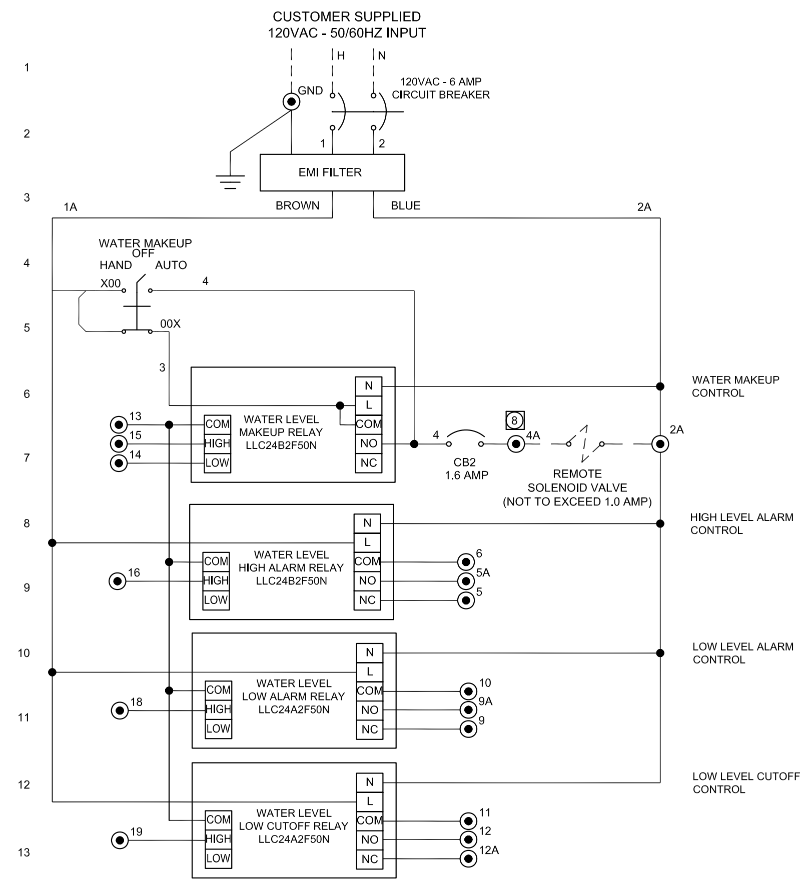
SPX
COOLING TECHNOLOGIES



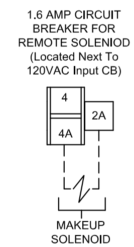
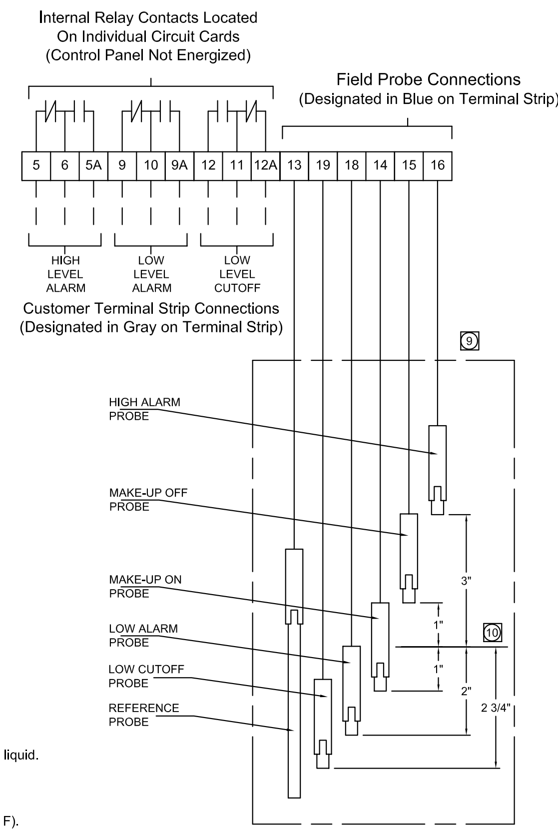


TABLE 1 OPERATION STATUS (Power Applied)				
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH ALARM	6 & 5	X	
		6 & 5A		X
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	



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

ECO NUMBER		MARLEY LLC WATER LEVEL CONTROLS MAKE-UP + HA + LA + LCO				SPX COOLING TECHNOLOGIES			
REV. BY	CHECKED								
REV. DATE		DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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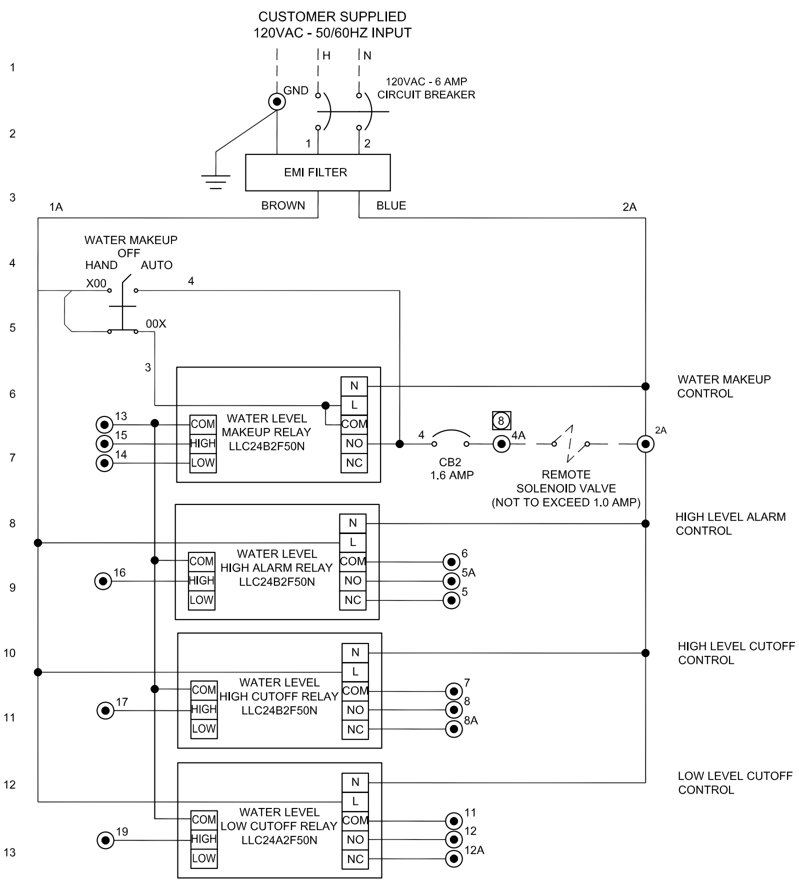

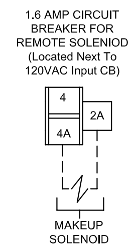

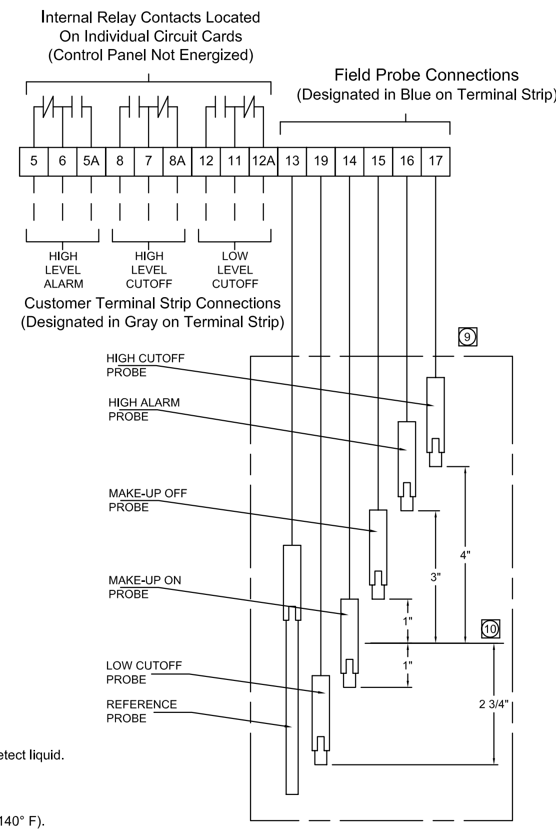

TABLE 1
OPERATION STATUS
(Power Applied)

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

MARLEY LLC WATER LEVEL CONTROLS
MAKE-UP + HA + HCO + LCO

SPX
COOLING TECHNOLOGIES

ECO NUMBER	REV. BY	CHECKED	REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
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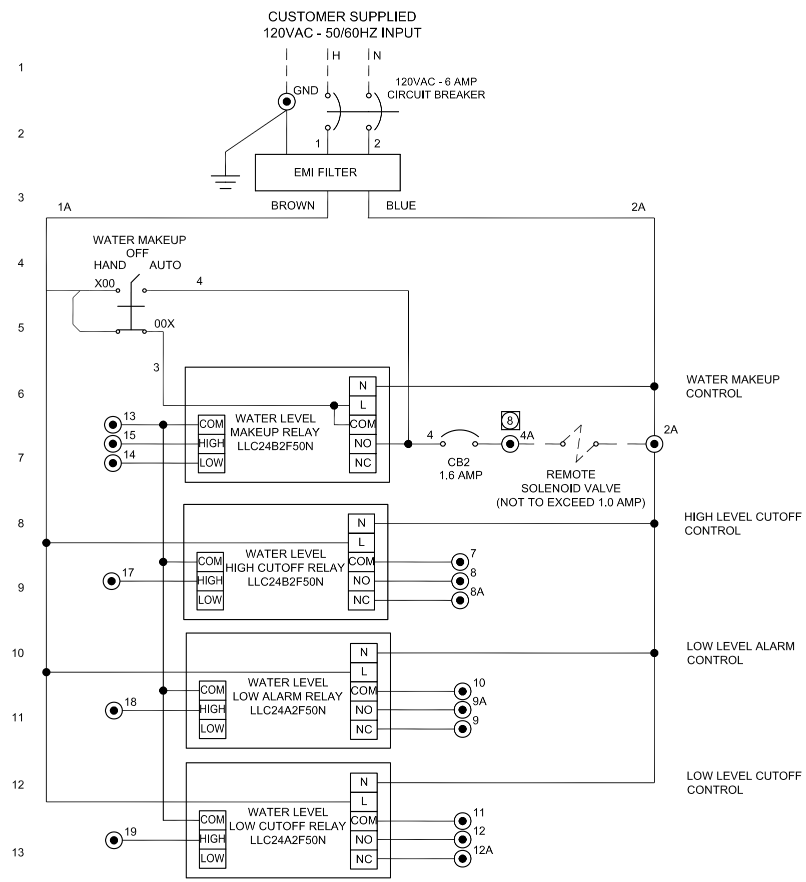
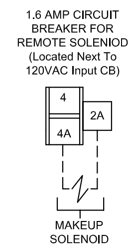




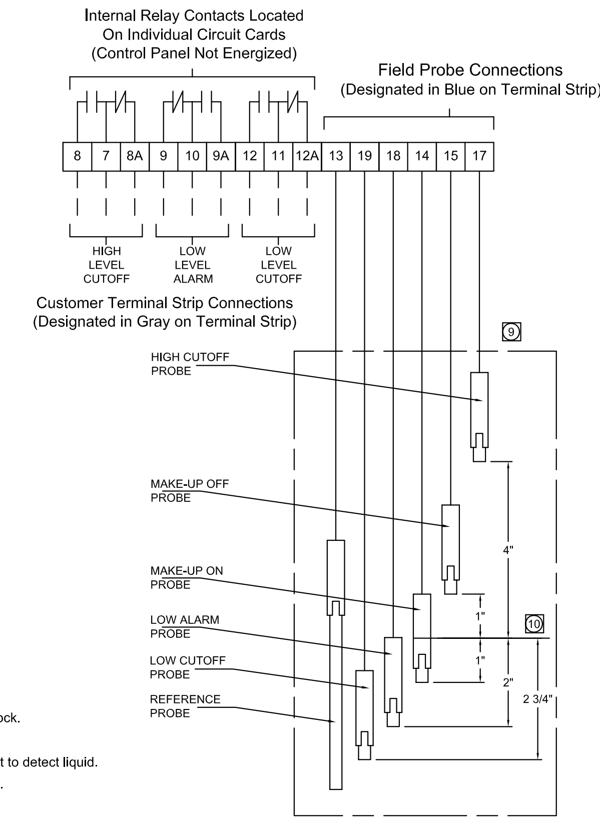


TABLE 1
OPERATION STATUS
(Power Applied)

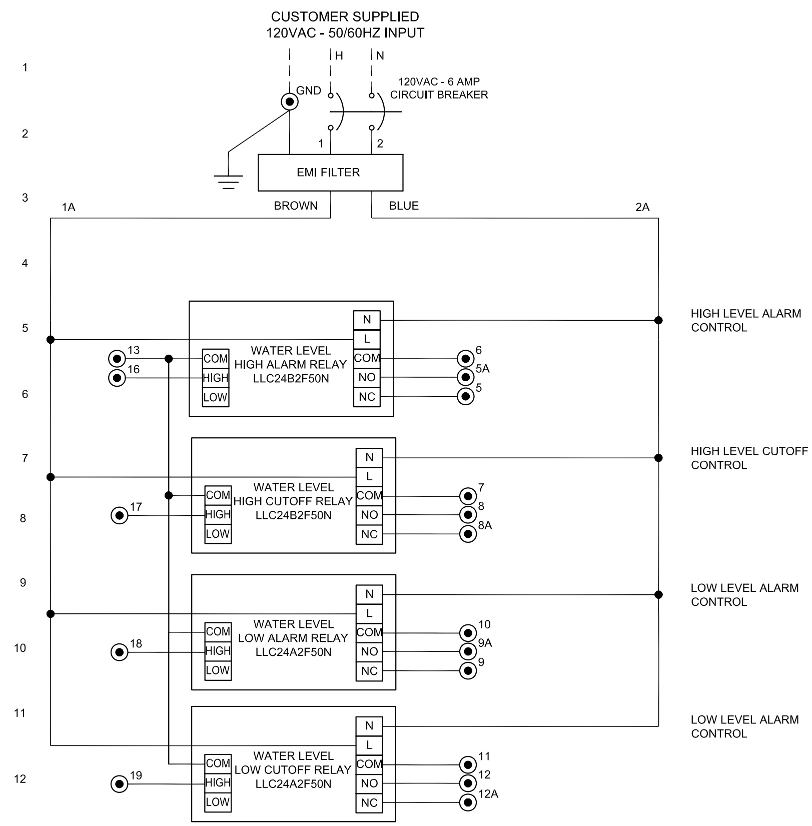
WATER DEPTH	SIGNAL	CONTACT BETWEEN	CLOSED	OPEN
PROBE INTO WATER (High Water)	HIGH CUTOFF	7 & 8		X
		7 & 8A	X	
PROBE OUT OF WATER (Low Water)	LOW ALARM	10 & 9	X	
		10 & 9A		X
	LOW CUTOFF	11 & 12		X
		11 & 12A	X	

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

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	



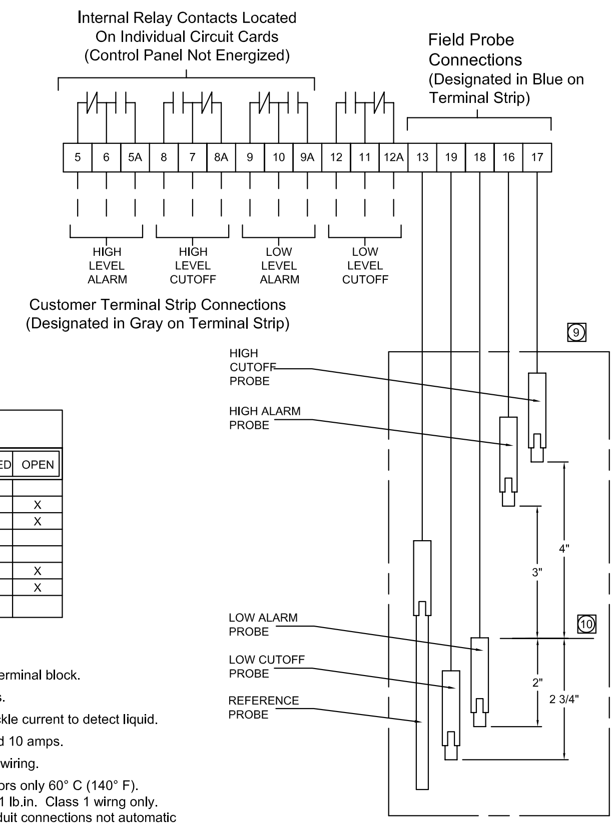


TABLE 1
OPERATION STATUS
(Power Applied)

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

MARLEY LLC WATER LEVEL CONTROLS
HA + LA + HCO + LCO

SPX COOLING TECHNOLOGIES

ECO NUMBER	REV. BY	CHECKED	REV. DATE	DRAWN BY	DATE	CHECKED	APPROVED	ORDER NUMBER	PLOT	DRAWING NUMBER	REV.
				DGWOOD	11/25/2008				1=5.2	08–24247	

SPX COOLING TECHNOLOGIES, INC.
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Z0628617_B | ISSUED 07/2018

SPX

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.

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**

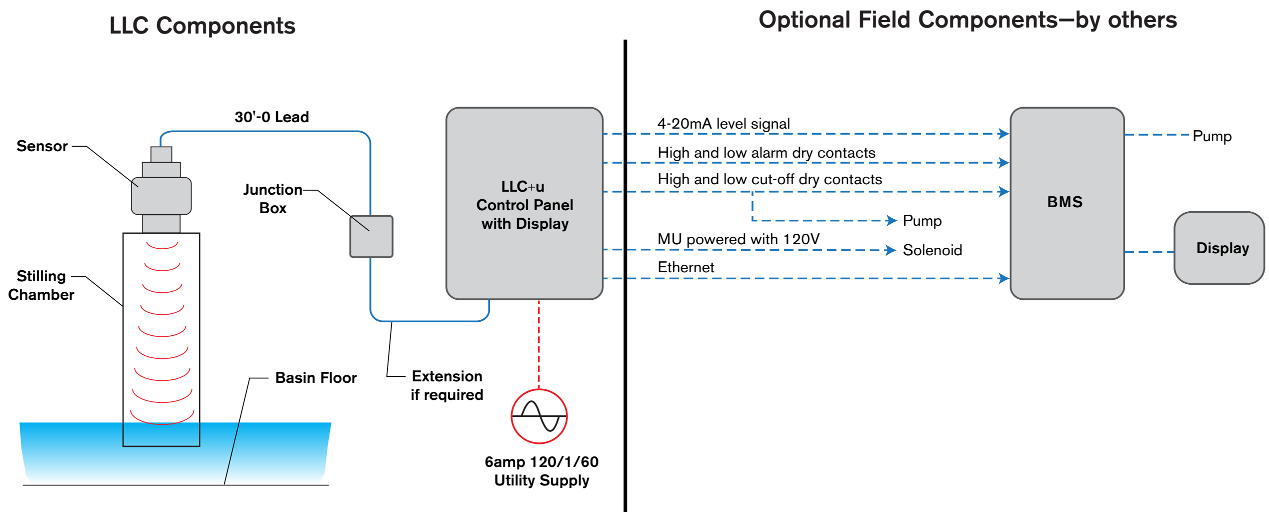
The following safety issues should be addressed by those responsible for installation, maintenance or repair of the tower and controls:

- 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.

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.

description

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.

programming

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

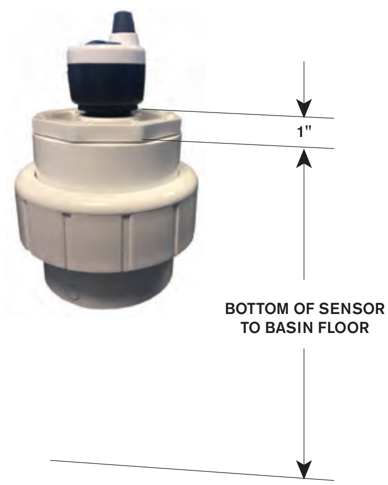
programming

CIRCUIT PROTECTION

Main circuit breaker powers the control panel

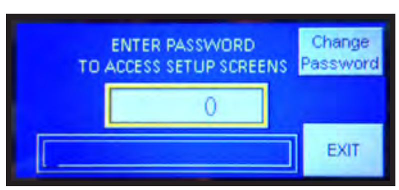
Feeder breaker powers the remote solenoid.

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.

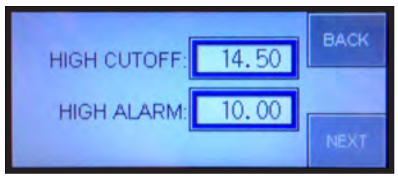


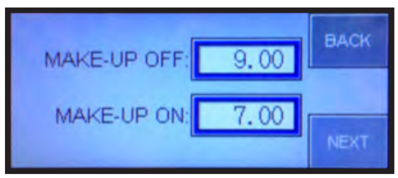
Access the program by pressing GOTO SETUP

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.

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.

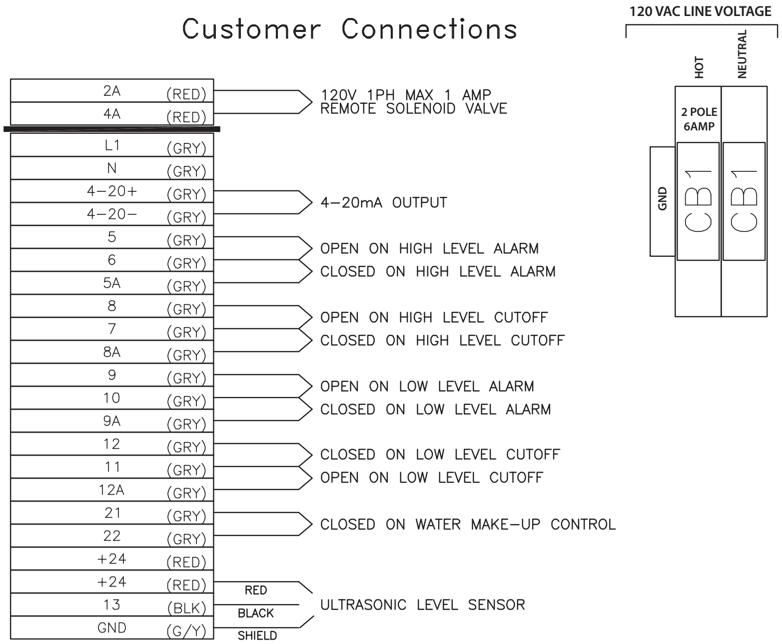
In an effort to troubleshoot the system, please check the following:

- 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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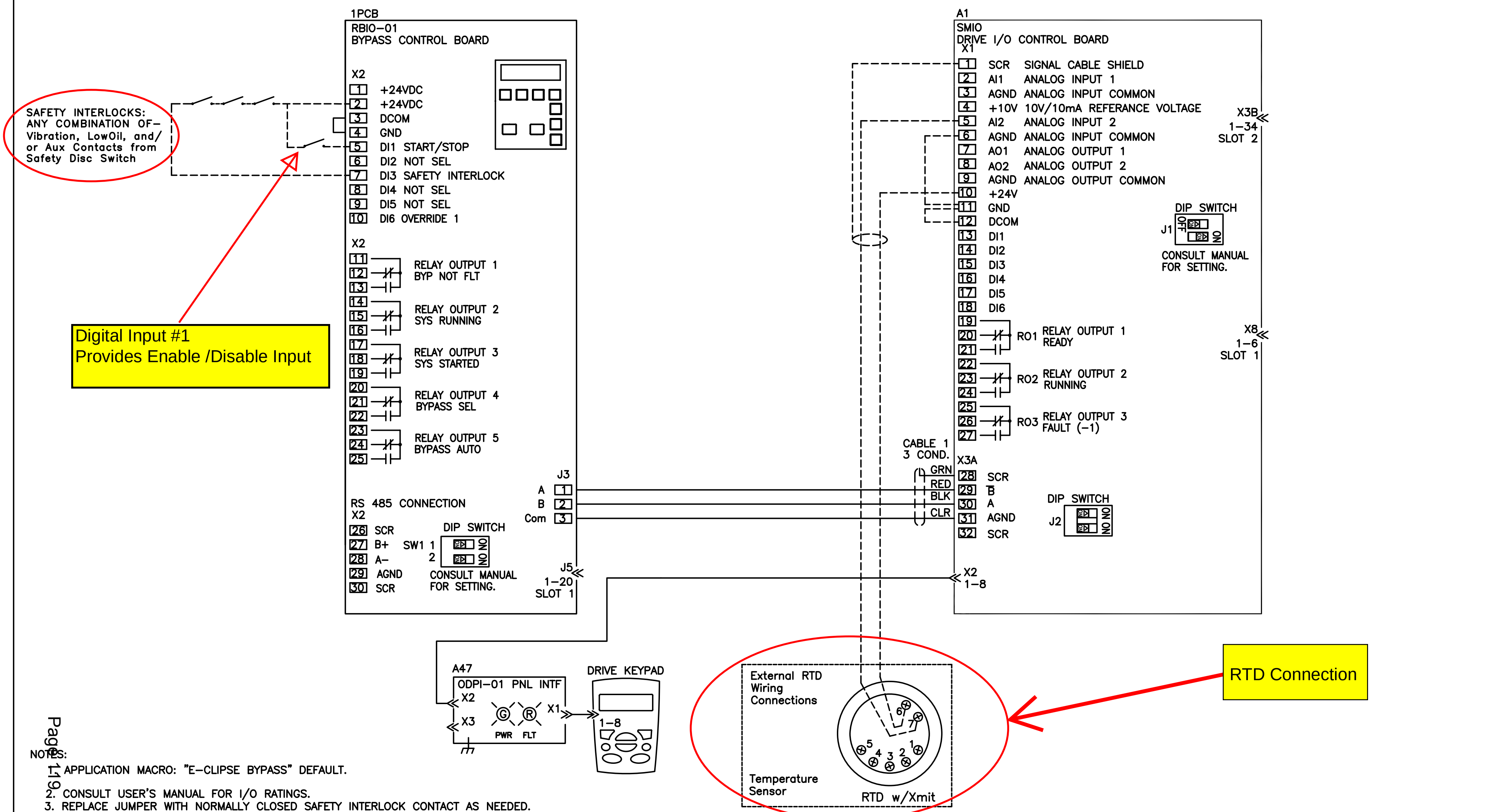
Controls Overview and Troubleshooting

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.

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

MARLEY®

user manual

IMI vibration switch

INSTALLATION - OPERATION - MAINTENANCE

Z0929039_B ISSUED 07/2017

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

contents

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.

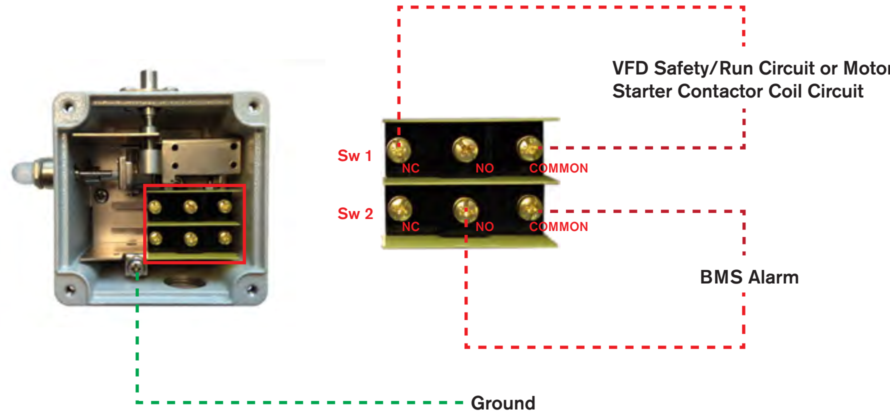


Figure 1

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

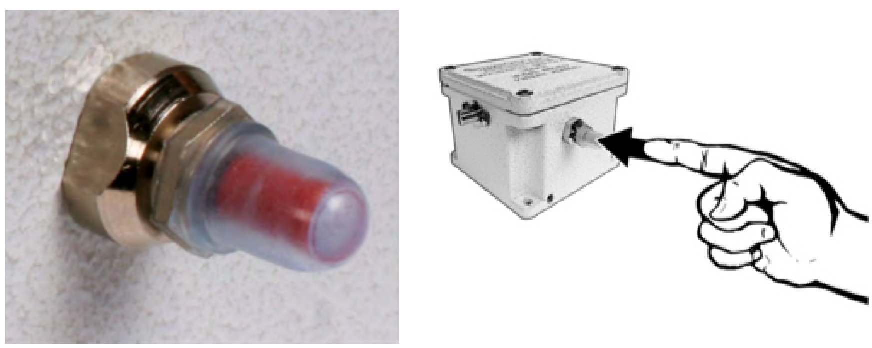


Figure 2

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.

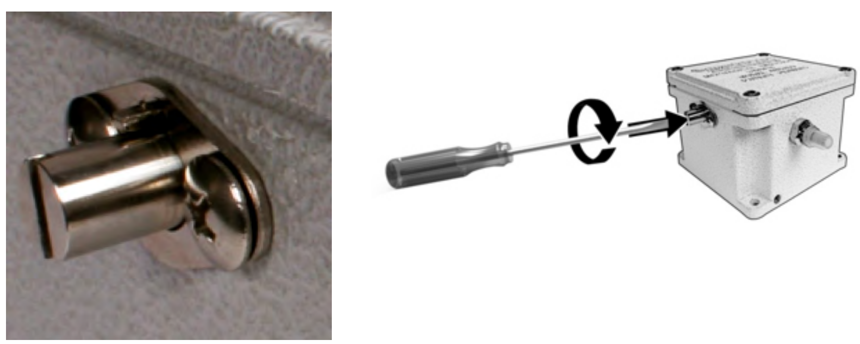


Figure 3

Note

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

operation

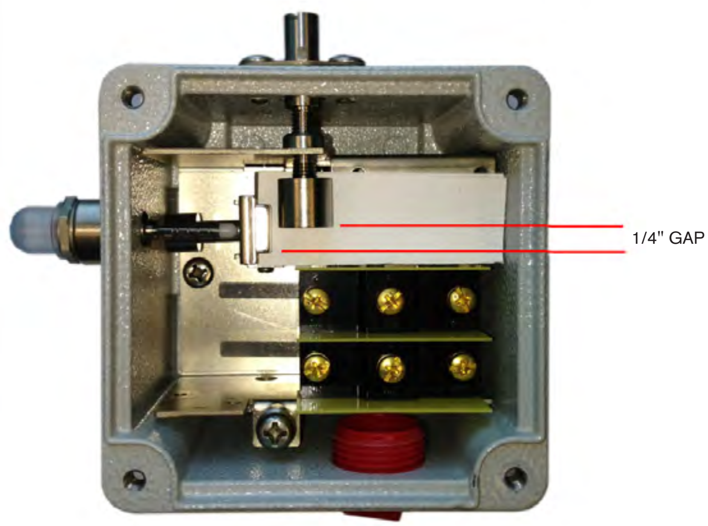


Figure 4

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.

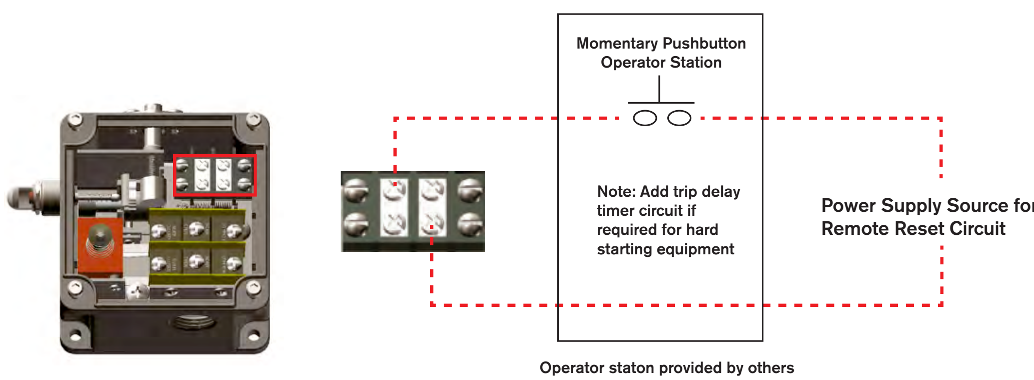


Figure 5

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**.

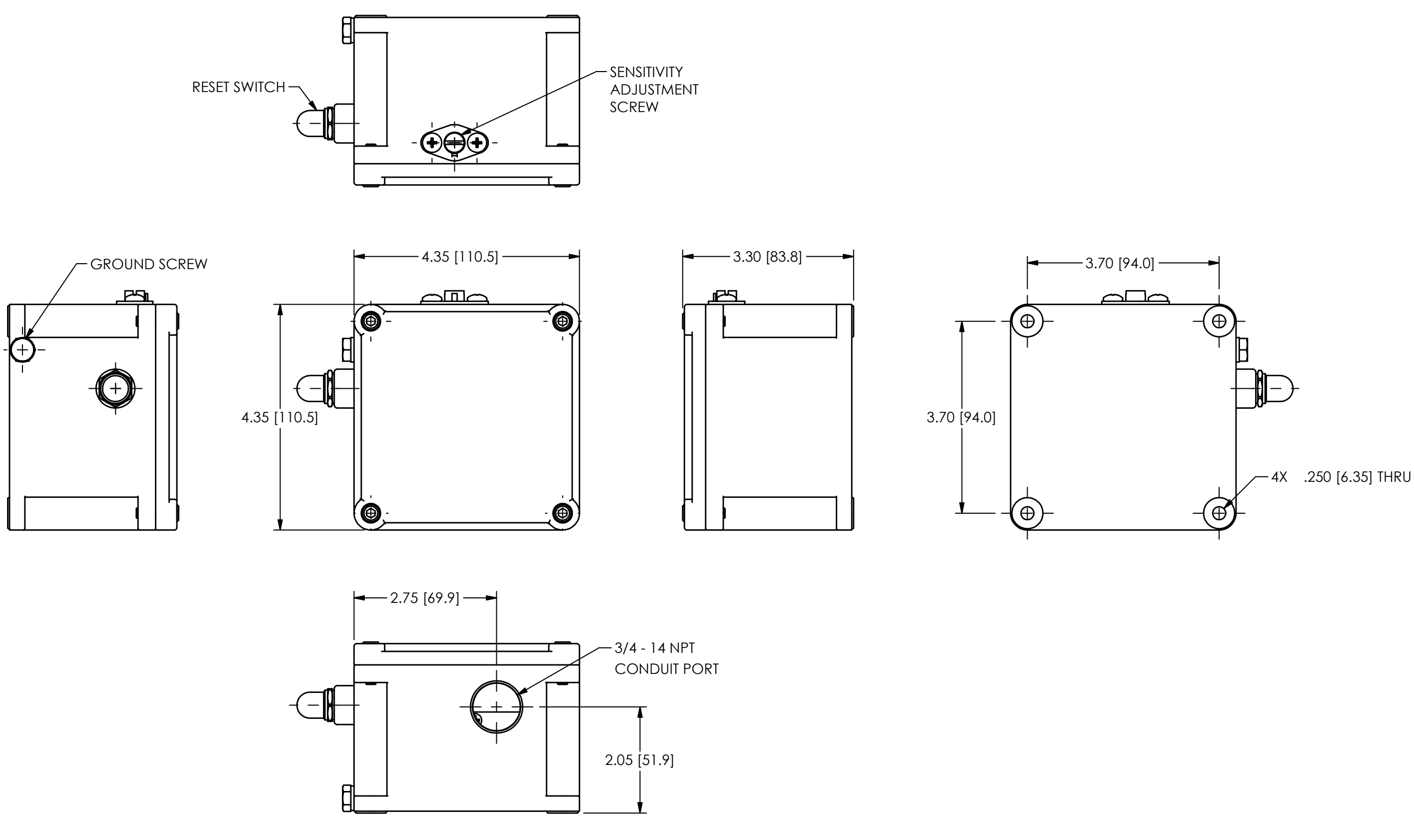
The switch is shock sensitive. Using a dead-blow hammer strike the lid or switch support beam to trip the switch. A trip is visually indicated by a protruding red stem shown in the reset button, **Figure 1**. Reset the switch for operation.

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			
2558913	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	
2558911	Timer required in customer's start circuit				
2558912					
2558913					

Dimensions



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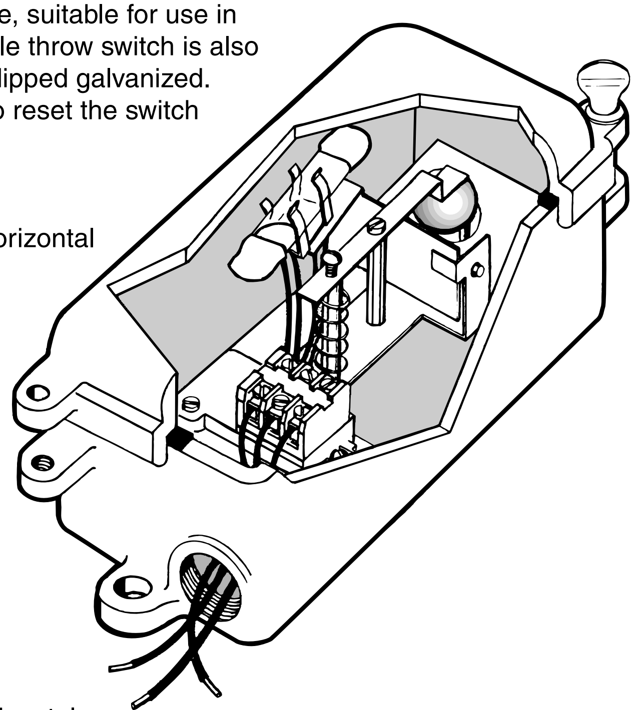
M-1 Vibration Switch
User Manual

The Marley M-1 Vibration switch is utilized in cooling tower motor control circuits to interrupt power to the motor and energize an alarm when excessive vibration occurs. The switch is a single pole, double throw type, suitable for use in NEMA 4 applications (an optional double pole, double throw switch is also available.) The cast iron housing and cover are hot dipped galvanized. Thumb screws allow removal of the housing cover to reset the switch and to adjust the sensitivity.



Description

The switch is sensitive to vibration primarily in the horizontal direction. A stainless steel ball rests on a pedestal attached to the bottom of the switch housing. When excessive vibration occurs, the ball falls off the pedestal into a balance cup. The weight of the ball in the cup causes the cup to pivot about its axis, tripping the attached mercury switch and breaking the electrical circuit. The tripping action is positive. The switch is equipped with one single pole, double throw mercury switch (two single pole double throw switches are available as an option). The switch is wired with the motor circuit normally closed and the alarm circuit normally open.

Installation

- Switch must be level and fastened securely to horizontal support.
- Connection of conduit to switch must be watertight.
- After wiring, trip switch manually to check circuit interruption.
- Adjust tension adjustment screw so that the lever is just touching the ball. Then tighten the screw about 1/2 to a full revolution so the trip ball won't fall out of the pedestal when motor is started.

  ⚠ **CAUTION** Do not screw the tension adjustment screw down all the way.

Resetting the Switch

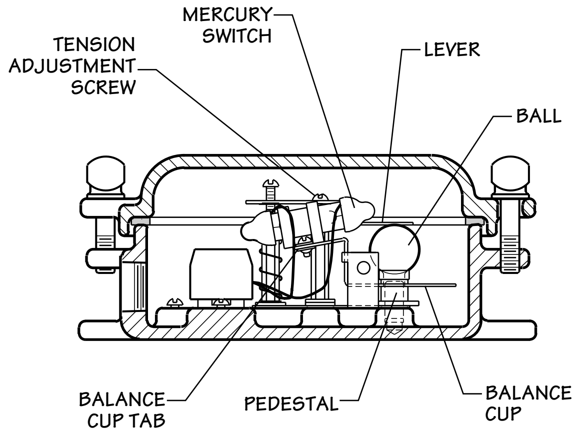
- Determine why the switch tripped and correct the cause. Some causes of excessive vibration may be a bent or unbalanced drive shaft, loose mounting bolts, unbalance of fan or shock from motor start up or speed change.
- Reset switch by repositioning ball on the pedestal.

Electrical Rating

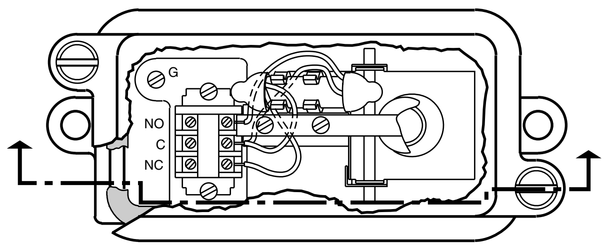
- Suitable for NEMA 4, weatherproof applications.
- 120V .... 4 Amps AC Continuous or 4 Amps DC.
  240V .... 2 Amps AC Continuous or 2 Amps DC.
  480V .... 1 Amp AC Continuous
- The terminal block is rated at 600 volts, max.
- The maximum wire size is #8.

Marley

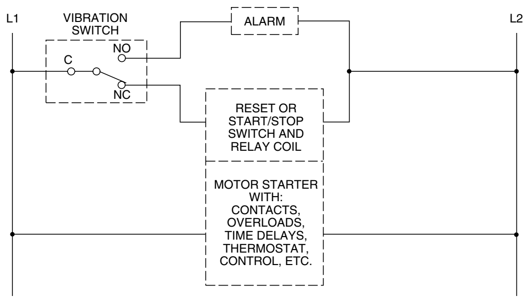
M-1 Vibration Switch



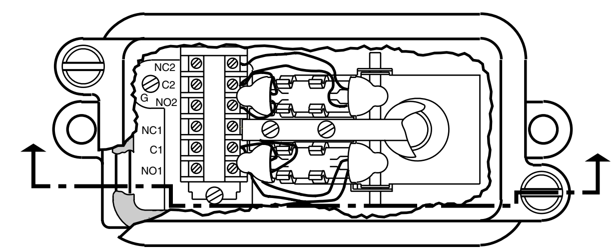
Section



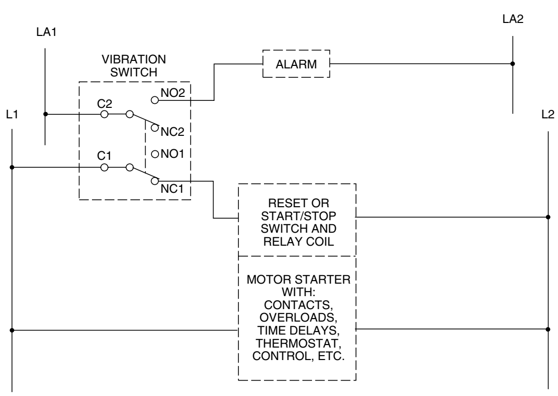
Single-Pole



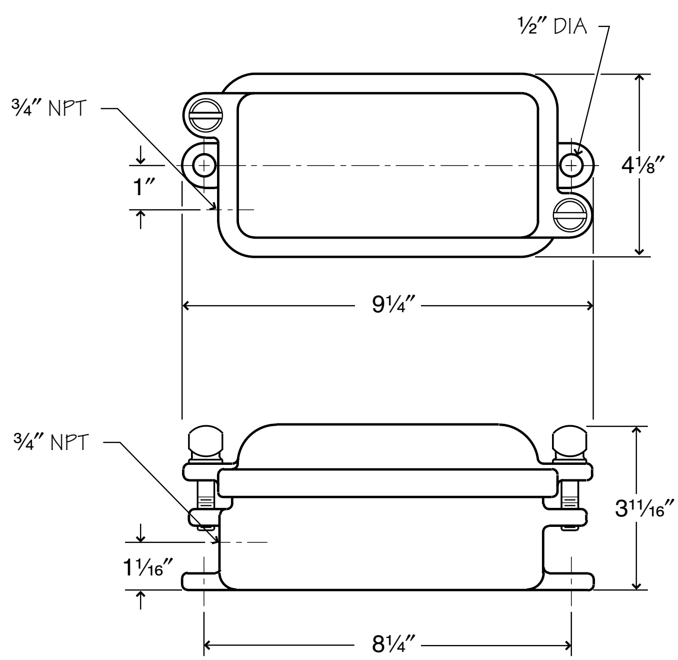
Single-Pole Wiring



Double-Pole



Double-Pole Wiring



Installation Details

Marley Cooling Tower
A United Dominion Company

The Marley Cooling Tower Company
7401 W 129 Street • Overland Park, KS 66213 • 913.664.7400
In the interest of technological progress, all products are subject to design and/or material change without notice.
 Printed in USA

Manual 95-1353B

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.

operation

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

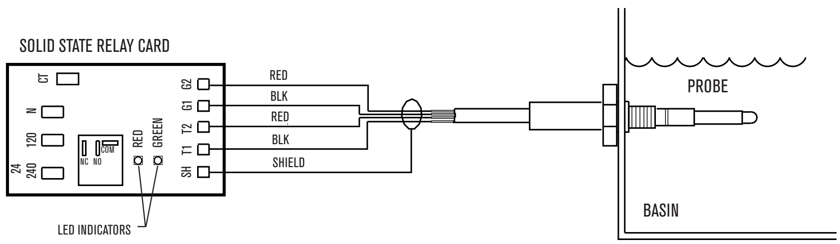


Table 3

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:

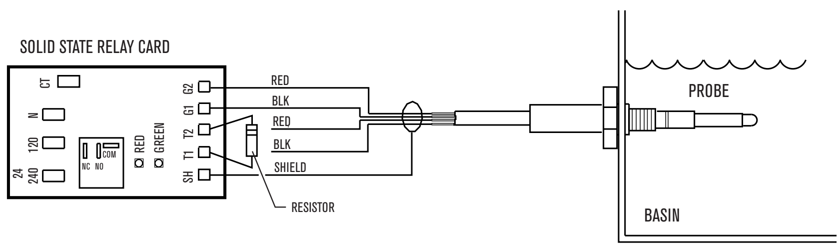
Method A

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

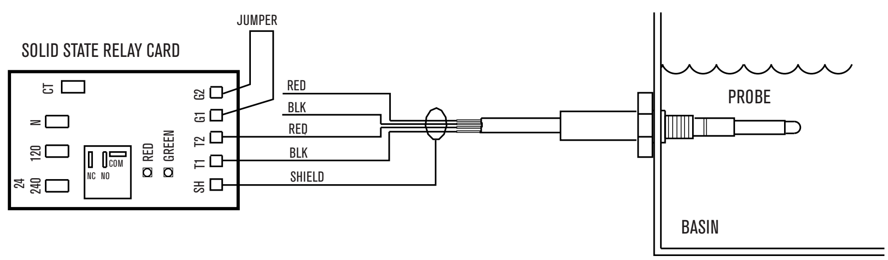
If the temperature/water level sensor assembly becomes encased in ice the heaters will not operate. Ice provides inadequate conductivity for the sensor probe to detect operational water level. To operate heaters in this situation and melt the ice follow these procedures.

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.

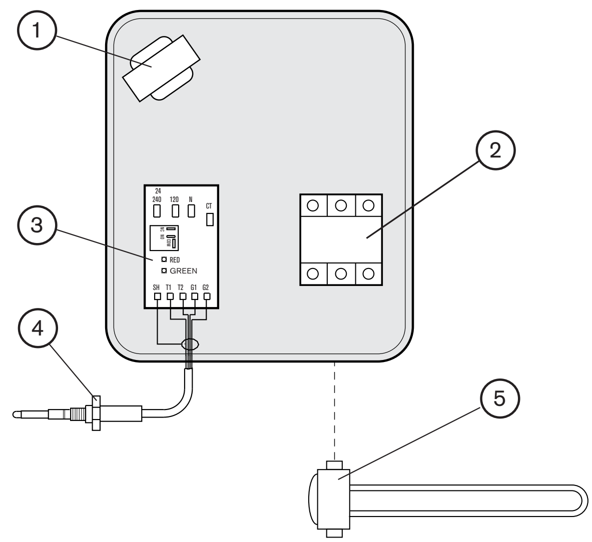
6. The sensor assembly can be checked for accuracy in the following manner.

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

Robertshaw
INDUSTRIAL PRODUCTS

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/ºC

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.

5318B - B 1 - A

- Key Model Number — 5318B
- Table 1 – Supply Voltage — B
- Table 2 - Options — 1
- Table 3 – Enclosure — A

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

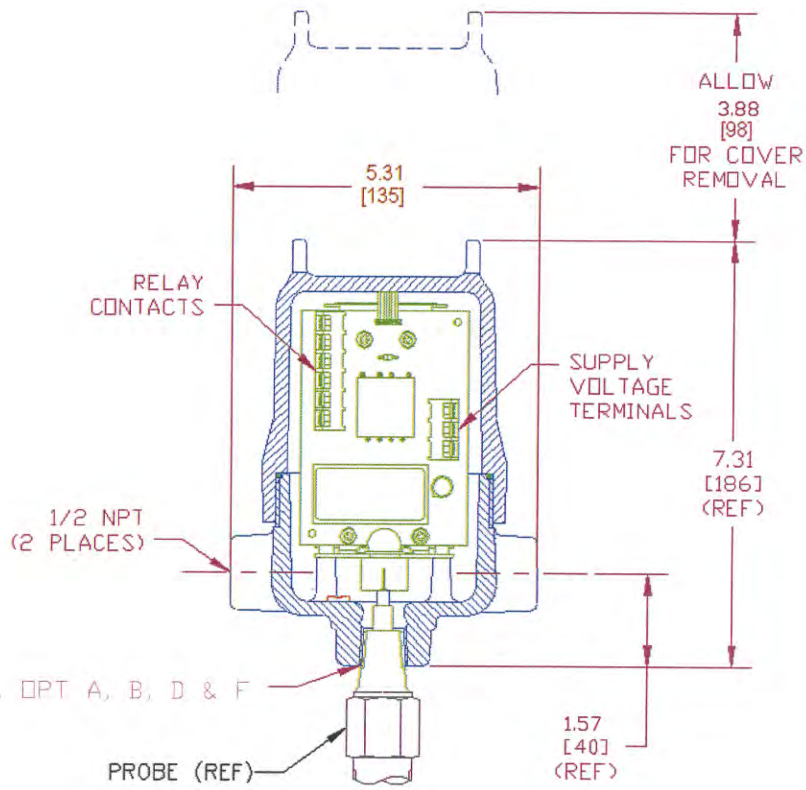
Table 2 – Options

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

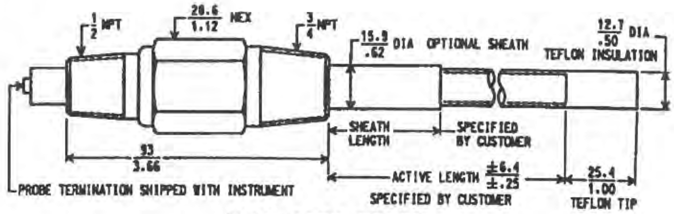
Canadian Registration Number (CRN) OH0461.9

BEND DIMENSIONS

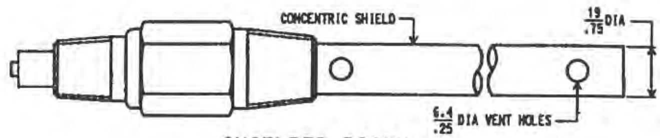
Probe Style	Minimum Lengths		
	L_1	L_2	L_3
Basic Probe	3.50"	3.50"	-
With Straight Sheath	4.50"	3.50"	-
With Bent Sheath	3.50"	4.50"	3.50"
With Welded Flange	4.75"	3.50"	-
With Welded Flange and Straight Sheath	4.75"	3.50"	-
With Welded Flange and Bent Sheath	4.75"	4.50"	3.50"

DIMENSIONAL DATA

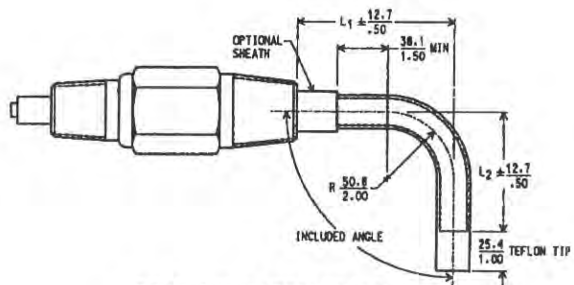
MM / INCH



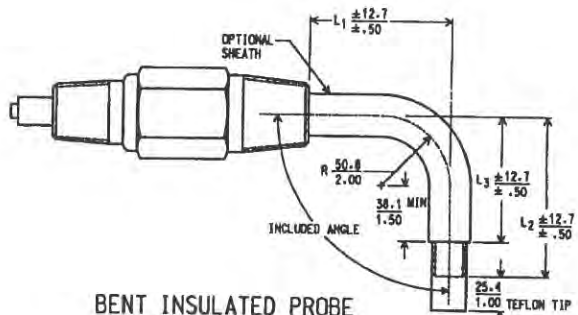
INSULATED PROBE



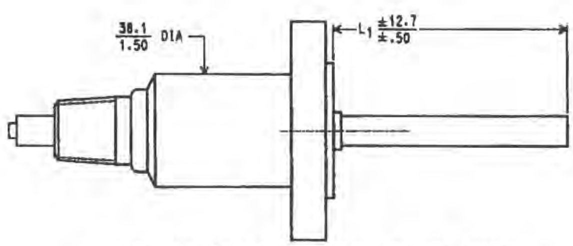
SHIELDED PROBE



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 PDK 20APR06 PDK 17MAY06 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 PDK 28FEB07 PDK 20APR07 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 → 5318B
- SUPPLY POWER OPTIONS → B1
- ENCLOSURE → A

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: ____________

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
06-70.0150

SCALE ____
EXP. DRAWING NUMBER

invensys

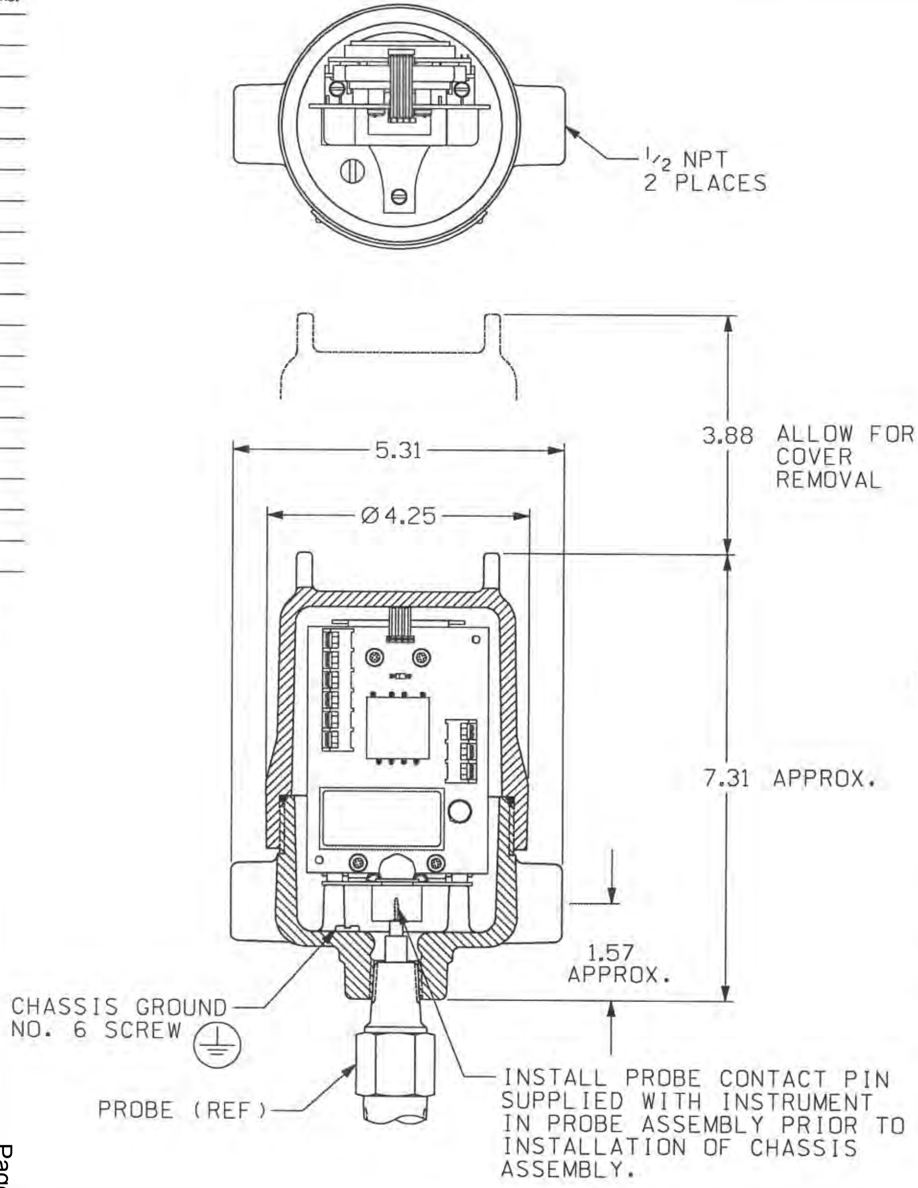
Robertshaw
INDUSTRIAL PRODUCTS
MARYVILLE, TENNESSEE

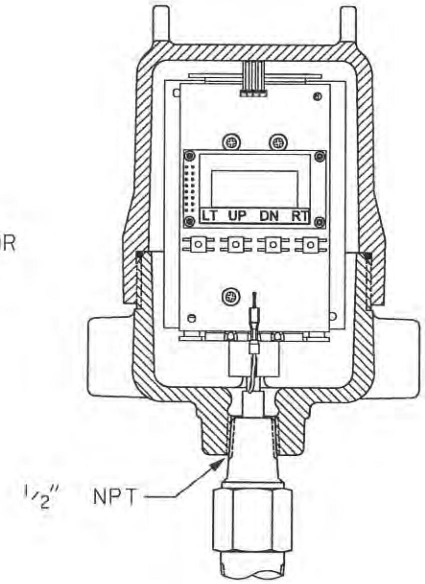
CERTIFIED PRINT
INSTALLATION DRAWING
MODEL 5318B

PROD. DWG. NO. 909HB918 REV. B

SHEET 1 OF 2

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





DISPLAY SIDE

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
06-70.0150

invensys

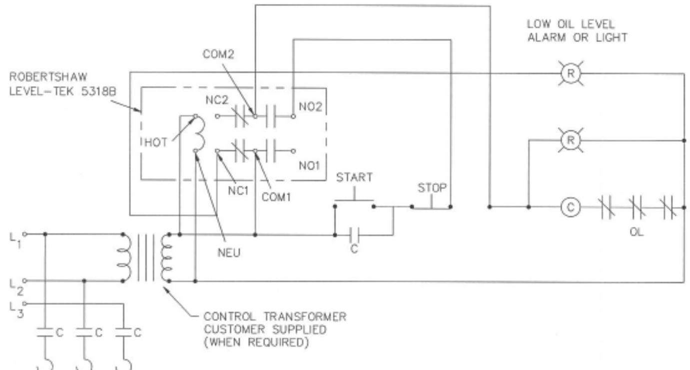
Robertshaw
INDUSTRIAL PRODUCTS
MARYVILLE, TENNESSEE

CERTIFIED PRINT
INSTALLATION DRAWING
MODEL 5318B

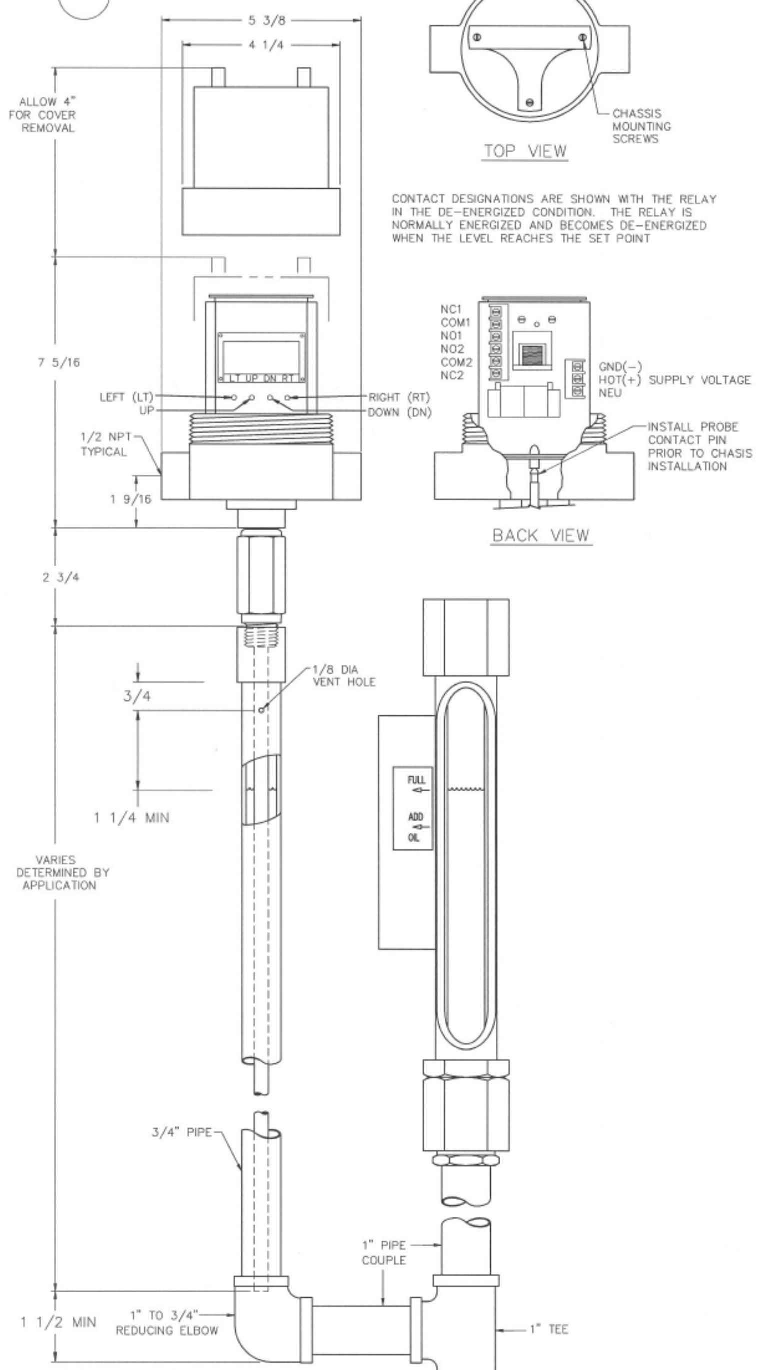
SCALE ____
EXP. DRAWING NUMBER
PROD. DWG. NO. **909HB918** REV. **B**

SHEET 2 OF 2

FILE NO.



WIRING DIAGRAM



TYPICAL INSTALLATION

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

LTR	DATE	REVISION	BY	CHKD
C	12/26/2012	16881	RWS	GLS
B	6/11/2009	12305	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	
NONE	05-07-2007	GLS	RL	RL	CAD

ORDER NUMBER	DRAWING NUMBER	REV
	07-22070	C

SPX COOLING TECHNOLOGIES

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:

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

Where $\boldsymbol{V}$ *= voltage*
$\boldsymbol{I}$ *= currents (amps)*
$\boldsymbol{f_p}$ *= 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)

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

TR-018 | ISSUED 10/2016

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. ______________
2. ______________
3. ______________
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. ______________
2. ______________
3. ______________
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®

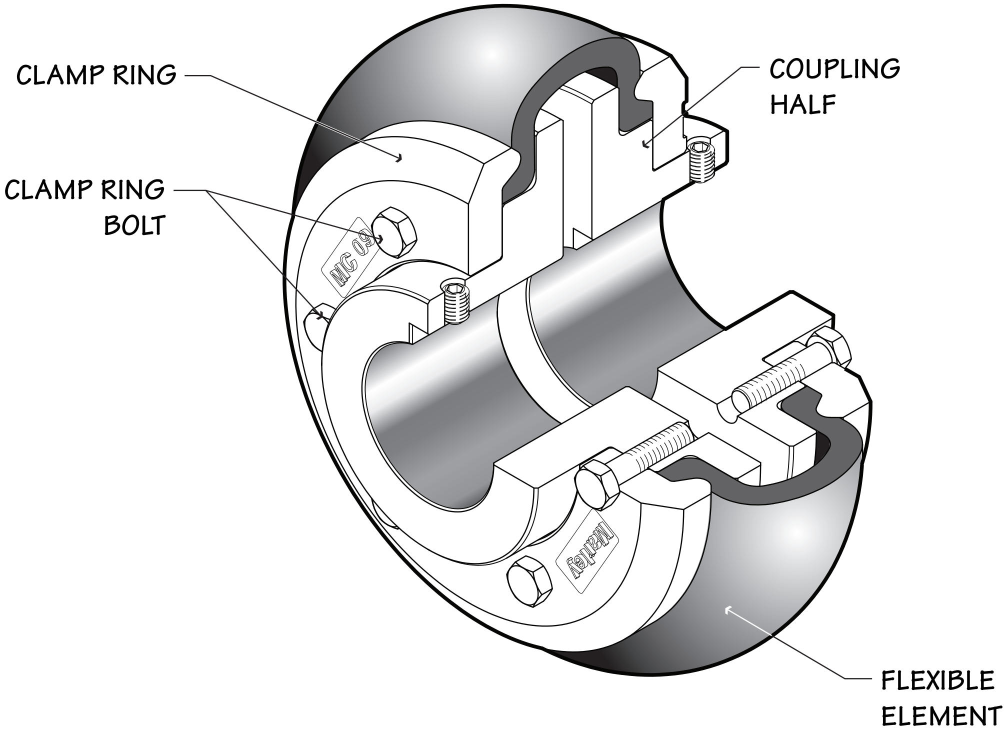
user manual

Softork™ MC coupling

INSTALLATION - OPERATION - MAINTENANCE

Z0592740_A ISSUED 02/2017

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

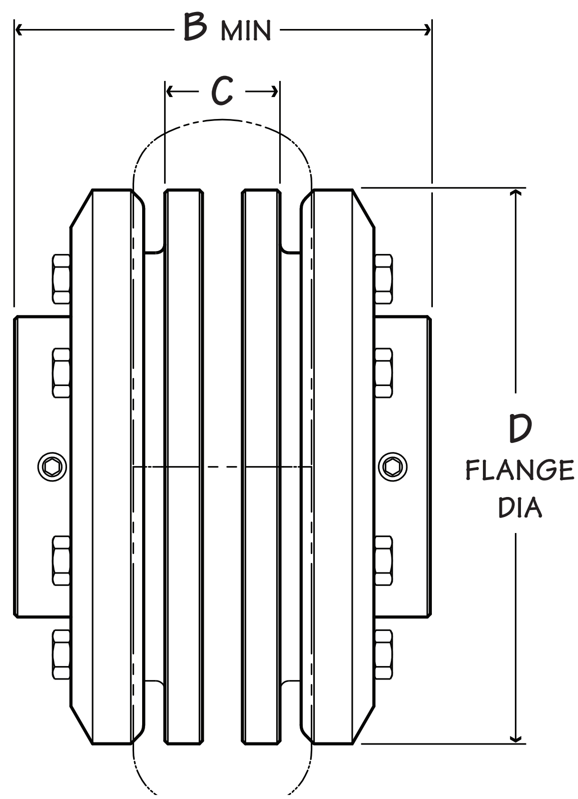


Assembly and Alignment

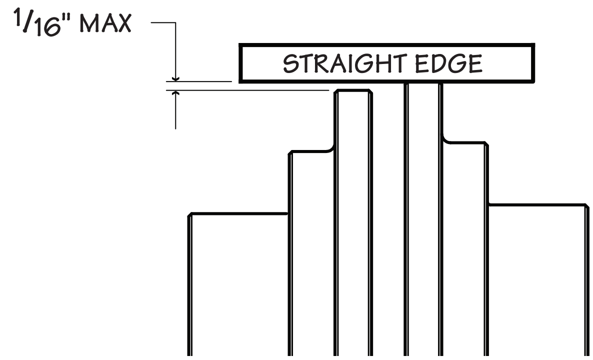
1. Inspect and clean motor and Geareducer® shafts. Remove any burrs on shafts with emery cloth or a fine file. Remove all lubricants from coupling bores and mating surfaces. Install keys in motor and Geareducer shaft keyways.
2. Install a clamp ring on each coupling half using the bolts provided.

   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 ⅛" 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.

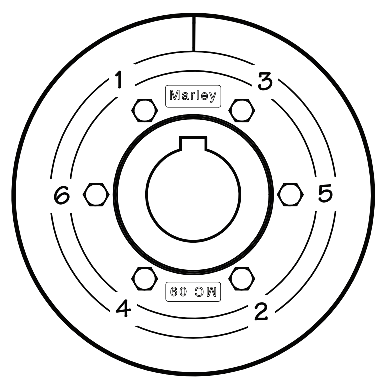
   Note: MC07 couplings have 5 bolts/half, use a similar cross pattern.

   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	5⅛"	1½"	5⅝"	24	5⁄16" x 1½"
MC09	59⁄16"	117⁄32"	7⅜"	33	⅜" x 1½"
MC11	6⅜"	19⁄16"	93⁄16"	33	⅜" x 1½"

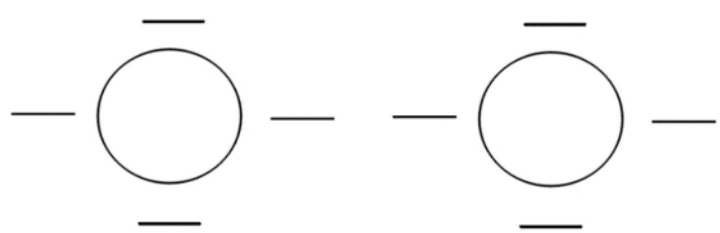
Hands on Training – Marley 6Q Driveshaft Replacement and Alignment Check

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?

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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

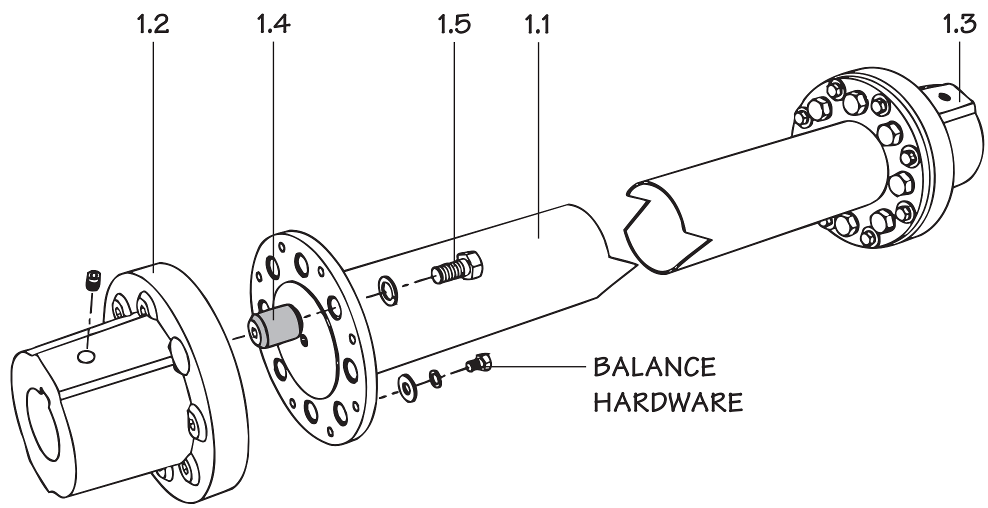

Figure 1 *250 Series shown*

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.

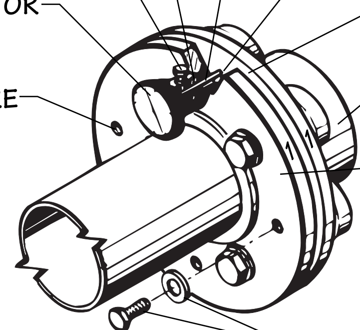

Figure 2 *6Q Series shown*

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.

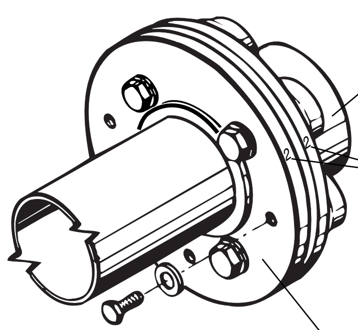

Figure 3 *6Q Series shown*

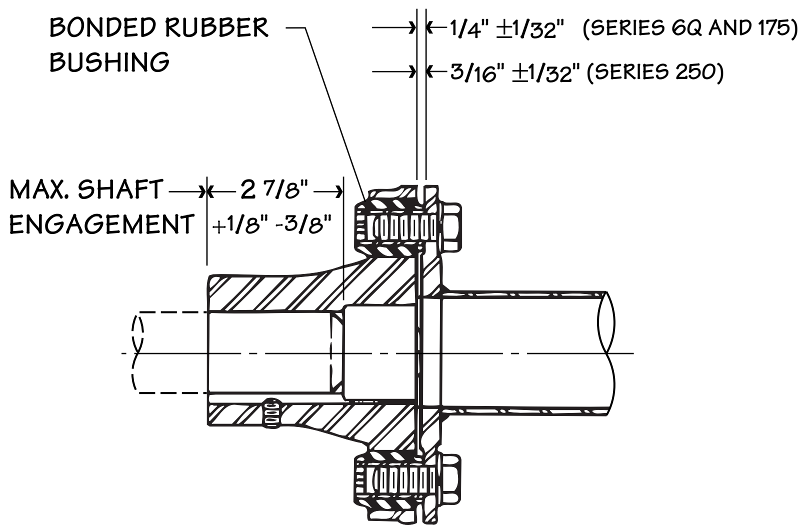

Figure 4 *250 Series shown*

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

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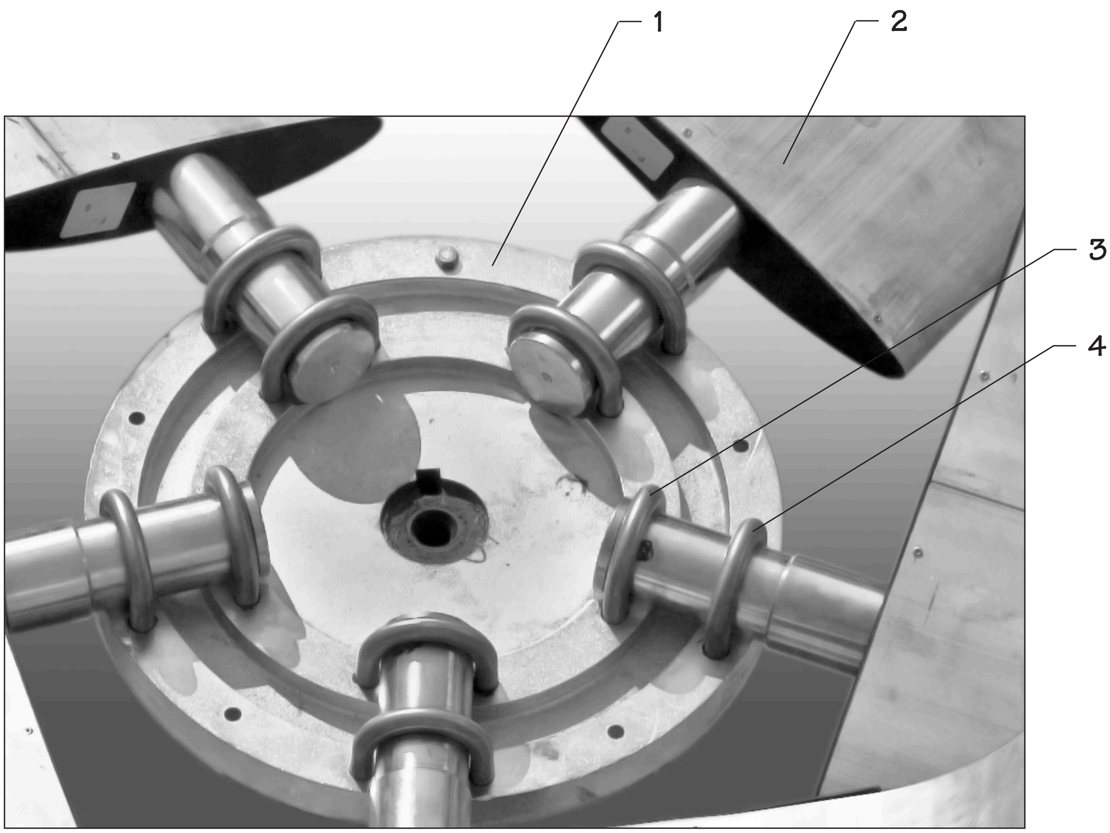

Figure 1–Typical Fan Assembly

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**.

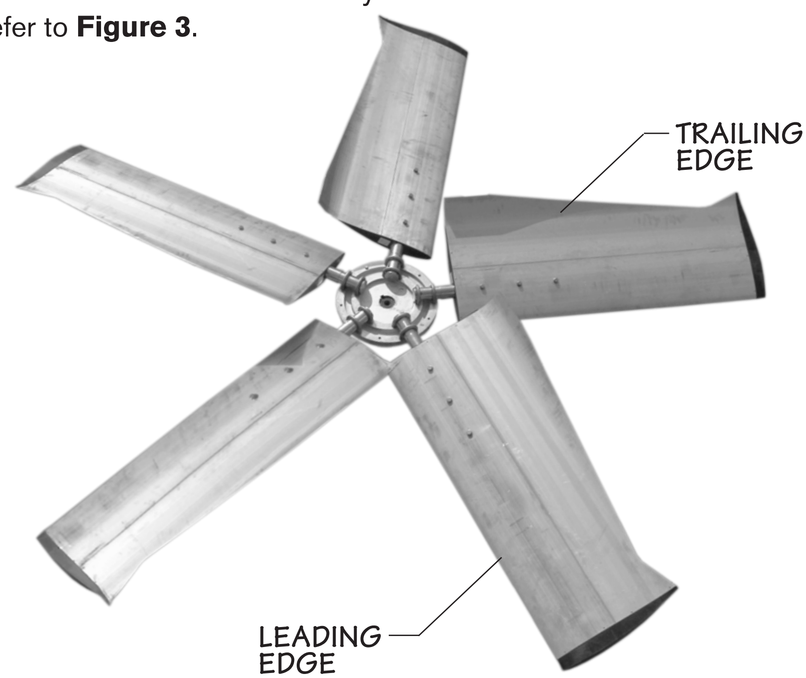

Figure 2

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.

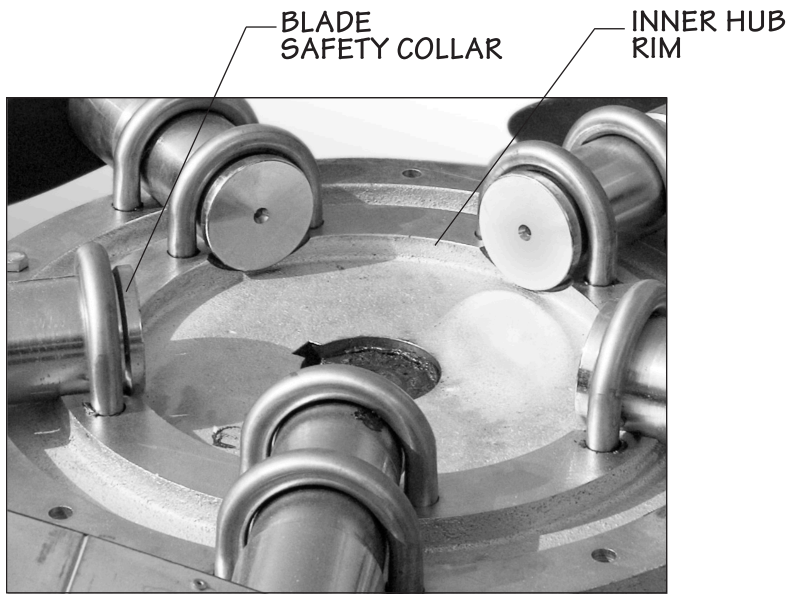

Figure 3

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.

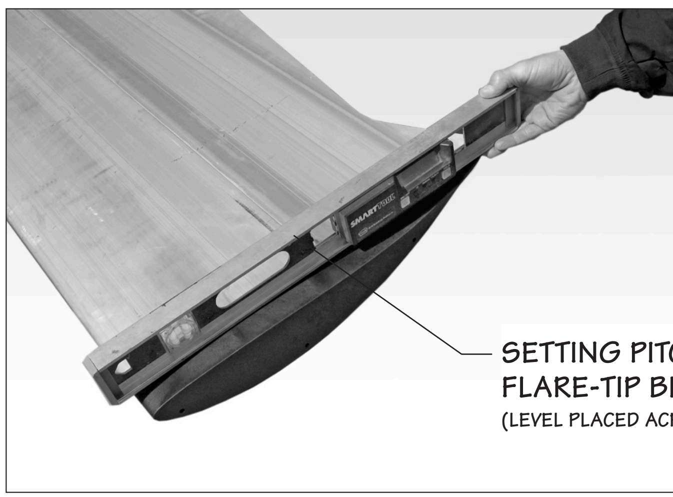

Figure 4

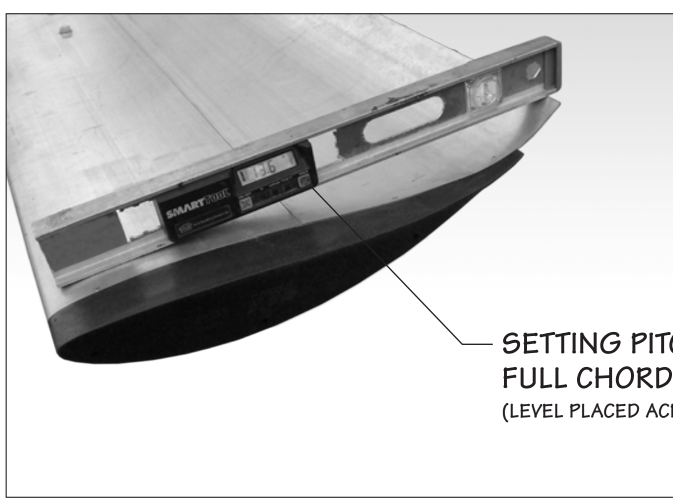

Figure 5

Table 6

Fan Model	Bolt Diameter mm	Torque Wrench Setting	
		ft·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
$VOLTS_A$	=	olts 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).

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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 B: ____________________________
Blade C: ____________________________
Blade D: ____________________________
Blade E: ____________________________
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:

user manual

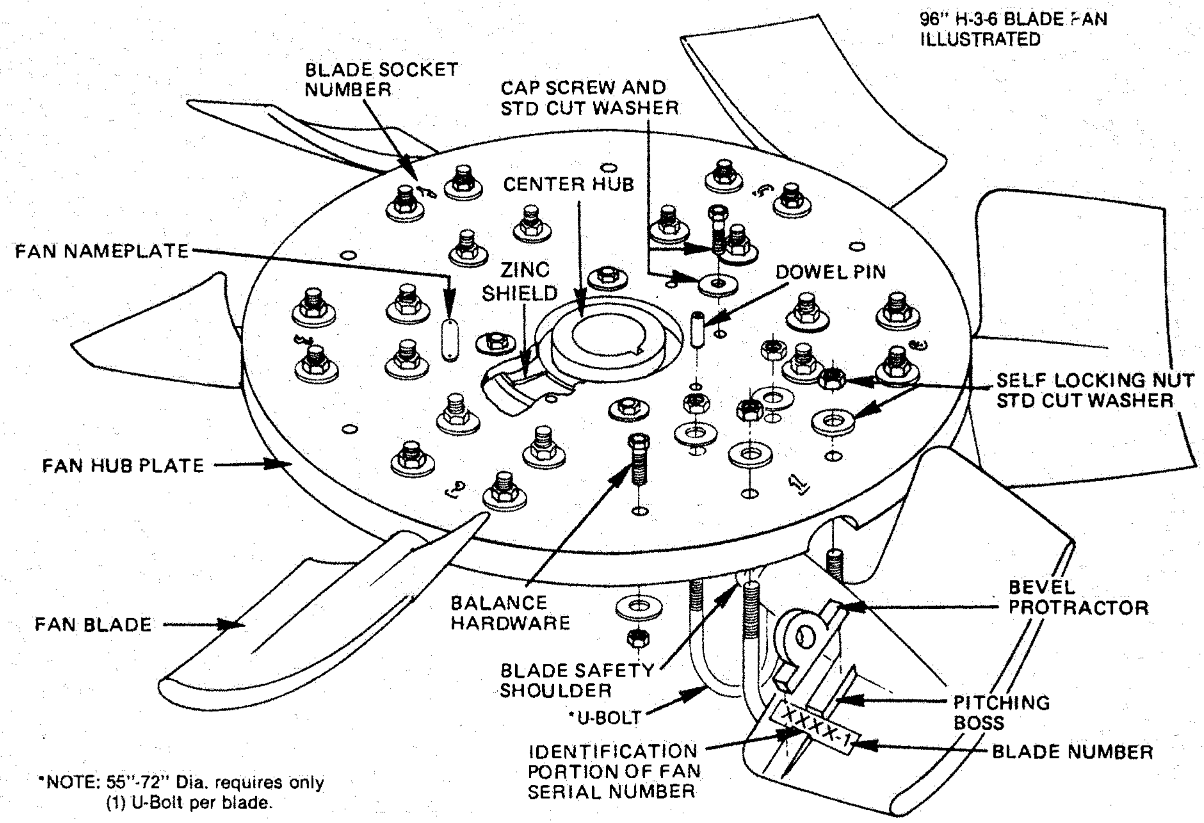
H3 fan

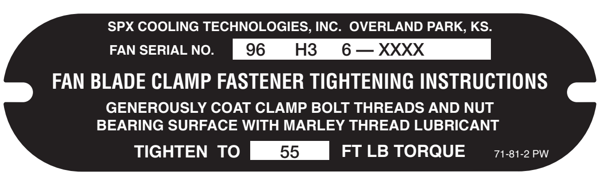
INSTALLATION - OPERATION - MAINTENANCE

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





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	Box Wrench
Digital Level	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®

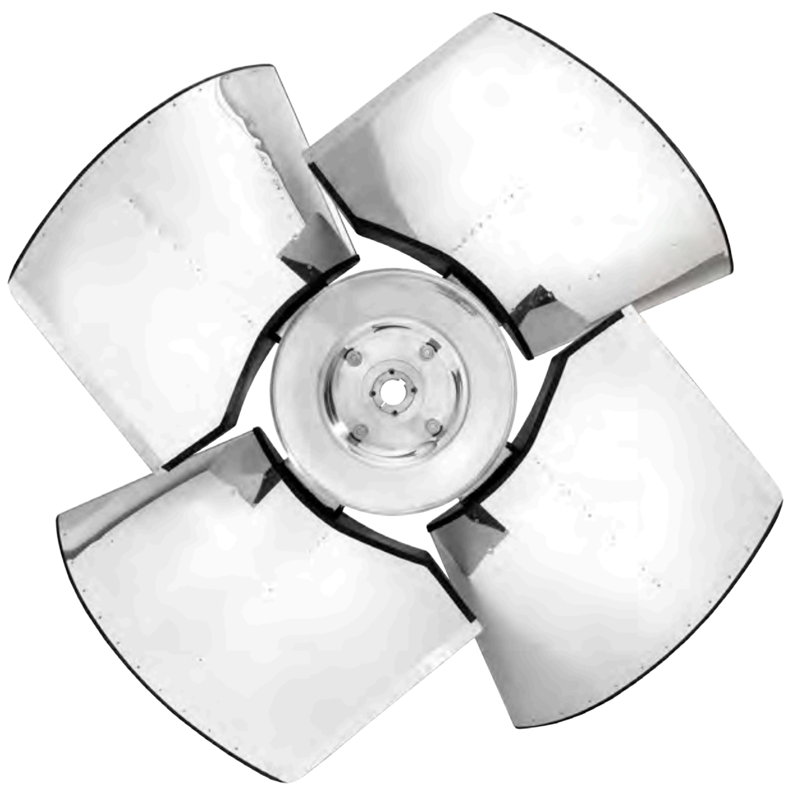
user manual

Ultra Quiet fan

INSTALLATION - OPERATION - MAINTENANCE

Z0414808_B ISSUED 06/2016

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



safety and handling

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 Technologies, Inc. engineering is authorized to evaluate any issues exceeding the above description of minor aesthetic imperfections.

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

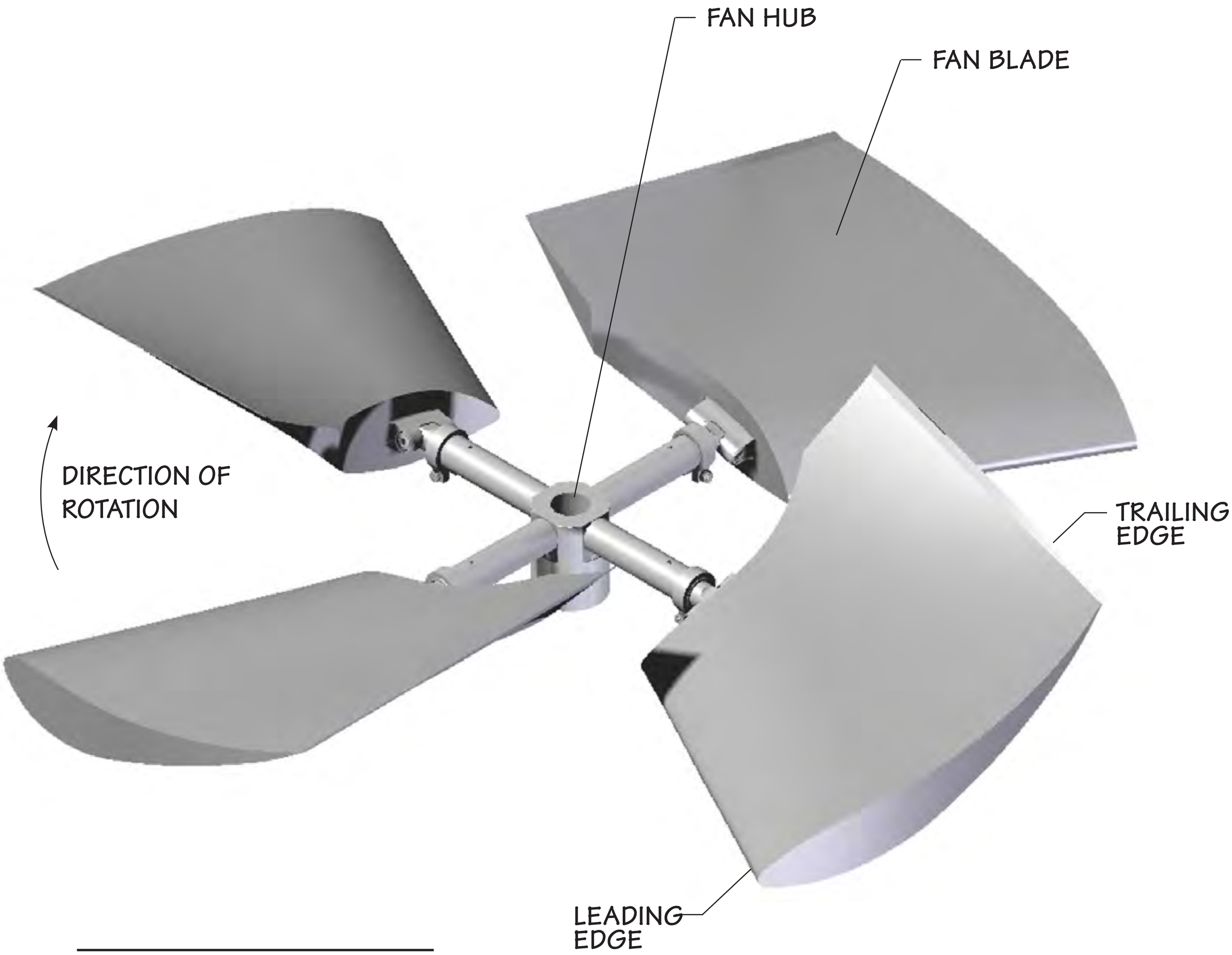


Figure 1

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**.

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.***

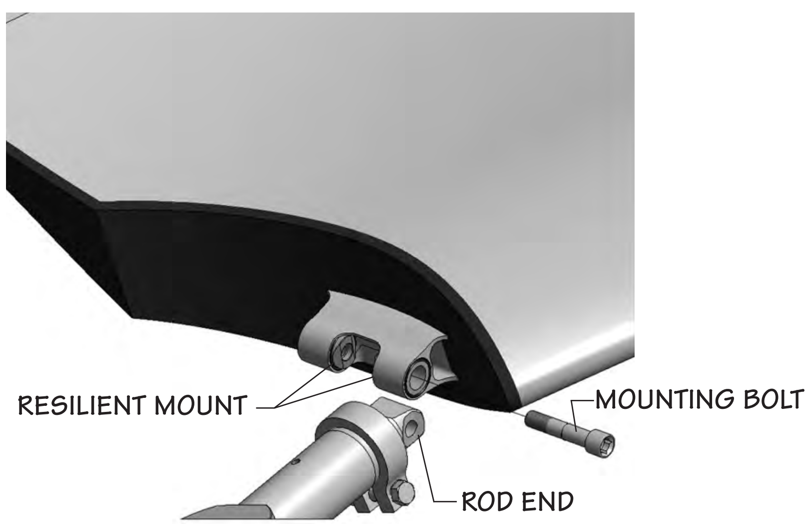


Figure 2

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 200 ft-lb (271 N·m) making sure the rod end and the resilient mounts seat.

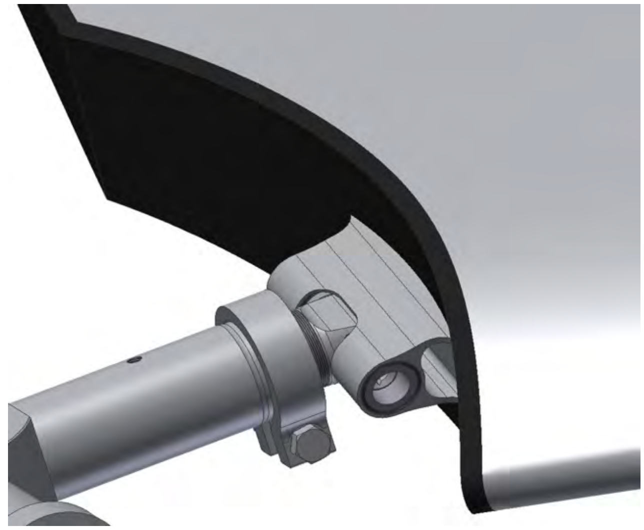


Figure 3

5ll-thestother blades. See **Figure 3** for completed blade connection. All bolts should be tightened to 200 ft-lb (271 N·m). If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

installation

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

Note

Installation is applicable to the fan being installed on a gear drive or belt drive fan shaft

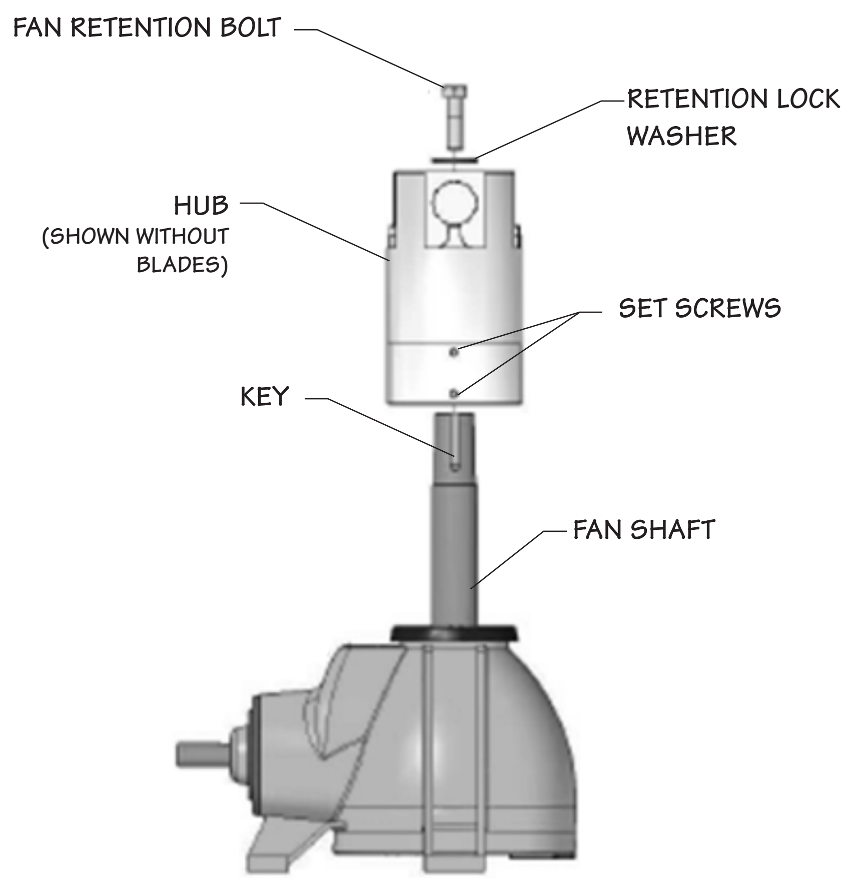


Figure 4

7–Install the hub retention bolt with the lock washer 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.

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 1** on page 11.

9–Install the air seal.

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 5**.

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 6**.

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 5

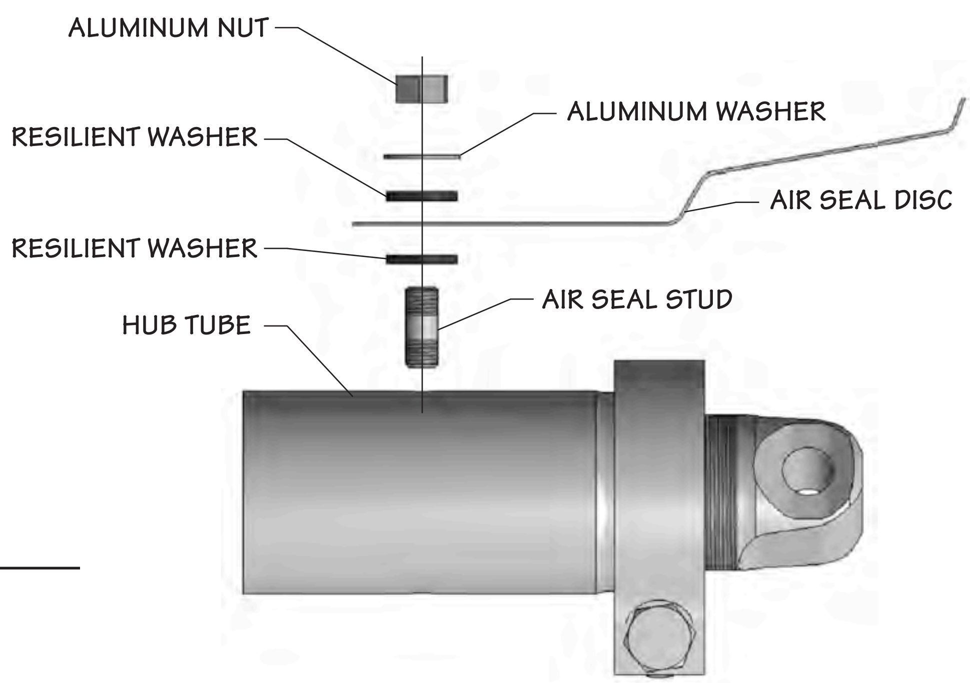


Figure 6

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 7**. 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.

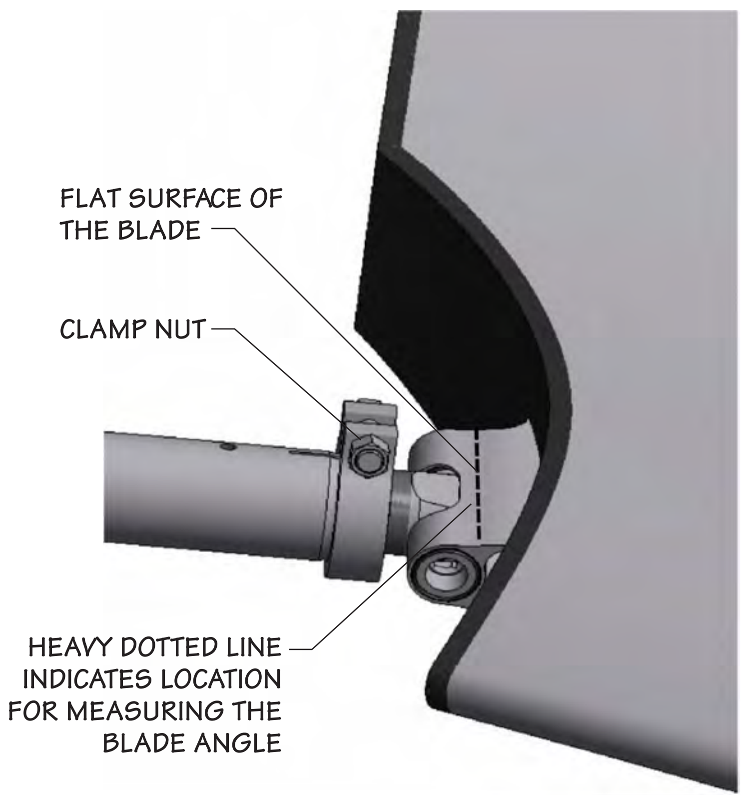


Figure 7

blade tip clearance adjustment

It may be necessary to adjust the fan diameter to suit a particular fan cylinder ring. See **Figure 8.** The tip clearance of the blades should be in the range of the fan diameter listed in **Table 1**. 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.

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)

Table 1

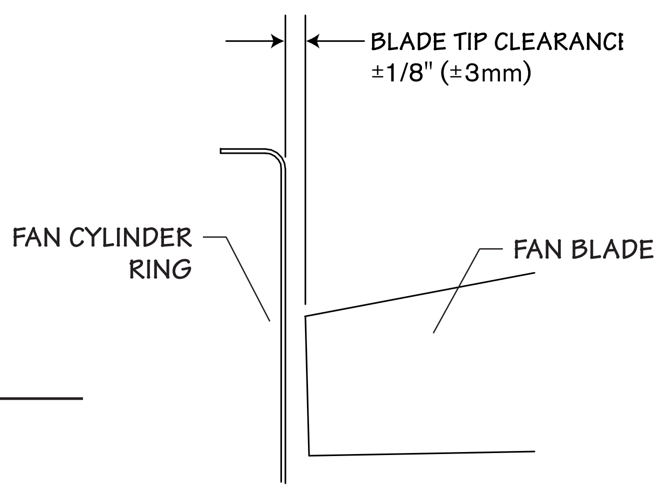


Figure 8

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 Technologies, Inc. Determine corrected horsepower using the following equation.

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

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

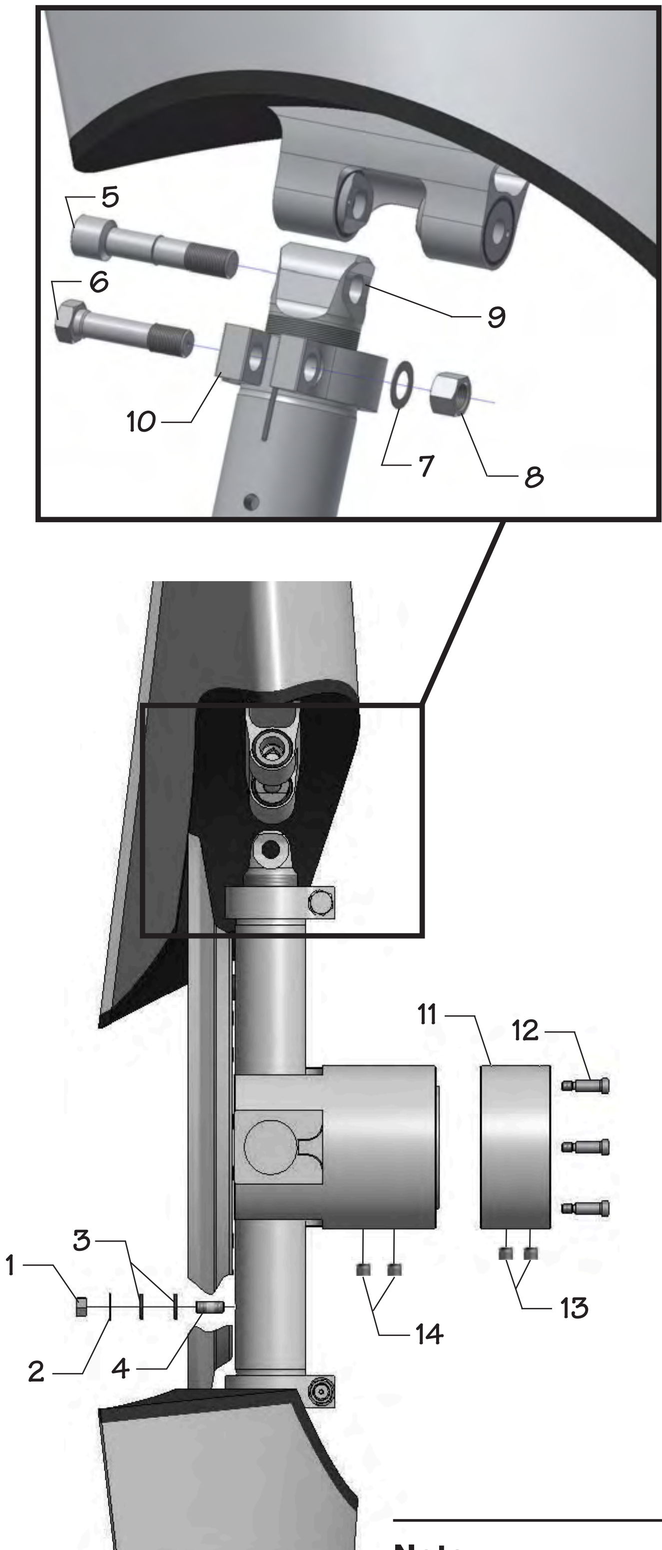
HP_C	=	Corrected Horsepower	$VOLTS_N$	=	Nameplate Volts
$VOLTS_A$	=	Actual Volts	$AMPS_N$	=	Nameplate Amperage
$AMPS_A$	=	Actual Amperage	HP_N	=	Nameplate Horsepower
$DENSITY_A$	=	Actual Air Density	$DENSITY_D$	=	Design Air Density

Note

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

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

parts list



1	ALUMINUM NUT
2	ALUMINUM FLAT WASHER
3	RESILIENT WASHER
4	AIR SEAL STUD
5	ALUMINUM BLADE BOLT (9' - 12' FAN DIA)
5	ALUMINUM BLADE BOLT (5'-8' FAN DIA)
6	CLEVIS CLAMP BOLT (9'-14' FAN DIA)
6	CLEVIS CLAMP BOLT (5'-8' FAN DIA)
7	SS FLAT WASHER (9'-14' FAN DIA)
7	SS FLAT WASHER (5'-8' FAN DIA)
8	CLEVIS CLAMP NUT (9'-14' FAN DIA)
8	CLEVIS CLAMP NUT (5'-8' FAN DIA)
9	MAG ROD END (9'-14' FAN DIA)
9	MAG ROD END (5'-8' FAN DIA)
10	MAG CLEVIS CLAMP (9'-14' FAN DIA)
10	MAG CLEVIS CLAMP (5'-8' FAN DIA)
11	GRDR-2000 SHAFT ADAPTOR
11	GRDR-2200 SHAFT ADAPTOR
11	GRDR-2400 SHAFT ADAPTOR
11	GRDR-3000 SHAFT ADAPTOR
12	1.5" SS SHOULDER BOLT (6)
13	SS SET SCREW (2) (9'-14' FAN DIA.)
14	SS SET SCREW (2) (5'-8' FAN DIA.)

Note

When ordering parts always provide the cooling tower serial number and if possible, the fan serial number located on the fan hub.

Hands on Training – Oil Seal Replacement on 22.3 Geareducer

Objective: Learn how to remove pinion cap, prepare the pinion shaft to keep from damaging a new seal during installation then install a new pinion cap with a lip type seal. Gain a better understanding of the information included in the field installation instructions and the time it takes to change the pinion cap seal located inside a tower.

Scenario: Customer has a leaking pinion shaft oil seal and needs to be changed. During your research using SPX service record and parts price catalog, you find that the oil seal installed in the geareducer is a Clipper seal. Per the price pages, this seal is no longer available and a new pinion cap with lip type seal is required.

22.3 Price Page – Located in Parts Catalog September 21st 2015

1.1C	PINION SHAFT LOCKWASHER (INCLUDED WITH GEAR KITS)	158857	$5.31	1/2
1.1C	PINION SHAFT LOCKNUT (INCLUDED WITH GEAR KITS) (2 REQUIRED)	158782	$23.00	1/2
	AIR VENT	035394	$24.00	1/2
1.2	OIL SLINGER	393934	$185.00	3
1.3	PINION SHAFT BEARINGS:			
	INNER ONLY	207878	$295.00	12
	OUTER ONLY	207852	$113.00	12
1.4	PINION SHAFT OIL SEAL, LIP TYPE (5) (6)	210302	$15.00	1/2
	RING SPACER ONLY (6)	C25772	$19.00	1/2
	PINION SHAFT OIL SEAL, LIP TYPE W / PINION CAGE CAP (5) (6)	C25812	$284.00	13

Pictures & More Info – Located in Parts Catalog September 21st 2015

Clipper

The Clipper seal is commonly called a bearing isolator and it's a combination lip seal & labyrinth seal in one unitized cartridge. The seal consists of two separate parts that are permanently connected together, a stainless steel inner member that rotates with the shaft and a PTFE outer member that remains stationary in the cap. You can see in the cut-away (pictured to the right) the two lips that ride on the stainless inner member to provide a contact seal and you can see how the stainless steel and PTFE parts nest together to form the labyrinth to keep dirt and moisture out as well. The inside of the stainless member and the outside of the PTFE member are sealed with o-rings.

The Clipper seal is OBSOLETE and no longer available. The replacement is now the Lip Type seal. However, the Clipper used a dimensionally different pinion cage cap compared to the Lip Type, because the Clipper is "thicker" than the Lip Type. The Lip Type seal can be used in place of the Clipper when an additional ring spacer is used. The ring spacer not only moves the position of the seal wear area on the shaft, but also serves to cover the open end of the pinion cage cap to keep dirt and moisture out as well. **SPX recommends replacing a Clipper seal with the Lip Seal Kit with Pinion Cage Cap.**

Procedure and Tools:

See the follow 3 pages "2200 Geareducer lip seal field installation" instructions.

Take Away Points:

- How to identify the type of seal in a gearducer.
- How to install a pinion shaft oil seal without damaging the new seal.
- Understand why oil seal ware out overtime.

Hands on Training – Oil Seal Replacement on 22.3 Geareducer

2200 GEAREDUCER LIP SEAL FIELD INSTALLATION

This procedure applies to the 22.1, 22.1T, 22.2, 22.3 & 2200 Marley Geareducers.

TOOLS REQUIRED

New Seal CR 13738 or equal (included in kit with cap and spacer)
Geareducer Oil
Small Flat File
Fine grit Emory cloth or Scotch Brite pad
Torque Wrench
Various wrenches and sockets
Dead blow hammer, Chisel and Pry Bars
Allen wrenches
Oil Buckets and rags

REMOVAL OF OLD SEAL AND CAP

1. Lock out motor control and follow all safety criteria.
2. Drain approximately 5 quarts of oil from the gear box to lower the oil level below the bottom of the pinion cage cap.
3. Disconnect and move driveshaft spacer tube out of the way. If close coupled, the motor may need to be moved or swiveled to allow enough space to access the Geareducer input shaft.
4. Remove driveshaft/coupling yoke or hub from the Geareducer input shaft.
5. Carefully remove key from pinion shaft without gouging or creating burrs on shaft.
6. Using a 9/16 socket or wrench, remove the ten hex head cap screws holding pinion cage cap.
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!
9. Remove old seal from input shaft if it dislodged from the cap during cap removal. Remove old seal from cap if the seal remained in the cap during removal from the shaft.

INSTALLATION OF LIP SEAL

Shaft Preparation:

1. Ensure pinion cap counterbore is clean and free of sharp edges or burrs.
2. Thoroughly clean the sealing surfaces of the pinion cage cap and pinion cage of any residual gasket or sealant material.
3. Ensure the pinion shaft is clean and free of sharp edges or burrs. File any sharp edges of pinion shaft keyway.
4. Lightly sand the pinion shaft extension using fine emory cloth or Scotch Brite pad as needed to smooth the shaft of any scale or buildup. **DO NOT SAND OR ABRADE**

THE SEAL SEAT REGION. ONLY SAND AREAS OF THE SHAFT THAT WILL BE EXTERIOR OF THE PINION CAP.

5. Using a clean dry cloth, wipe the pinion shaft clean to remove any dust particles.

Lip Seal Installation in Cap Casting:
*NOTE: If kit is provided skip steps 6 & 7.

6. After the cap is clean, use an arbor press or hydraulic ram and appropriate flat surface disc or tube against the seal to press the new seal into the cap. **DO NOT DRIVE THE NEW SEAL INTO THE CAP WITH A PUNCH OR SCREWDRIVER.** See Figure 1.
7. The seal orientation is to have the seal spring toward the oil sump.
8. Install a wrap of electrical tape over the exposed shaft and keyway starting the wrap closest to the Geareducer and spiraling toward the outboard shaft end. See Figure 2.
9. Retrieve shim pack.
10. Apply a coating of oil to the seal lip and over the electrical tape. Carefully slide the seal, pinion cap, and shims over the shaft until the cap bears against the pinion cage mating surface. See Figure 3.
11. Reinstall pinion cap hex head cap screws. Tighten caps crews progressively, using a crossing pattern to 20 ft.-lbs.
12. Remove the electrical tape.
13. Refill the gear box with oil.
14. Reinstall driveshaft and return to service.

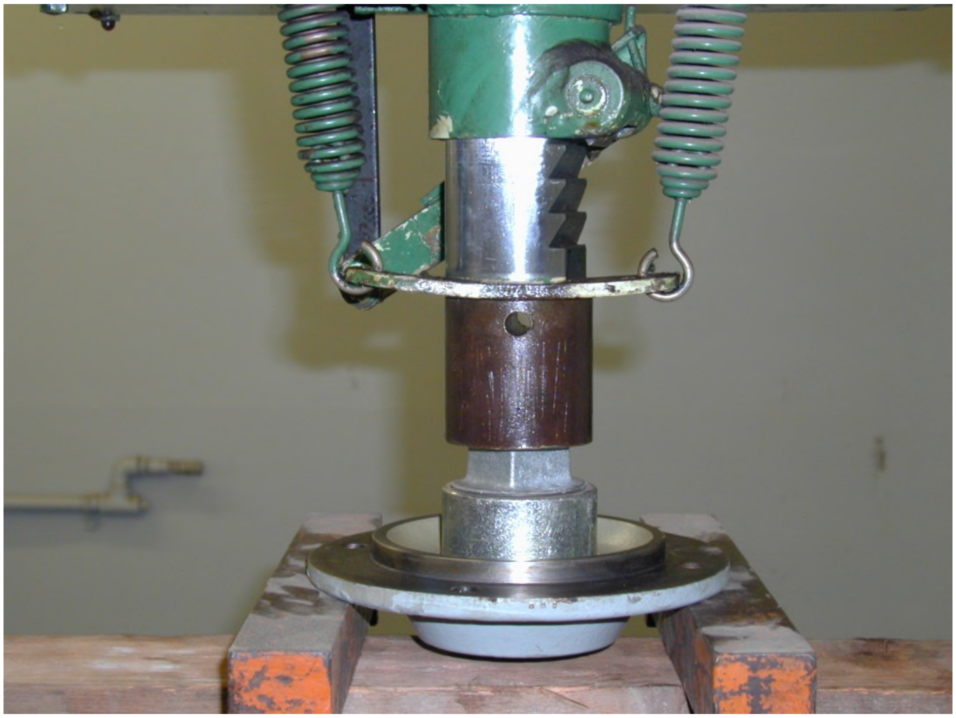


Figure 1. Seal Installation in Cap using Hydraulic Press and pipe coupling

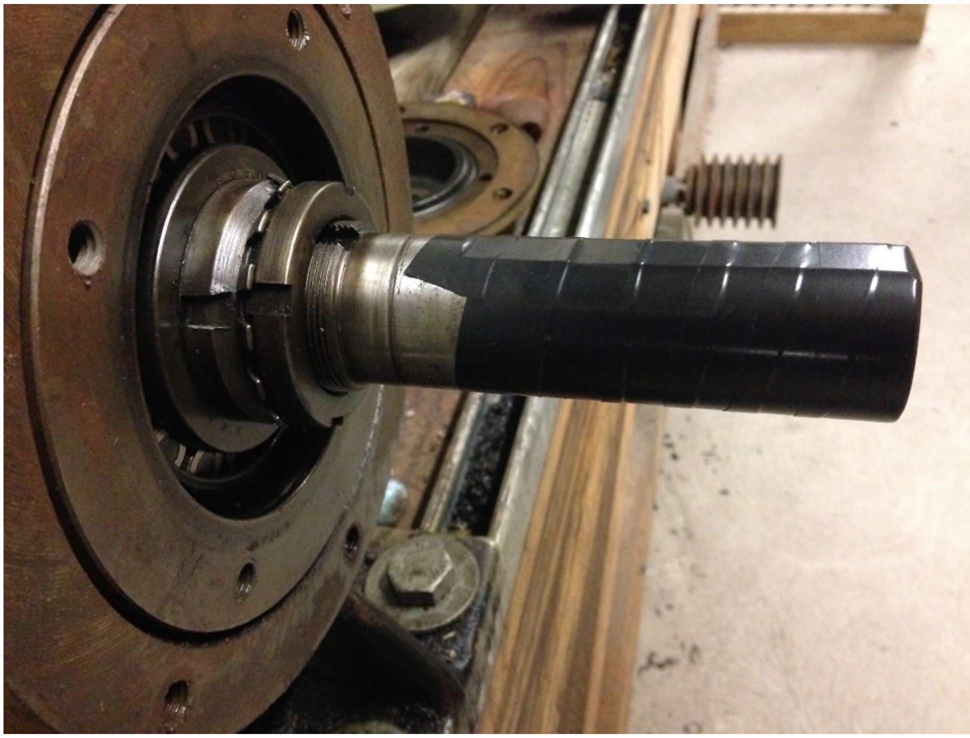


Figure 2. Install a wrap of electrical tape over the exposed shaft and keyway.

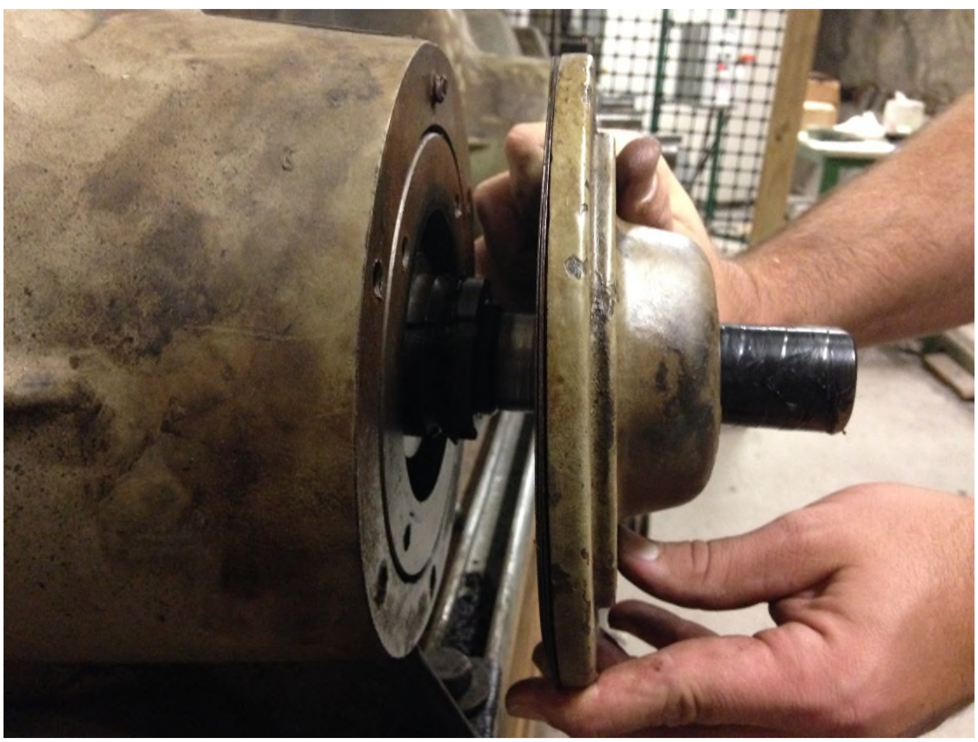


Figure 3. Slide the seal, pinion cap, and shims over the shaft until the cap bears against the pinion cage mating surface.

MARLEY®

user manual

Geareducer® models 2200 - 2250 - 2400

OPERATION - MAINTENANCE – REPAIR

Z0490769_A ISSUED 02/2017

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

operation and service

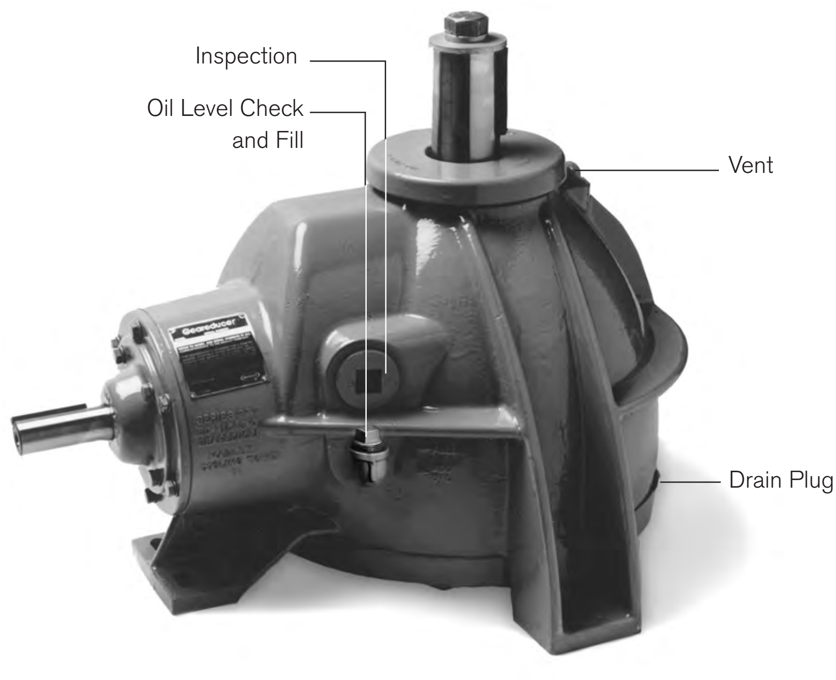


Figure 1 Service Fittings

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

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

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

Changing Geareducer Oil

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

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

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

Protection Against Corrosion

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

Repair and Overhaul

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

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

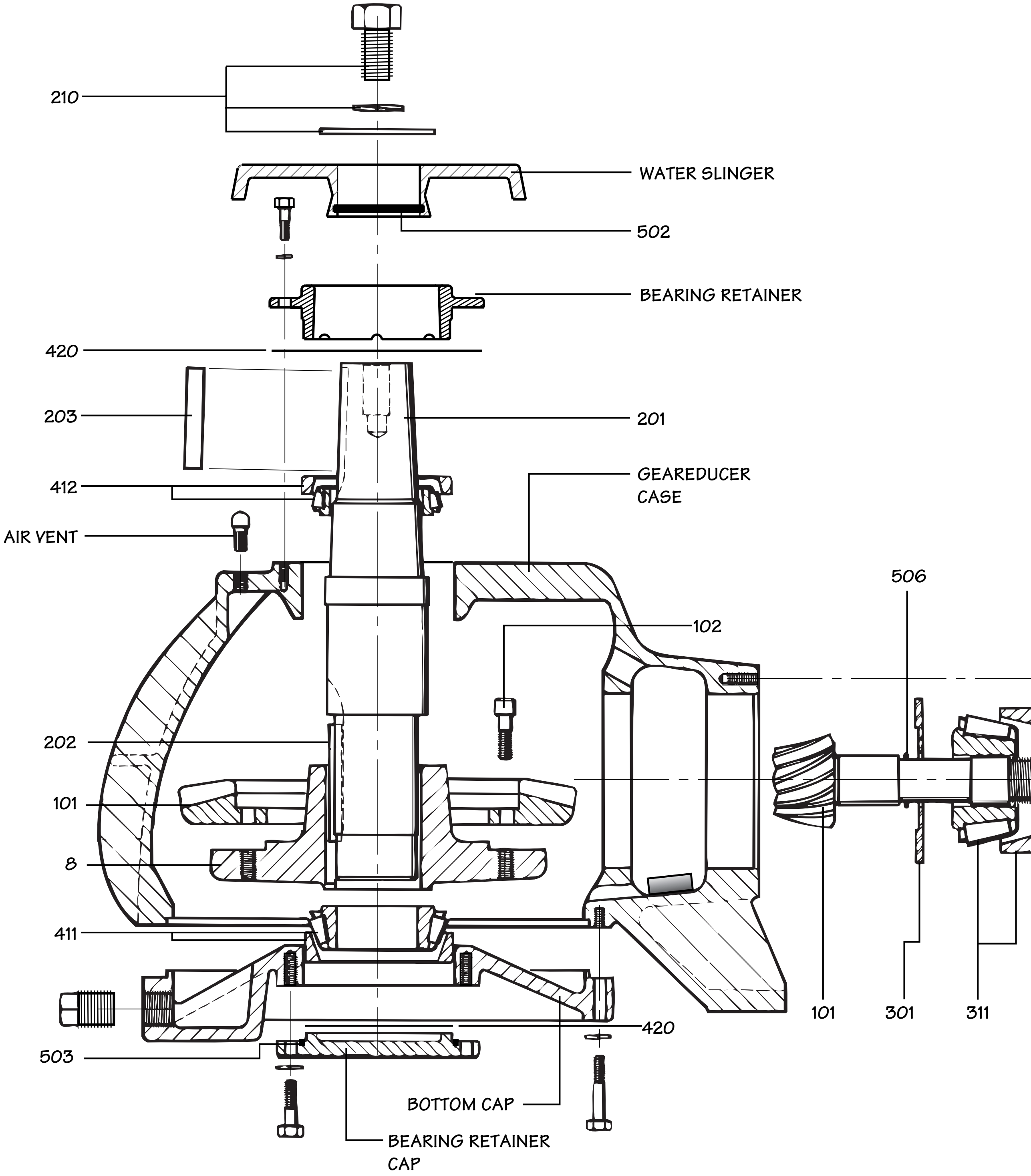
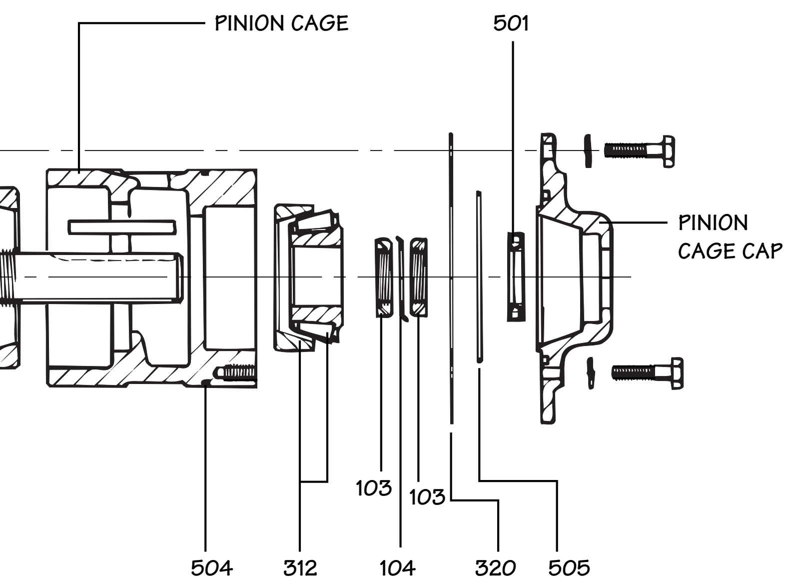


Figure 2 Exploded Cross Section

Parts List



1 Complete Geareducer Assembly.
8 Ring Gear Hub.
100 Spiral Bevel Gear Set.
- 101 Set of matched spiral bevel gears including integral pinion shaft with key.
  Gear ratios as follows:

3.45 to 1	3.79 to 1	4.10 to 1
4.56 to 1	5.11 to 1	5.50 to 1
6.12 to 1	6.50 to 1	7.33 to 1

- 102 Ring gear attaching hardware.
- 103 Locknuts.
- 104 Lockwasher.

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

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

320 Pinion Cage Shims.

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

420 Fan Shaft Shims.

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

501 Pinion Shaft Oil Seal.

field repair

General

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

Disassembly

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

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

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

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

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

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

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

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

Pinion Cage Disassembly

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

Fan Shaft Disassembly

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

Assembly

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

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

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

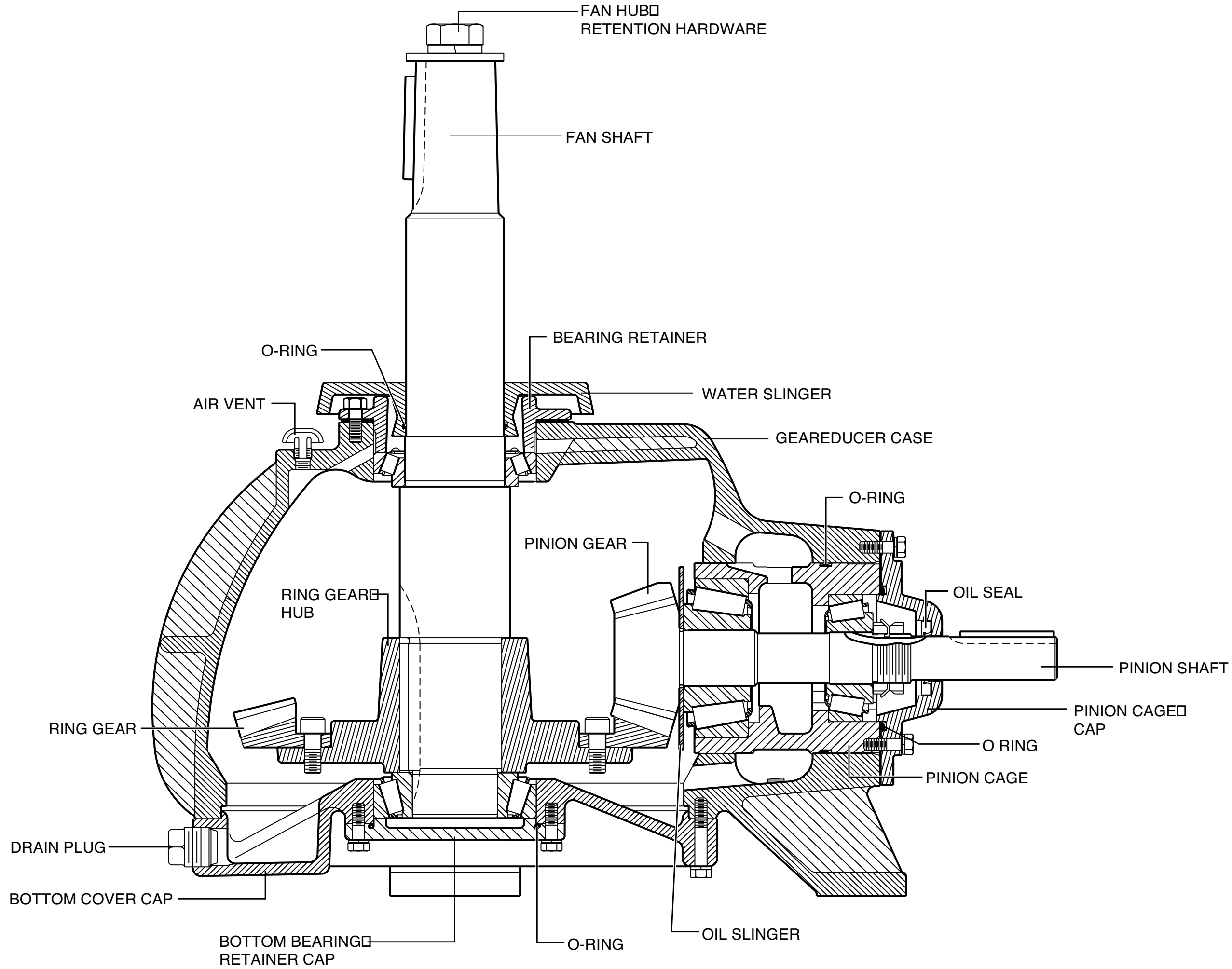


Figure 3 Cross Section

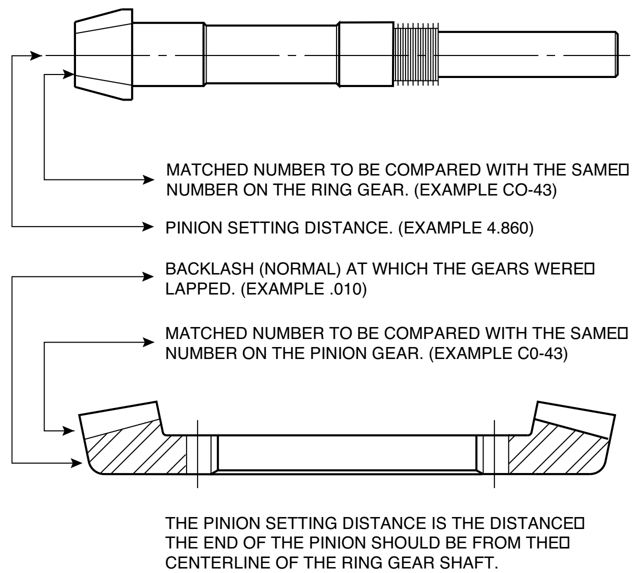


Figure 4 Gear Match Numbers and Setting Data

Pinion Cage Subassembly

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

Installation of Fan Shaft

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

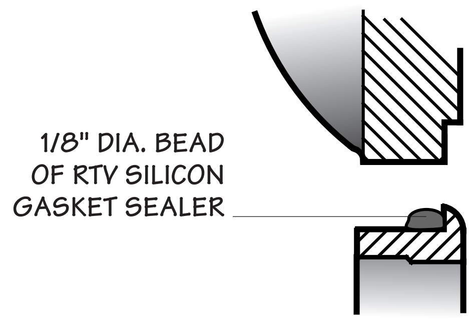


Figure 5 Flange Seal of Bottom Bearing Cap

Installation of Pinion Cage

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

   Example:

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

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

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

Gear Setting Procedure

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

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

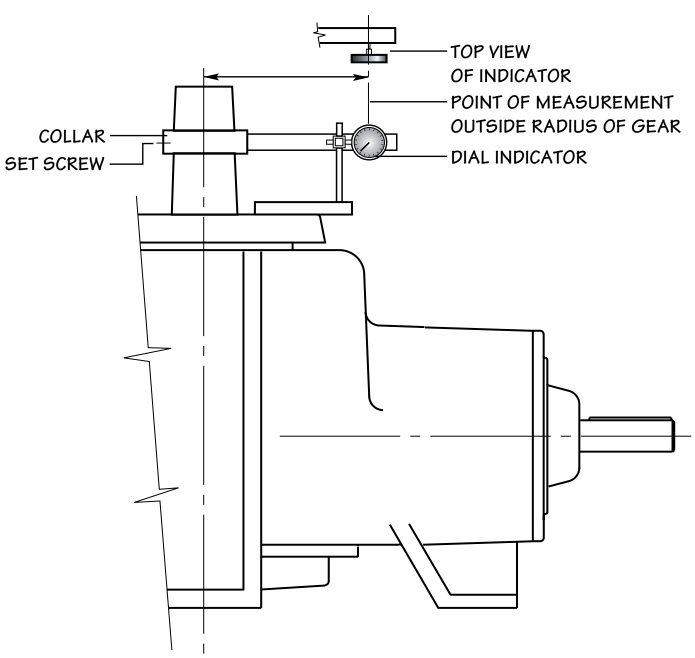


Figure 6 Gear Backlash Measurement

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

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

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

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

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

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

Final Assembly

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

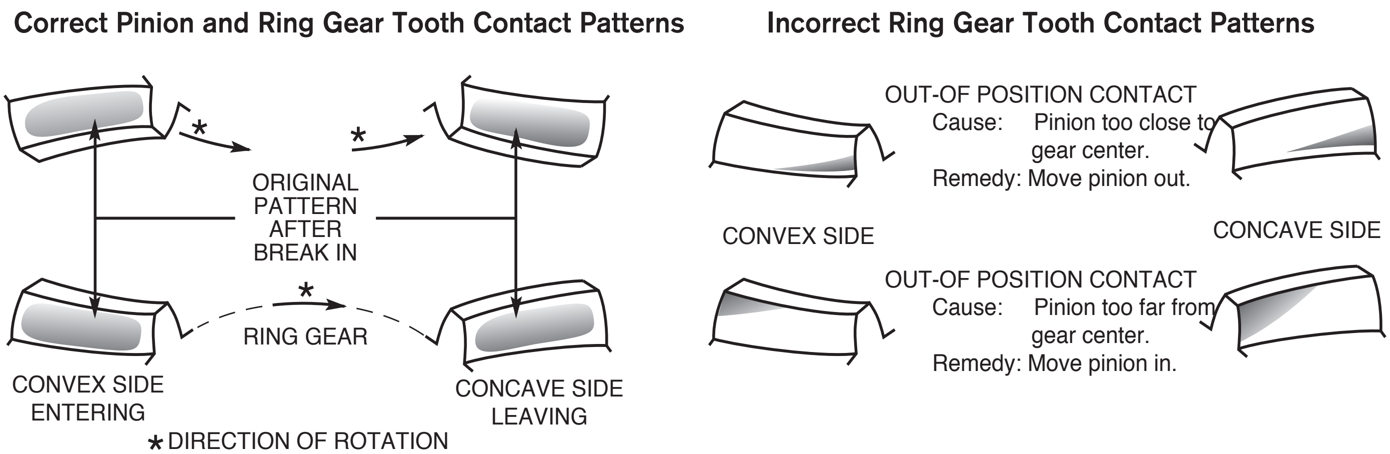


Figure 7 Tooth Contact Pattern—Correct and Incorrect

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

Z0490769_A (M99-1260E) | ISSUED 02/2017

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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.

tu_clean.doc Created: April 1, 1997 RWP

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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.

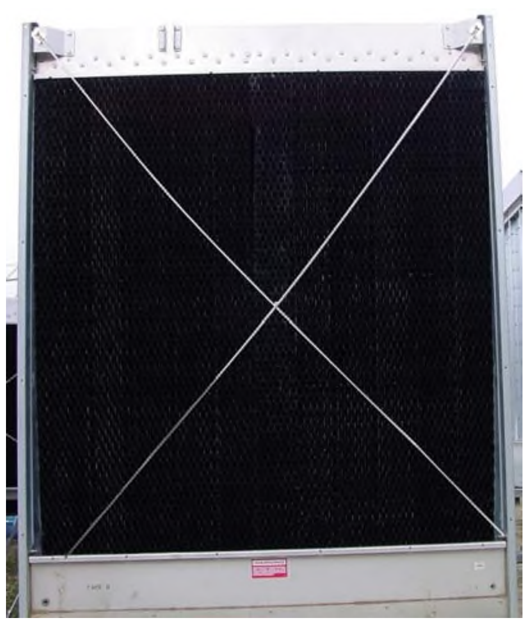
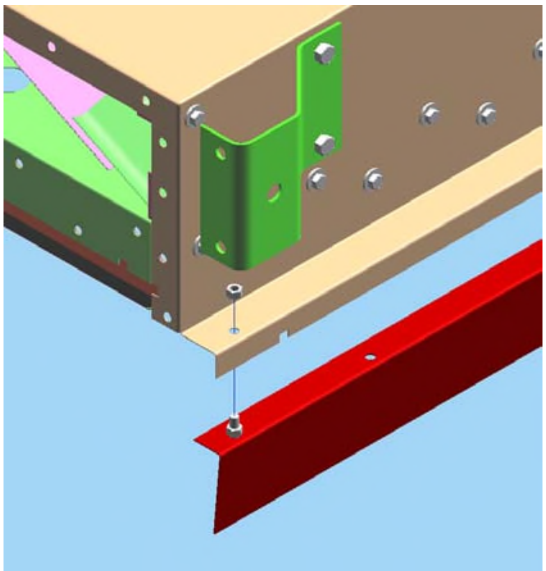
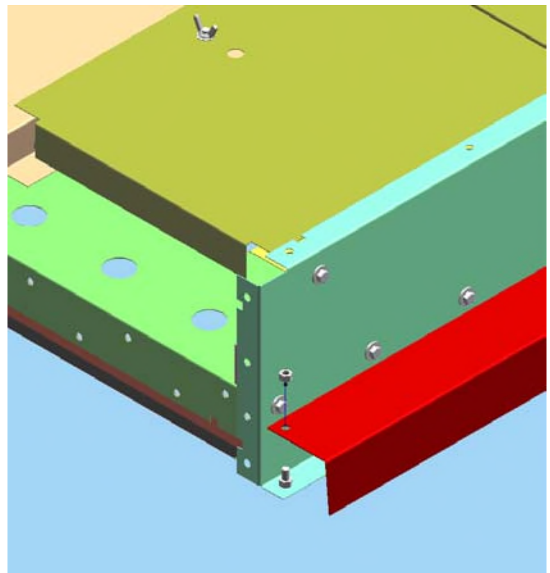


Figure 8

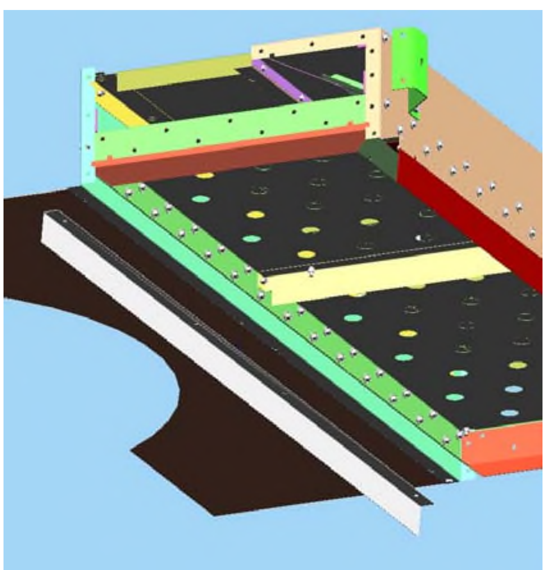
9. For NC models only install additional fill retainers using 3/8” hardware. Drill hot water basin louver and eliminator side using retainers as pattern. Minimum 4 holes are required for full hot water basin width retainer. Minimum 3 holes required for half hot water basin width retainer. Where possible use existing holes in hot water basin.



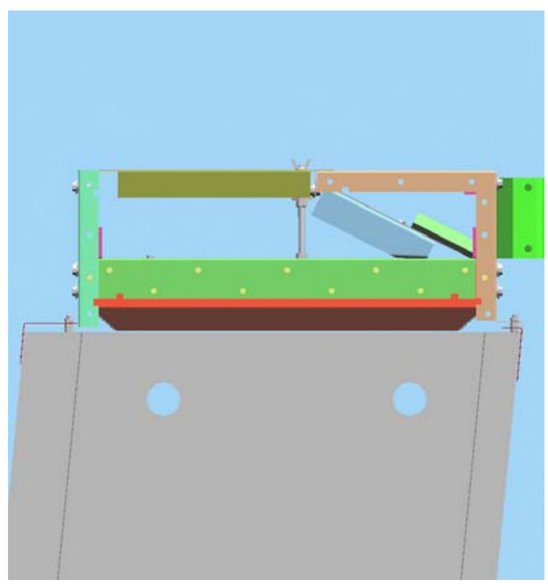
a. Louver side retainer. Install bolt thru the retainer. Tighten nut to create stud bolt. Install to HW basin as shown.



b. Eliminator side retainer.



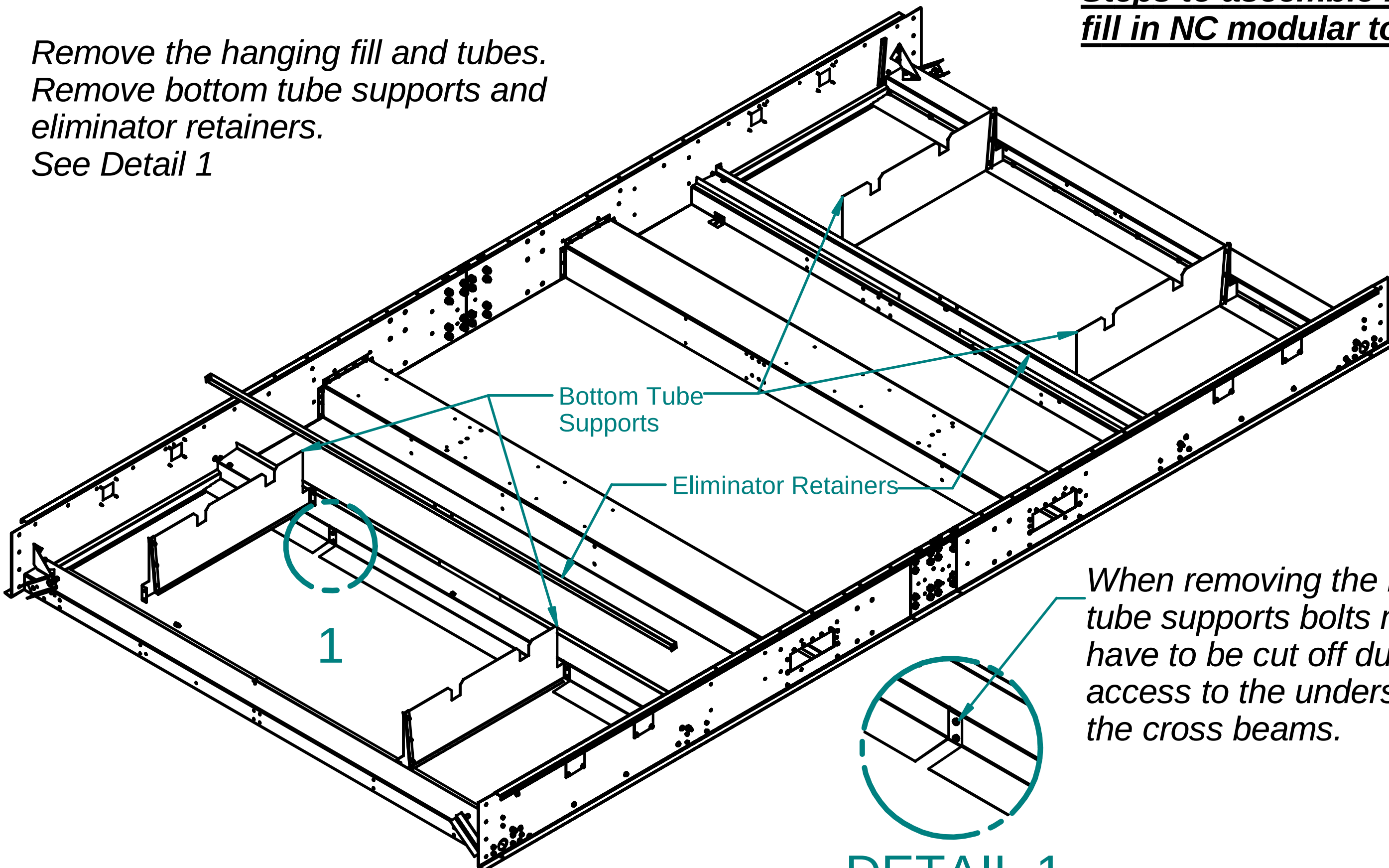
c. Eliminator side retainer (option with 8900 series tower). Retainer attaches to lower fan deck.



d. Louver and eliminator side retainers elevation view.

Steps to aseemble MBX fill in NC modular towers

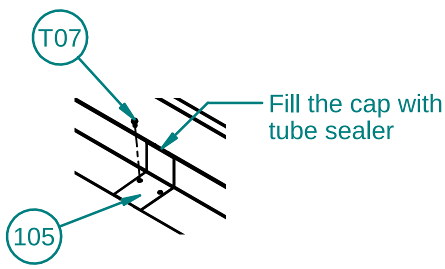
Remove the hanging fill and tubes.
Remove bottom tube supports and eliminator retainers.
See Detail 1



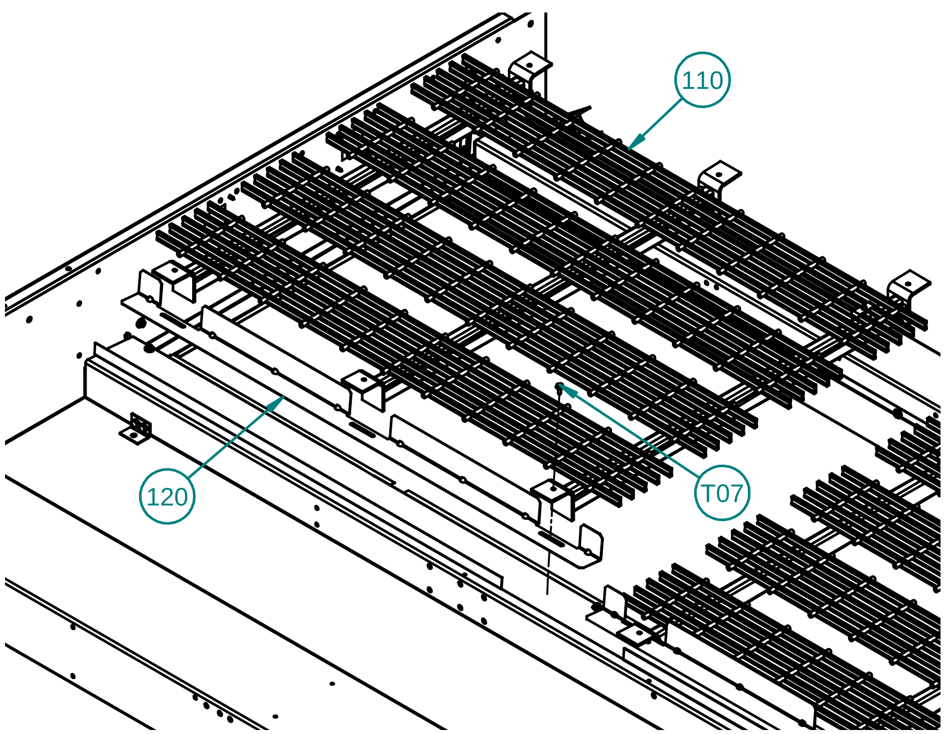
When removing the bottom tube supports bolts may have to be cut off due to no access to the underside of the cross beams.

DETAIL 1

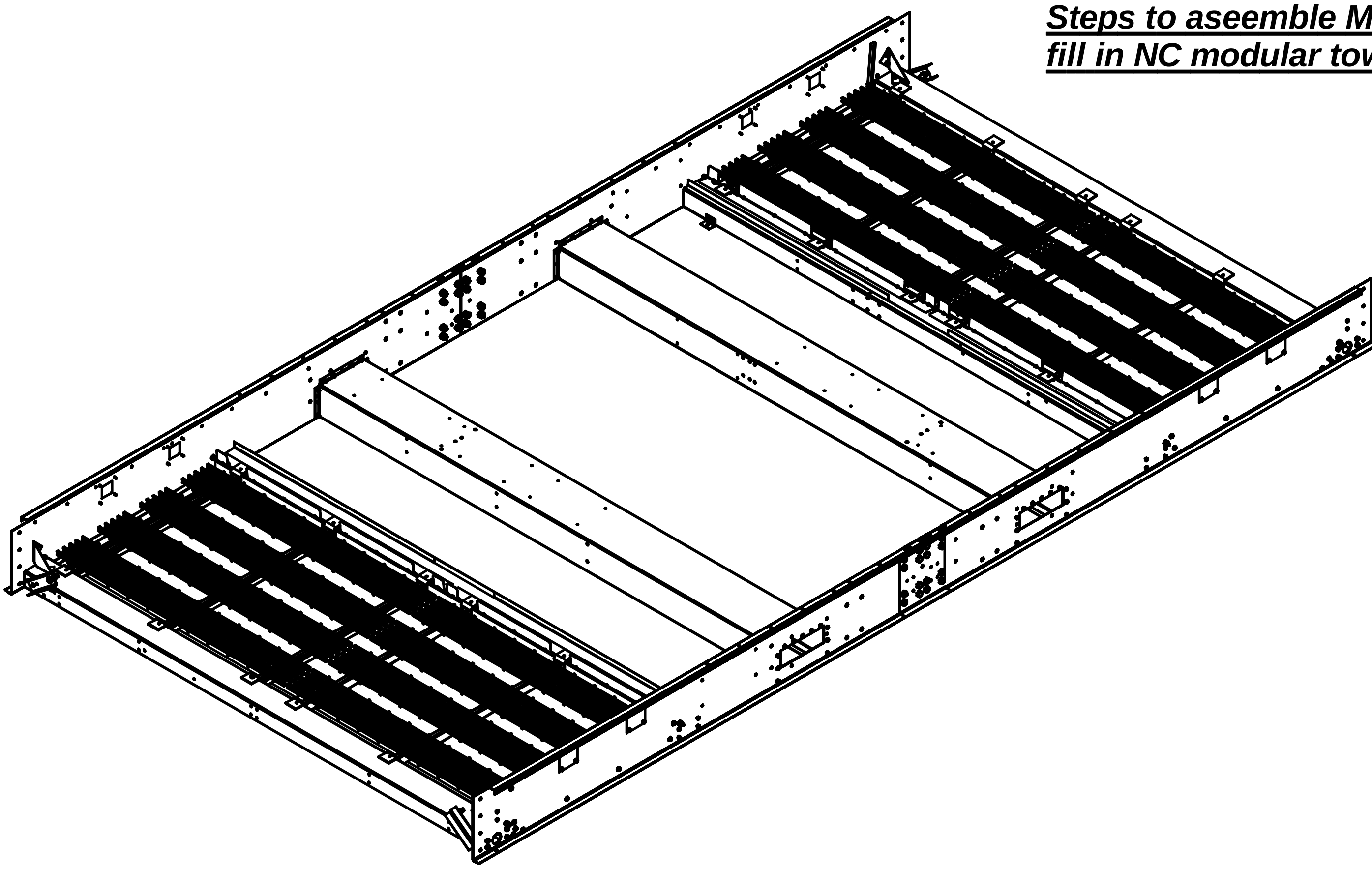
For each tube support removed, there will be 2 inch gap in the water deflector. Patch 2 inch gap with find # 105 to insure water deflection.
See Detail 2



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.

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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.

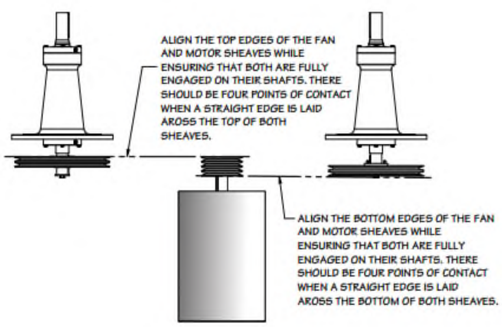
Step 1: Remove old belt and sheaves on fan and motor and reinstall new.

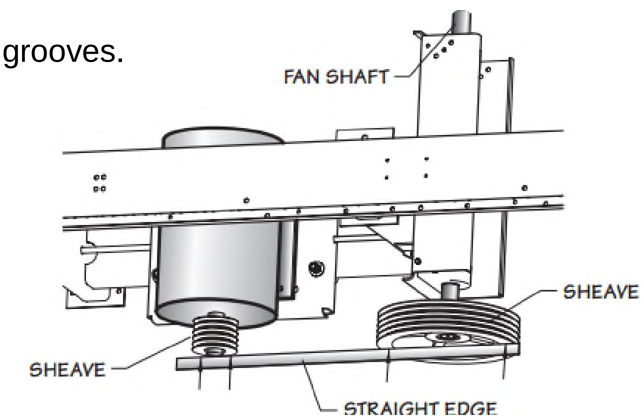
Step 2: Check Sheave Alignment

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.

MARLEY®

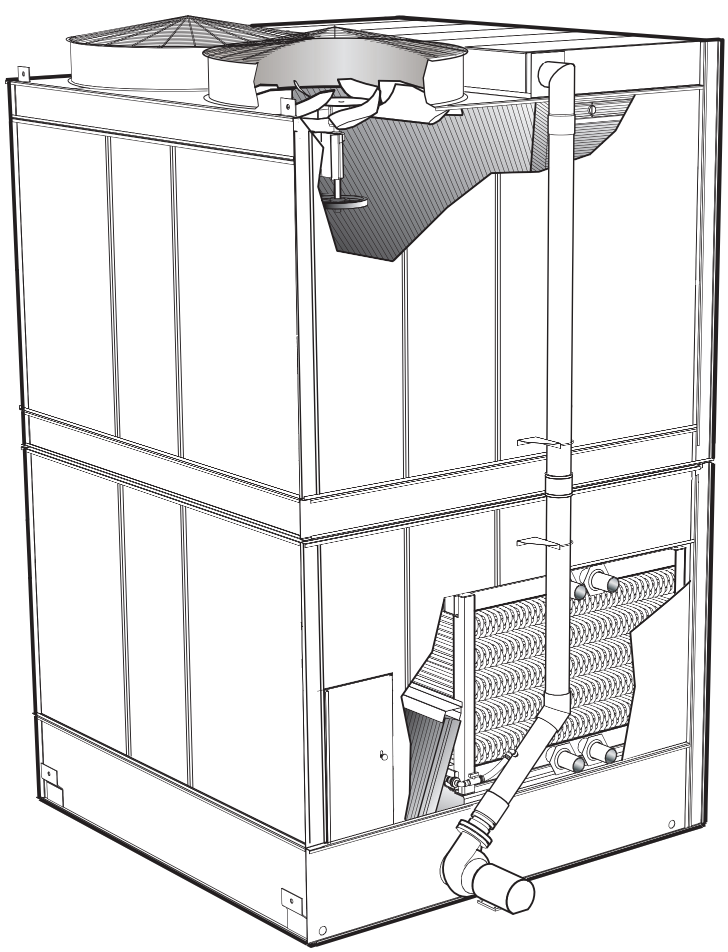
user manual

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. Maintain sufficient flow rate through the coil.
2. Maintain 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.

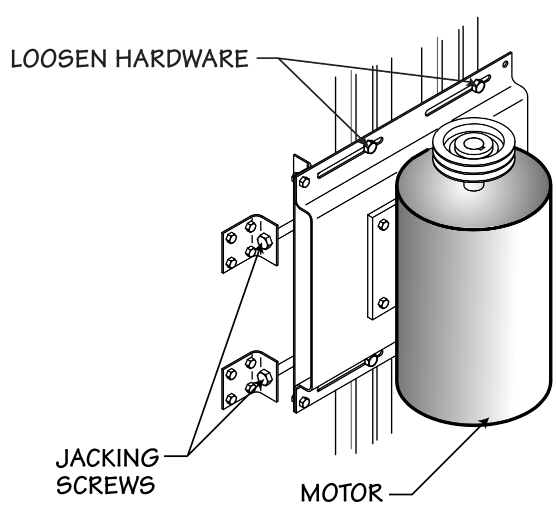


Figure 1

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.

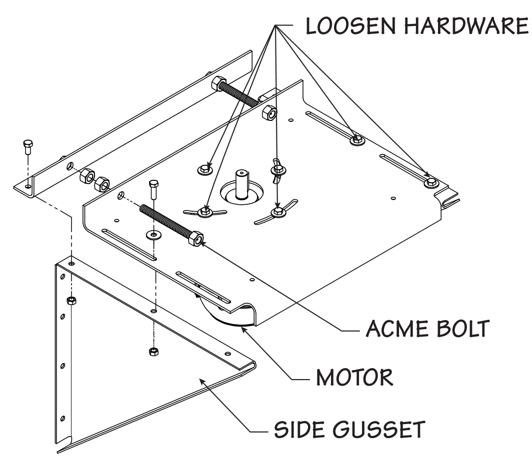


Figure 2

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

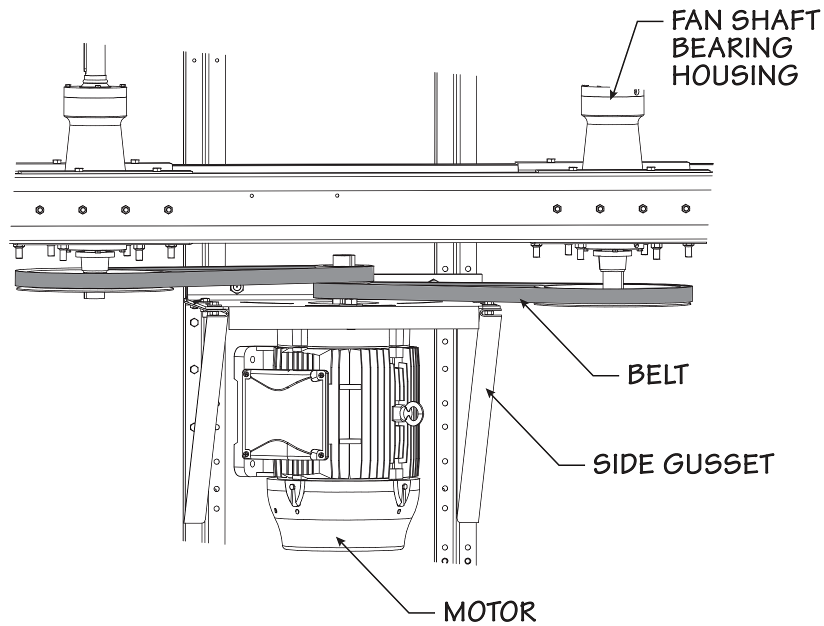


Figure 3

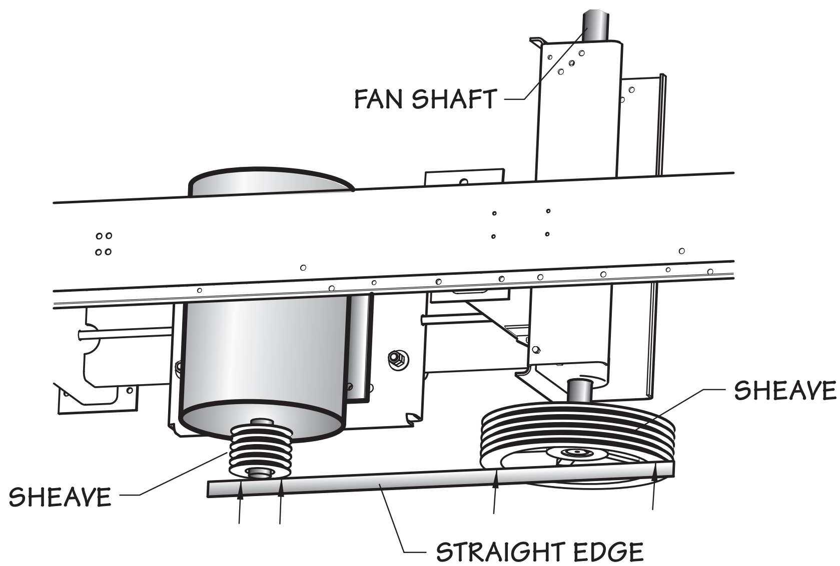
SINGLE MOTOR—TWO FANS. MHF7101 THRU MHF7109 ONLY.

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.

maintenance

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

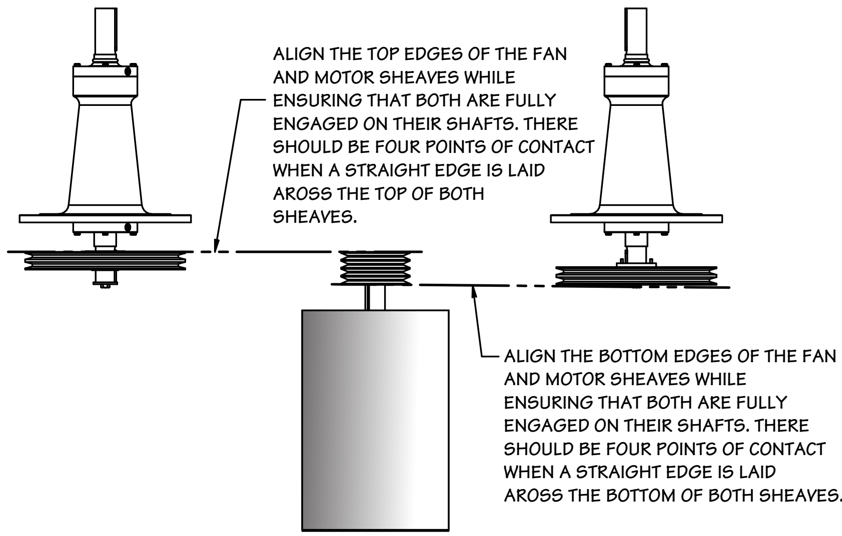


Figure 5

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

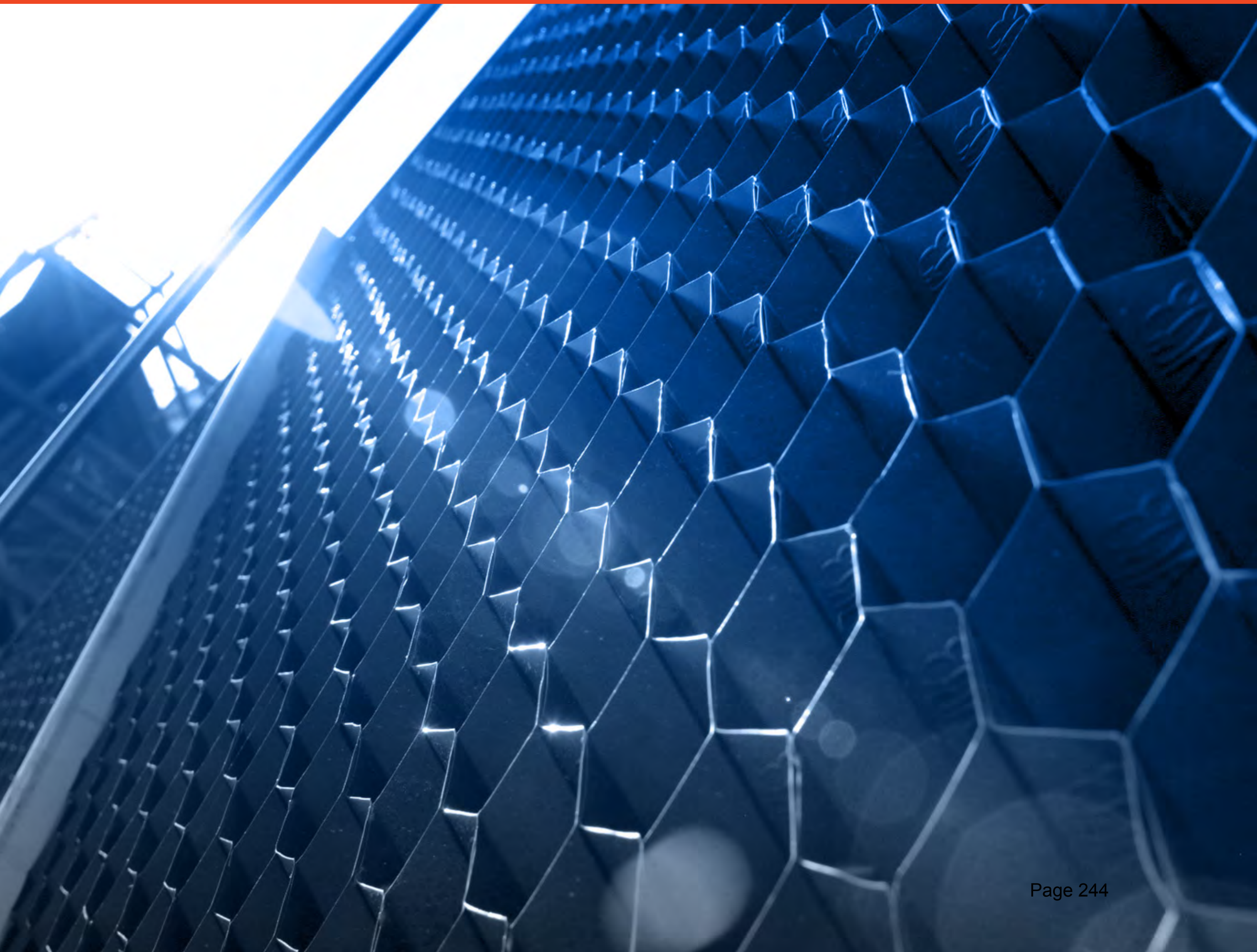
Hands on Training

Notes / Take away Points:

Marley Replacement Parts

For Your BAC Cooling Tower

MARLEY®



OUR MARLEY PARTS. YOUR BAC TOWER.

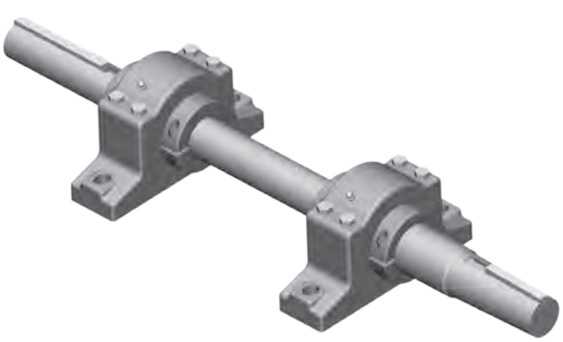
Now Marley parts are available for your non-Marley cooling tower. When your maintenance and repair projects demand quality and reliability, count on Marley, engineered to fit, cooling tower components.

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.

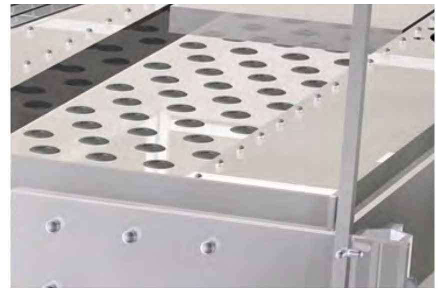
Marley X7 Fan ②

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.

SPX COOLING TECHNOLOGIES, INC.
7401 WEST 129 STREET
OVERLAND PARK, KS 66213 USA
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SPX

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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

SPX COOLING TECHNOLOGIES, INC.
7401 WEST 129 STREET
OVERLAND PARK, KS 66213 USA
913 664 7400 | spxcooling@spx.com
spxcooling.com

CCS-BSFP-17 | ISSUED 08/2017

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.

Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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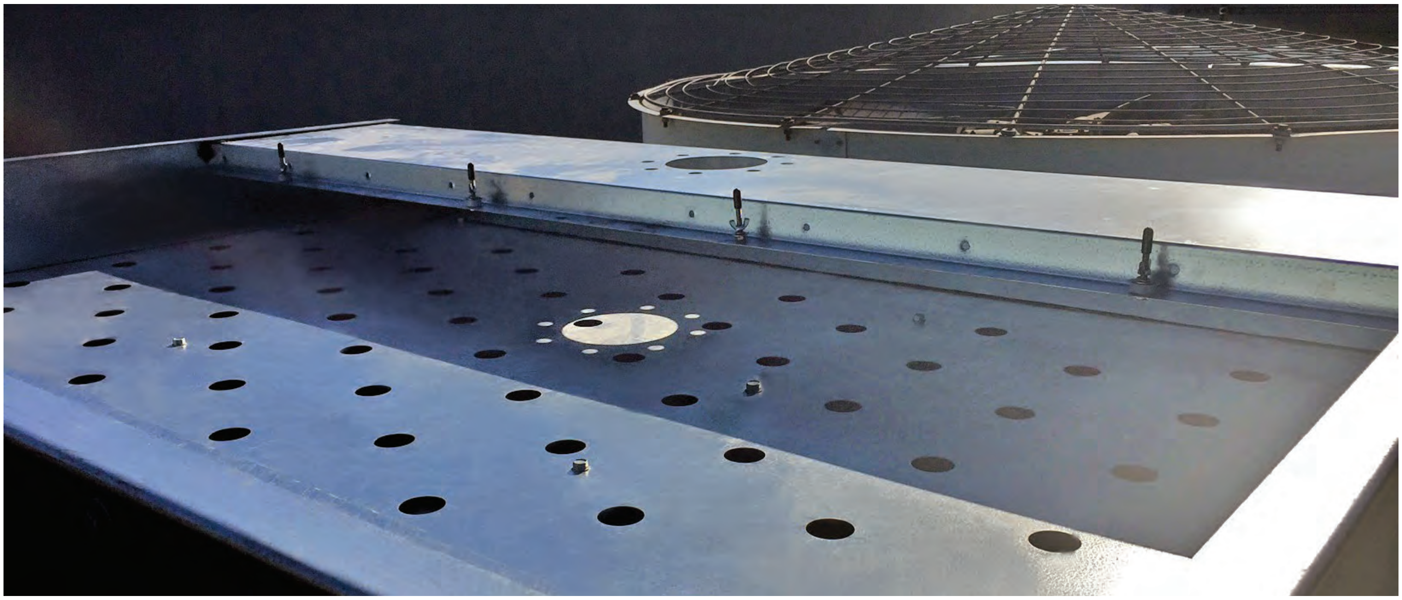
CCS-RFE-18 | ISSUED 05/2018

MARLEY®

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.



Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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CCS-HWB-17 | ISSUED 08/2017

SPX®

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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.

Contact your Marley representative to identify parts for other manufacturers' towers: spxcooling.com/replocator

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CCS-CC-17 | ISSUED 08/2017

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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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CCS-FR-17 | ISSUED 08/2017

SPX®

Component Case Study

Evapco Fan Replacement

MARLEY®

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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spxcooling.com

CCS-X7-18 | ISSUED 09/2018

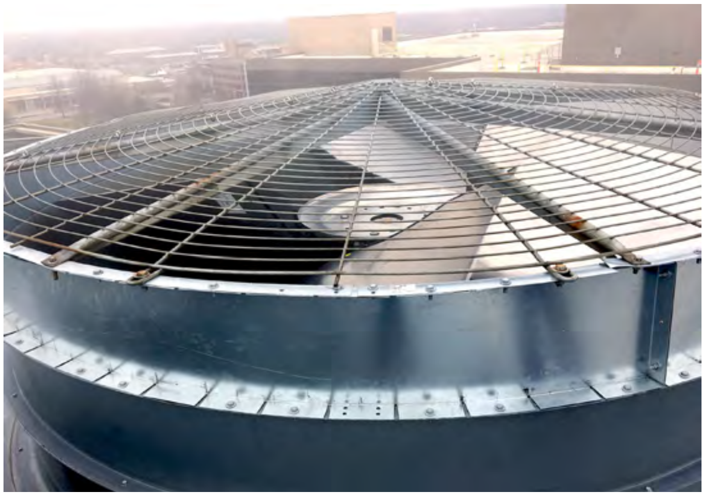
SPX®

MARLEY®

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

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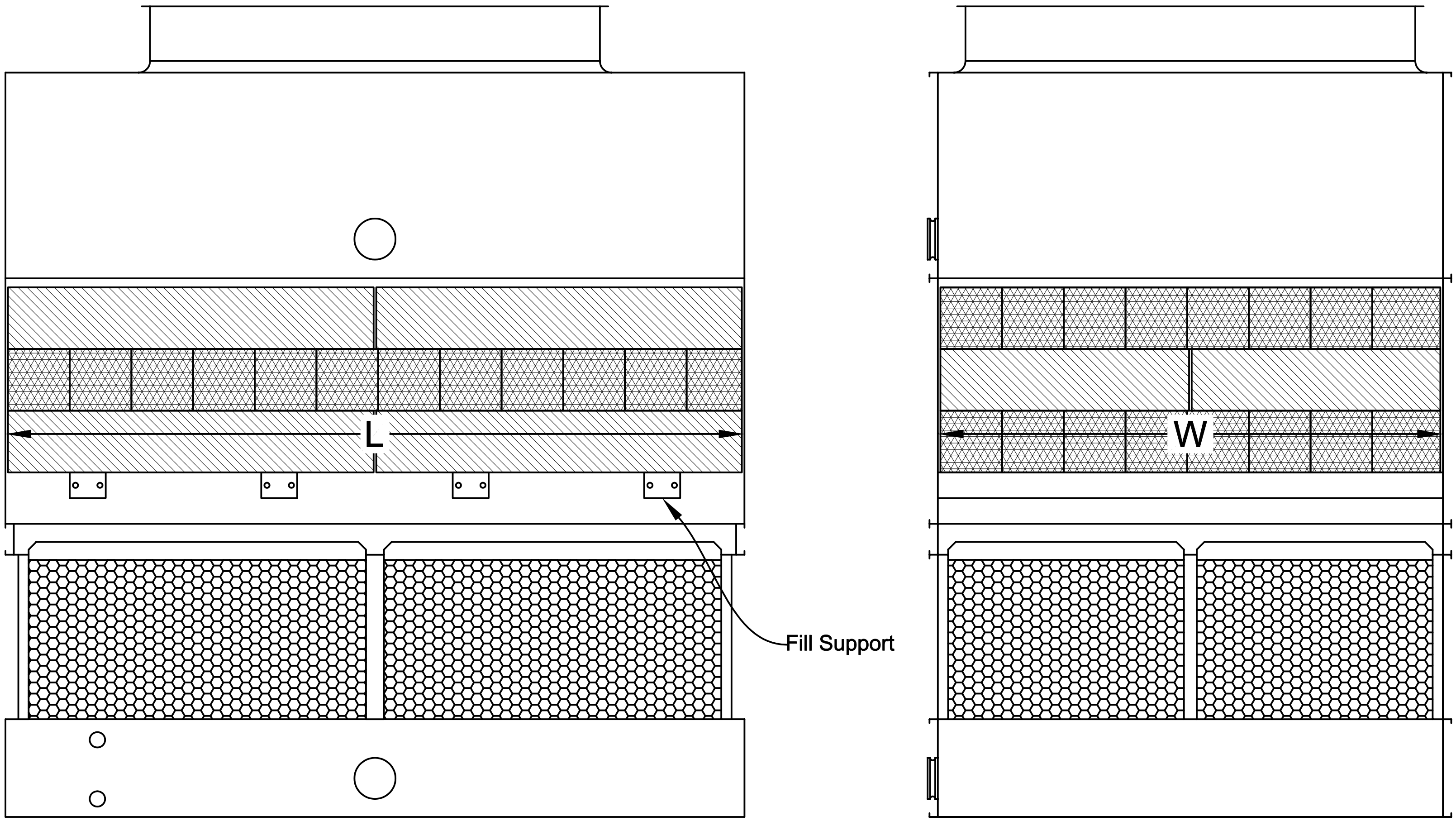
CCS-UQF-18 | ISSUED 05/2018

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:

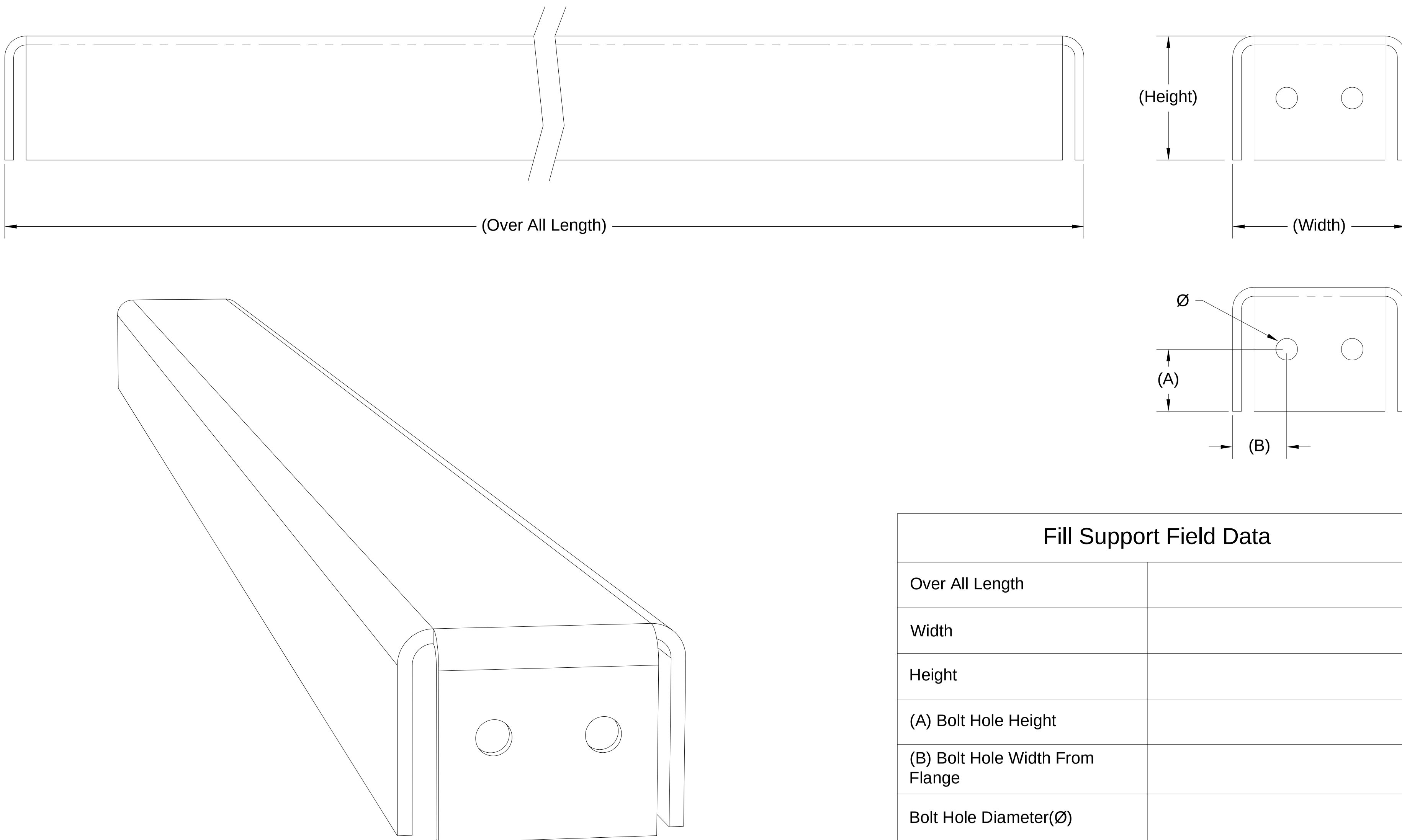
[1] The Inside-Inside Casing Dimensions are easily measured by removing a pair of opposing louver frames to expose the underside of the fill area.

[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.

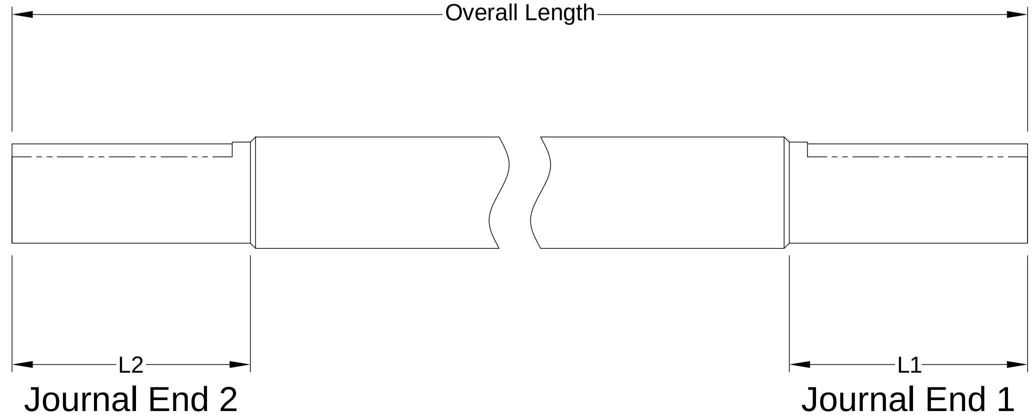
[2] Specify to the closest $\frac{1}{16}$ of an inch.

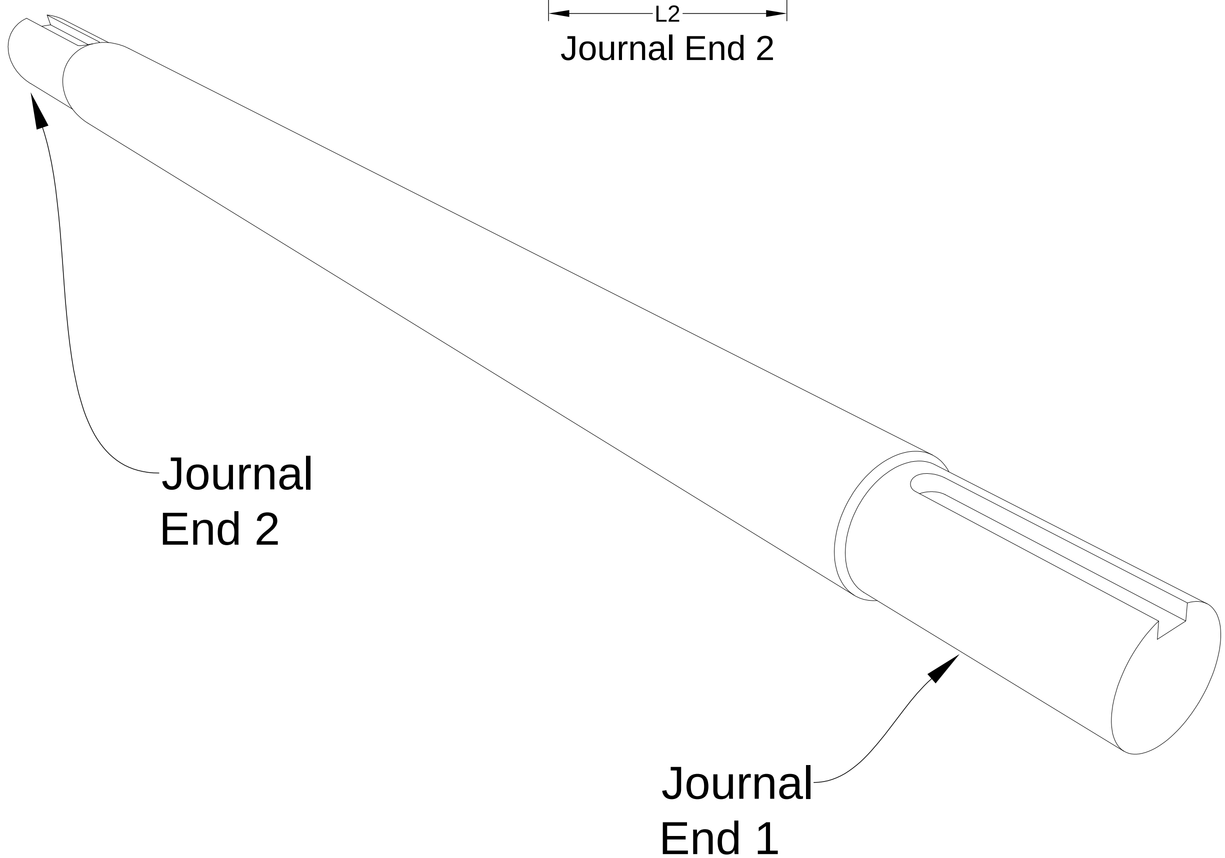
[3] Double Check all Measurements.

[4] Fill Supports will be fabricated with 10ga steel.

Marley After-Market Field Data

SPX Cooling Technologies			
DRAWN BY BFC	DATE 12/13/2017	Aftermarket Drawing No. MAM-FSP-001	Description Evapco Fill Support



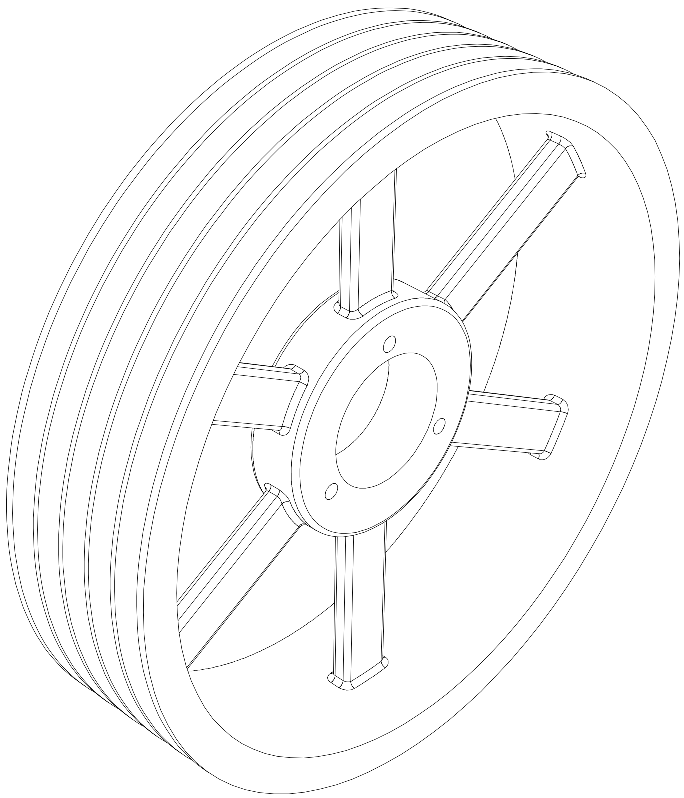


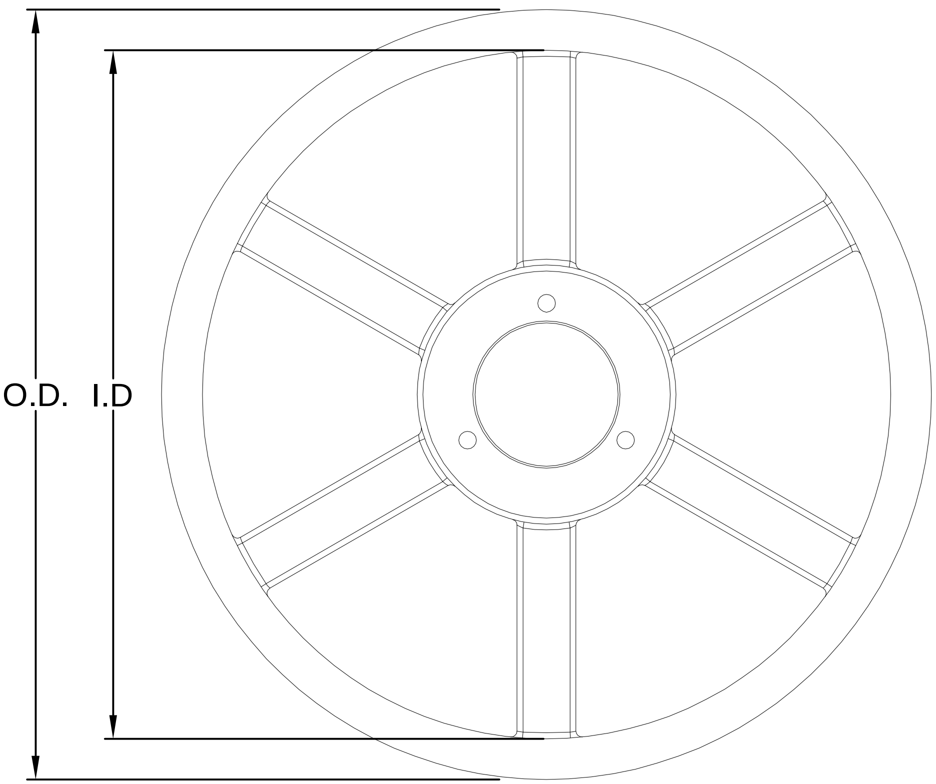
Fan Shaft Data	
Shaft Body Diameter	
Journal 1 Diameter	
Journal 2 Diameter	
Journal 1 Length (L1)	
Journal 2 Length (L2)	
Overall Length	

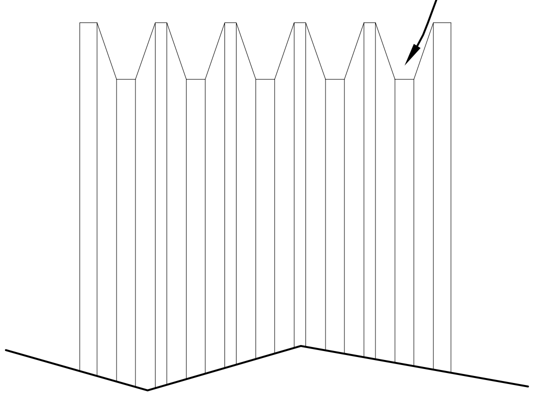
Marley After-Market Field Data

SPX Cooling Technologies

DRAWN BY BFC DATE 12/12/2017	Aftermarket Drawing No. MAM-SFT-001	Description Evapco Fan Shaft



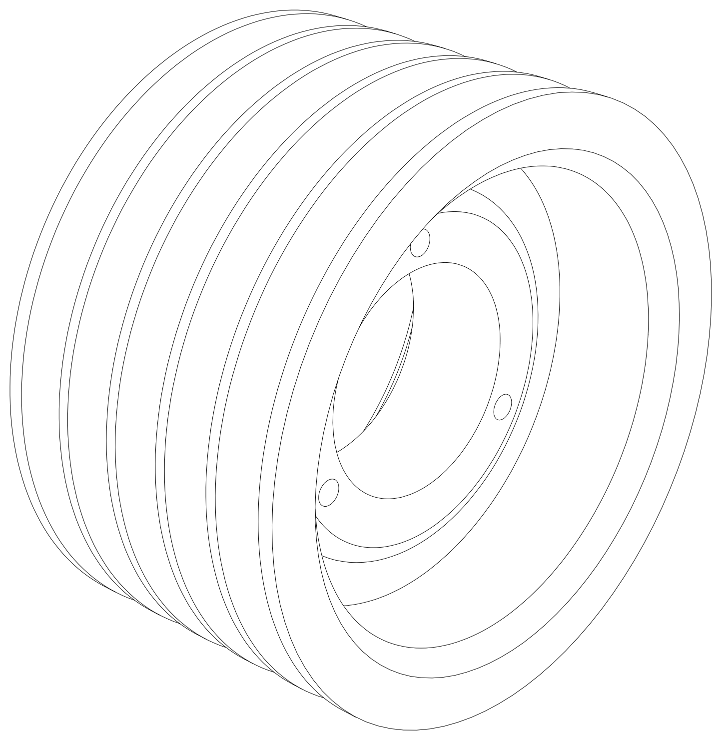


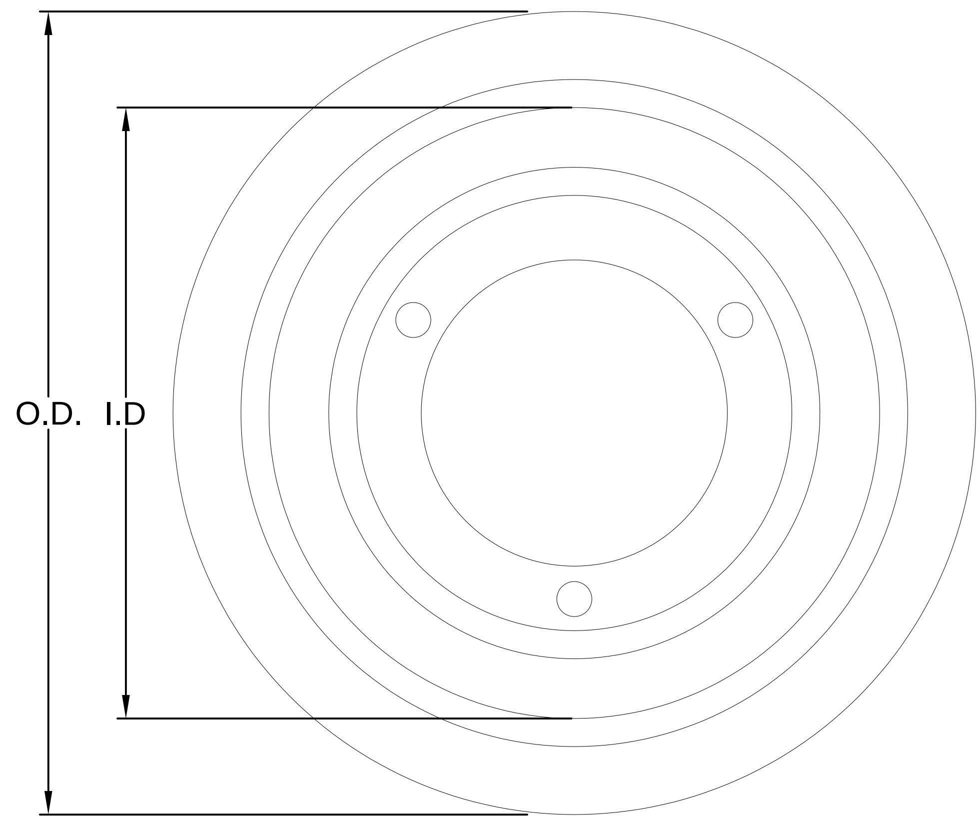


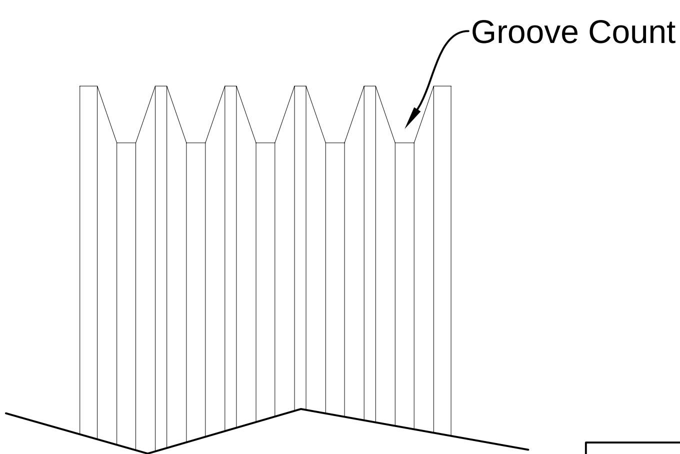
Measurement Data	
Groove Count	
O.D.	
I.D.	
Material (CI,ALUM)	
Bushing Diameter and type	

Marley After-Market Field Data

SPX Cooling Technologies		
DRAWN BY BFC DATE 12-29-2017	Aftermarket Drawing No. MAM-SDM-001	Description Sheave Dimensions







Measurement Data	
Groove Count	
O.D.	
I.D.	
Material (CI,ALUM)	
Bushing Diameter and type	

Marley After-Market Field Data

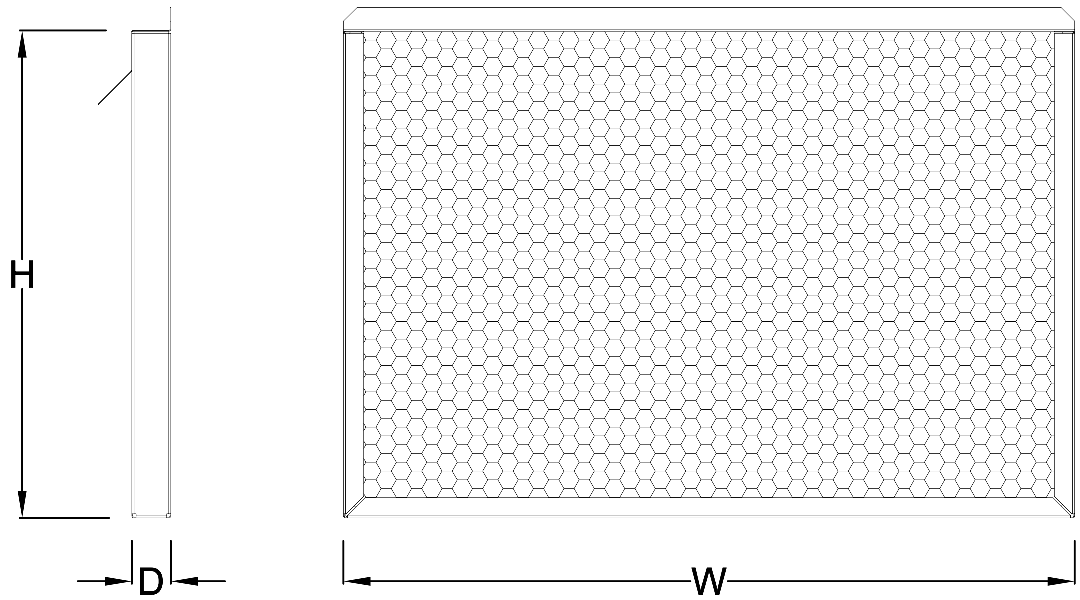
SPX Cooling Technologies			
DRAWN BY BFC	DATE 02-06-2017	Aftermarket Drawing No. MAM-SDM-002	Description Sheave Dimensions

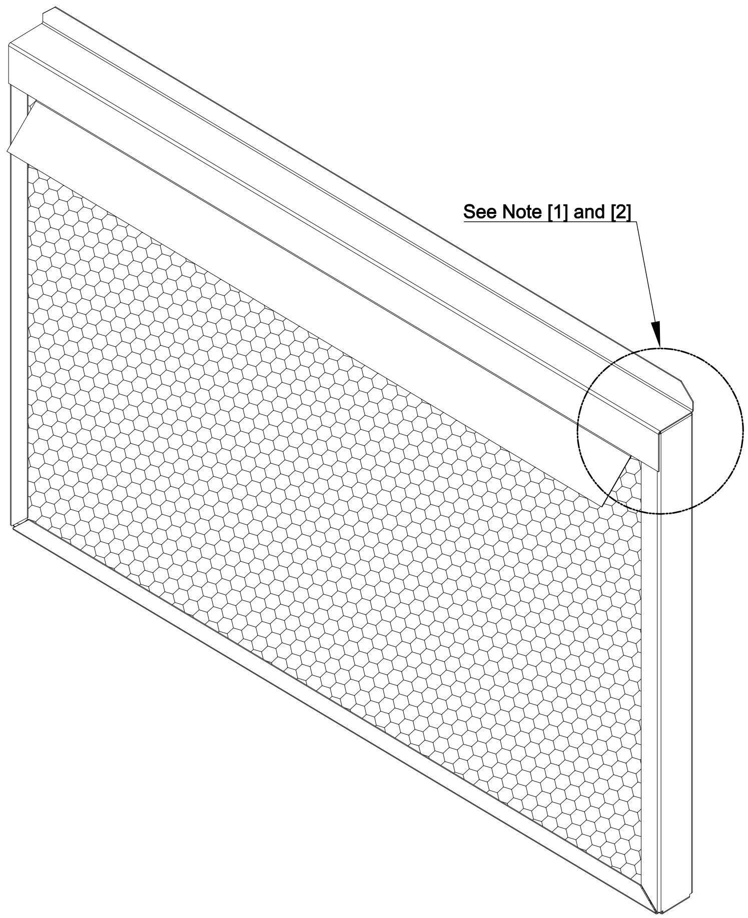
NOTES

[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.



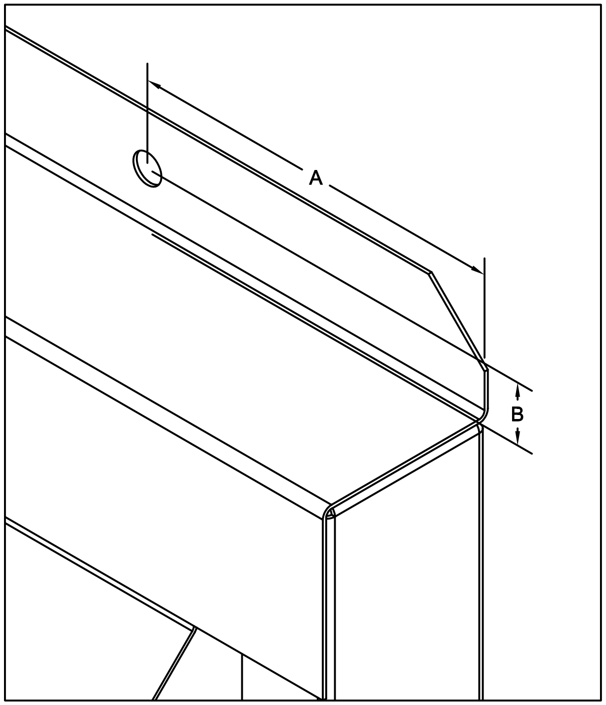


Out to Out of Frame Detailes		
Dimension	Side Louvers	End Louvers
Width (W)		
Height (H)		
Depth (D)		
Frame Material (SS or Galv.)		
Evapco Tower Model and Serial Number	Model:	Serial:

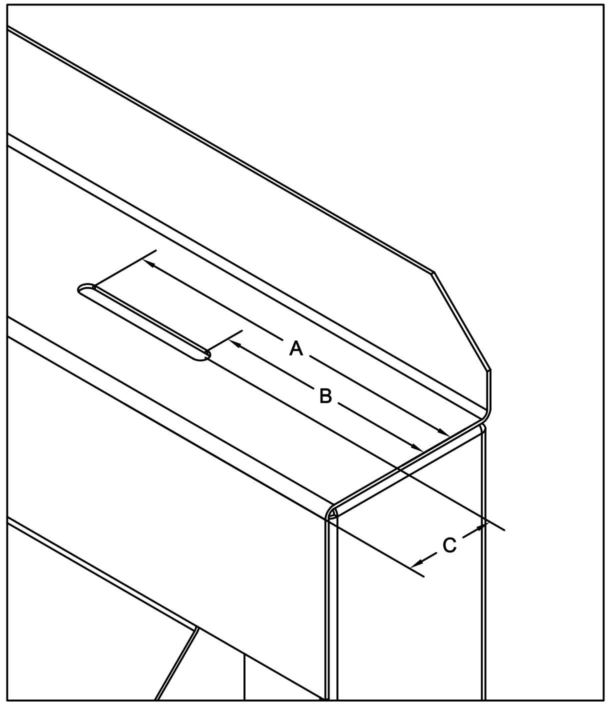
Marley After-Market Field Data

SPX Cooling Technologies

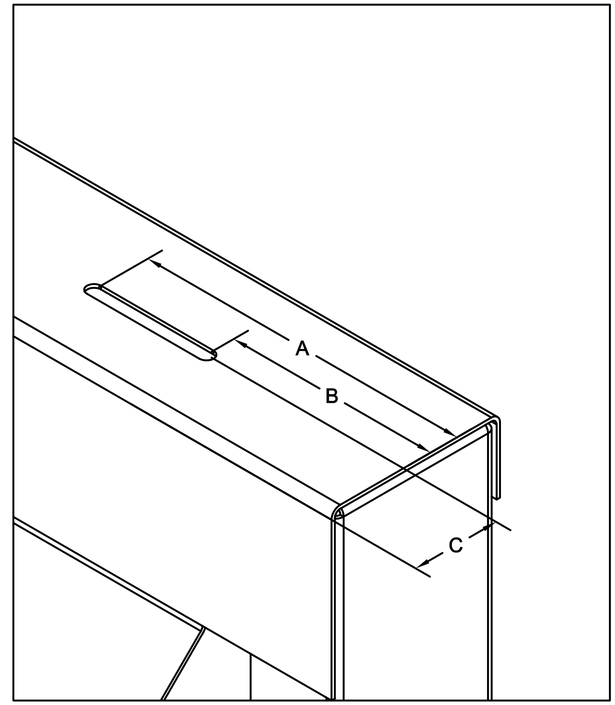
DRAWN BY BFC / DATE 01-03-2018	Aftermarket Drawing No.	Description
DRAWN BY: BFC; DATE: 01-03-2018	MAM-LVR-001	Evapco Louver Old Style



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		

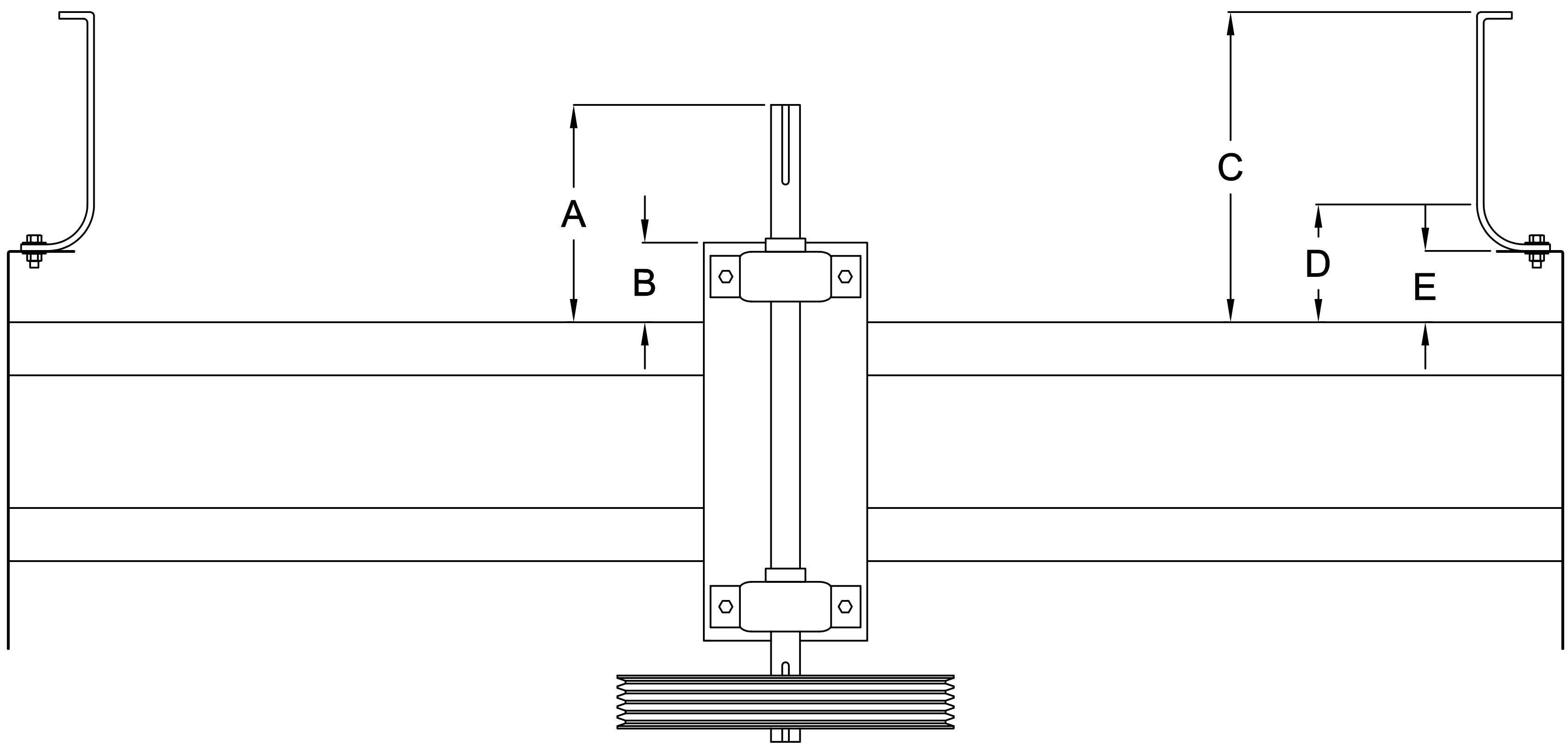
Flange Style 3		
Dimension	Side Louvers	End Louvers
A		
B		
C		

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 BFC DATE 01/08/2018	Aftermarket Drawing No. MAM-LVR-002	Description Louver Flange Details



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 BFC DATE 01/25/2018	Aftermarket Drawing No. MAM-FAN-001	Description Fan Fitting

Cooling Tower Start-up and Tower Inspection

SPX

Agenda

SPX

- ✓ Site visit –Preparation
- ✓ Start-up - Process & Report
- ✓ Inspection – Process & Examples
- ✓ Site visit – Post Start-up and Inspection – Report & Tips
- ✓ Replacing Other OEM Towers Parts

Site Visit

- ✓ Cooling Inspection for aging towers
  - ➢ Parts, Recon, Replacement towers
- ✓ Start-up Inspection for new towers
  - ➢ Fulfilling contract, identifying spare parts, customer needed options
- ✓ Trouble shooting for specific customer issue
  - ➢ Future business

Reasons for site visit – Value-Creating Partner

Site Visit –Preparation – Start-up

Upon notification to perform a start-up

Ask if everything is ready on site, by having the Pre-Startup Checklist filled out and verified:

Why do this?

This is to insure that everything on site is ready to go, so you don't waste a trip.

Prepare, Execute, and Deliver

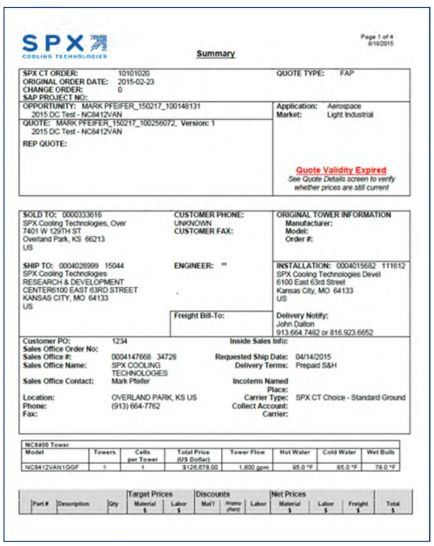
Site Visit –Preparation – Start-up

✓ After receiving back the Pre-Startup 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 (option)
    - LLC
    - Basin Heater
    - Etc.
5. Review Start-up Checklist
6. Create "Spare Parts list"

Prepare, Execute, and Deliver

Site Visit –Preparation – Start-up


SPX COOLING TECHNOLOGIES

Page 1 of 4
8/18/2015

Summary

SPX CT ORDER: 10101020
ORIGINAL ORDER DATE: 2015-02-23
CHANGE ORDER: 0
SAP PROJECT NO:
QUOTE TYPE: FAP

OPPORTUNITY: MARK PFEIFER_150217_100148131
2015 DC Test - NC8412VAN
QUOTE: MARK PFEIFER_150217_100256072, Version: 1
2015 DC Test - NC8412VAN
REP QUOTE:

Application: Aerospace
Market: Light Industrial

Quote Validity Expired
See Quote Details screen to verify whether prices are still current

SOLD TO: 0000333616
SPX Cooling Technologies, Over
7401 W 129TH ST
Overland Park, KS 66213
US

CUSTOMER PHONE: UNKNOWN
CUSTOMER FAX:

ORIGINAL TOWER INFORMATION
Manufacturer:
Model:
Order #:

SHIP TO: 0004028999 15044
SPX Cooling Technologies
RESEARCH & DEVELOPMENT
CENTER6100 EAST 63RD STREET
KANSAS CITY, MO 64133
US

ENGINEER: **

INSTALLATION: 0004015682 111612
SPX Cooling Technologies Devel
6100 East 63rd Street
Kansas City, MO 64133
US

Freight Bill-To:

Delivery Notify:
John Dalton
913.664.7482 or 816.923.6652

Customer PO: 1234
Sales Office Order No:
Sales Office #: 0004147668 34726
Sales Office Name: SPX COOLING TECHNOLOGIES
Sales Office Contact: Mark Pfeifer
Location: OVERLAND PARK, KS US
Phone: (913) 664-7762
Fax:

Inside Sales Info:
Requested Ship Date: 04/14/2015
Delivery Terms: Prepaid S&H
Incoterm Named Place:
Carrier Type: SPX CT Choice - Standard Ground
Collect Account:
Carrier:

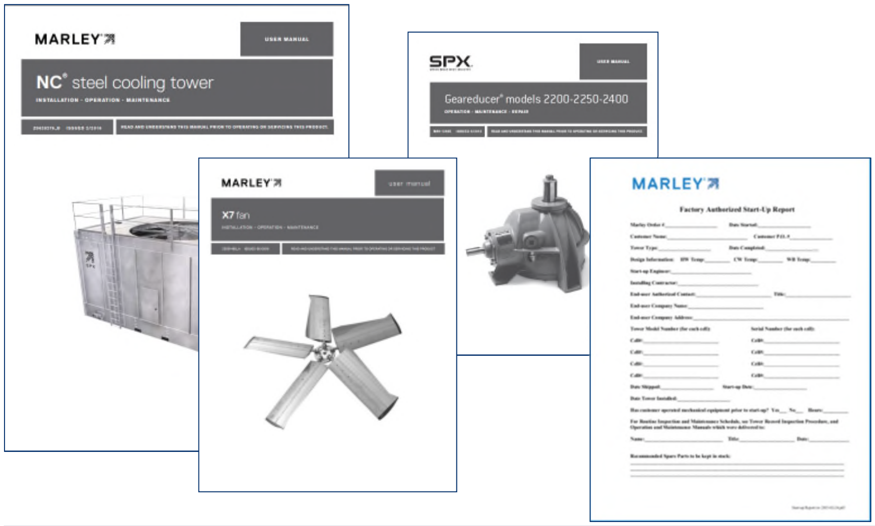
NC8400 Tower

Model	Towers	Cells per Tower	Total Price (US Dollar)	Tower Flow	Hot Water	Cold Water	Wet Bulb
NC8412VAN1GGF	1	1	$126,678.00	1,800 gpm	95.0 °F	85.0 °F	78.0 °F

Part #	Description	Qty	Target Prices Material $	Target Prices Labor $	Discounts Mat'l	Discounts Promo (Part)	Discounts Labor	Net Prices Material $	Net Prices Labor $	Net Prices Freight $	Total $

Receive from Marley Representative - QTC Quote Summary - NC8412VAN Tower

Site Visit –Preparation – Start-up



Located on www.spxcooling.com

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

Prepare, Execute, and Deliver

Site visit - Leave Behinds

Place labels on all towers.

Place information label here.

Make sure your customer knows who to call!!

Site Visit – Start-up or Inspection

- Typical Inspection Gear
  - 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
  - Camera

i.*** Needs change depending on inspection scope

Preparation - In the bag…

Safety Review

Safe meeting!!

Site Visit – Pre-Inspection

SAFETY BEFORE TOWER ENTRY

a) Is proper LOTO in place?

b) Do I understand all of the specific hazards relative to this site and tower?

c) Do I have the proper training including, but not limited to, fall protection, water chemistry, energy sources, tower structural conditions, etc.?

d) Do I understand the plant evacuation procedure?

e) Do I have the proper support regarding hole watches, etc.?

f) Do I know exactly what I would do in the case of a fall and all other potential situations?

g) Should I ask for help?

- **If you are unsure or the least bit uncomfortable, do not do it!!!**
- **SPX has the resources to help… do not hesitate to ask for it!!**

Not worth the risk!!!

Agenda

- ✓ Site visit –Preparation
- ✓ Start-up - Process & Report
- ✓ Inspection – Process & Examples
- ✓ Site visit – Post Start-up and Inspection – Report & Tips
- ✓ Replacing Other OEM Towers Parts

Check-in and Overview of the Tower

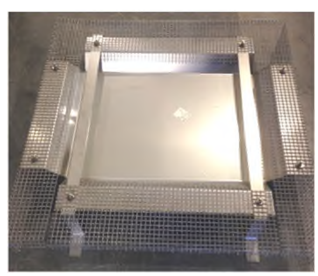
- ✓ Check-in if needed to get necessary access to the towers.
- ✓ Become familiar with the tower and the area in which they are located.
- ✓ Find the towers disconnect or control panel so that you can lock out the tower before entering.

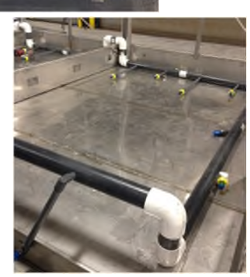
Overall Tower Condition

- ✓ 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

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.





Basin cleanliness and Optional Equipment Checks

SPX

- ✓ 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.

Basin cleanliness and optional equipment

Mechanical Equipment Checks

SPX

- ✓ 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

Overall Tower Condition

Top of the Tower Checks

SPX

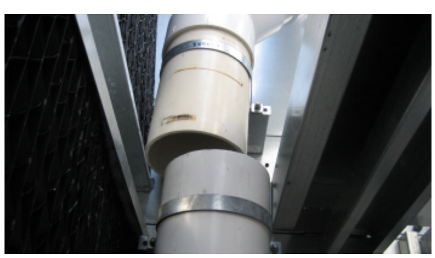
- ✓ Check that hot water basins are free of debris and all covers are in place and secured.
- ✓ Verify you have the correct orfice size nozzle by comparing back to your order summary.
- ✓ Check and see that the fan guard is in place and properly fastened.

Basin cleanliness and optional equipment

Piping and Water Treatment

SPX

- ✓ 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.

Pre-Startup Checklist

SPX

- ✓ 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

Motor & Controls

Wiring Completion Checks

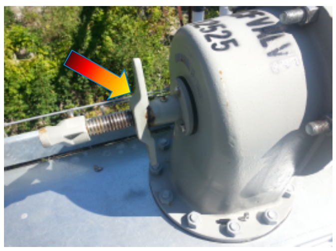
SPX

- ✓ 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.

Motor & Controls

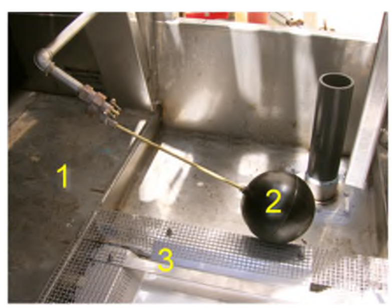
Start-up – Pumps Only

- ✓ 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



Follow the Water Flow and Check for Leaks

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

Follow the Water Flow and Check for Leaks

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 the
  tower and on the fan deck

Turn on the motor

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.

Turn on the motor

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

Check for leaks

Checks after the Pumps and Fans are Turned 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.

Turn off your pumps and fan motors

Agenda

- ✓ Site visit –Preparation
- ✓ Start-up - Process & Report
- ✓ Inspection – Process & Examples
- ✓ Site visit – Post Start-up and Inspection – Report & Tips
- ✓ Replacing Other OEM Towers Parts

Inspections

Capture Customer information and Tower Serial Number

Serial Number Plate located on Access Door

Also painted on cold water basin side on some models

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

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 tower twice – look low and high

Inspections

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

Inspections

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

Inspections

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

Inspections

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 systems

- Check to make sure Float Valve and/or Electronic water make-up systems are working properly.

Inspections

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

Inspections

Structure

- Inspect steel tower for evidence of corrosion (loss of metal)
- Check joints to be sure that hardware is tight and in good condition

Inspections

Motor

Ask about lubrication schedule for re-greasable 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

Example FAP cooling tower issues

SPX

Corroded grease fitting on motor. Replace!

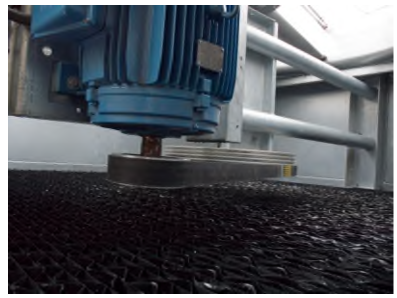
So… you say you perform proper maintenance?

Inspections

Belt Drive Fan 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

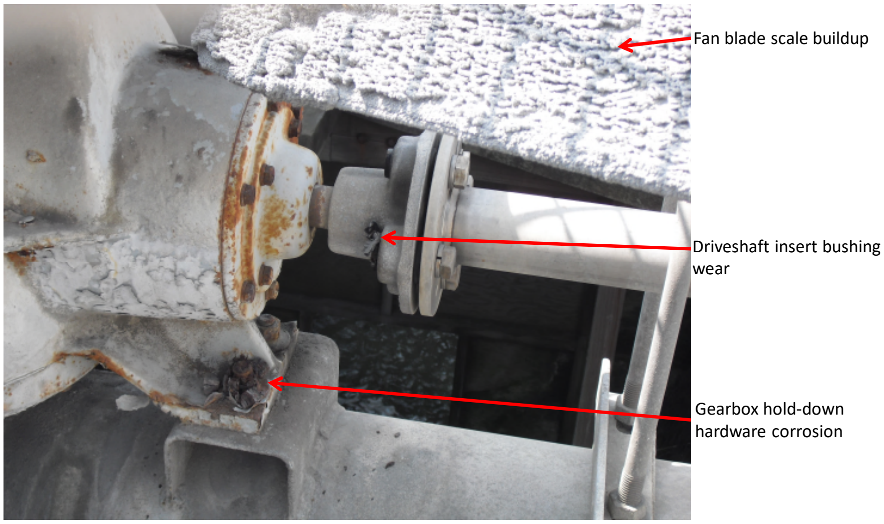


Inspections

Gearboxes

- 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

Inspections



Inspections

Driveshafts and Couplings

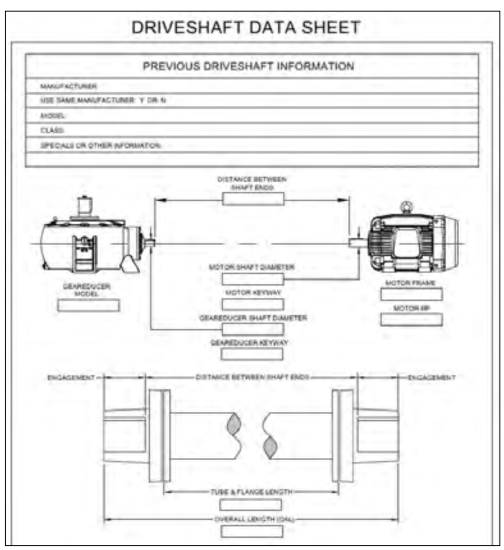
- Check alignment using approved method
- Look for evidence of corrosion or damage on tube
- Check all connections between tube and flex elements
- Check connections between coupling and motor and gear shafts
- Examine metallic flex elements for signs of corrosion or fatigue, cracks, brittleness and other signs or wear

Driveshaft Inspection

Driveshaft inspection should be performed on a semi-annual basis:

1. Inspect for corrosion, checking or cracking of rubber bushings and couplings, and looseness of hardware.
2. Inspect for excessive wear of flexible elements
3. Replace rubber components showing excessive deterioration, and tighten all loose nuts and screws
4. If vibration readings indicate imbalance or misalignment, follow instructions for correcting this found in the appropriate driveshaft service manual

Driveshaft Replacement



We can replace other driveshaft brands too!

Inspections

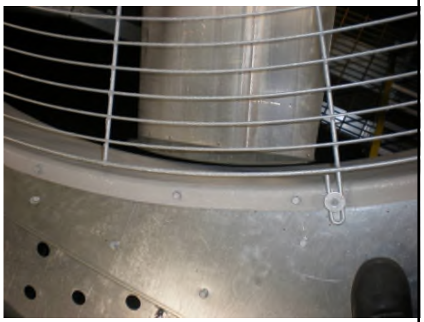
Fans

- 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

Inspections

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



Inspections

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

Example FAP cooling tower issues

Corroded mechanical support.

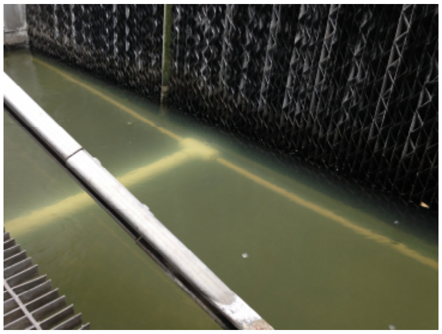
If corrosion is mild, a wire brush can remove.

If heavy corrosion, support must be replaced

Inspections

Drift (mist) 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



Inspections

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

Fill Maintenance

Scale Removal

- Calcium carbonate is the most typical buildup on 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

Inspections

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

Inspections

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

Inspections

Example FAP cooling tower issues

Excessive Drift

Example FAP cooling tower issues

Foreign substance in water.

Example FAP cooling tower issues

Scaled fill and corroded Tower.

Limited tower access.

Limited or No Access To Tower

Example FAP cooling tower issues

Example FAP cooling tower issues

Plugged fill and heavy scale.

Time to go perform a start-up and inspection!

- ✓ Make sure to take your checklist / binder
- ✓ Make sure you have all your PPE
- ✓ Take a quick break if needed, and we will gather outside the office lobby.

Agenda

- ✓ Site visit –Preparation
- ✓ Start-up - Process & Report
- ✓ Inspection – Process & Examples
- ✓ Site visit – Post Start-up and Inspection – Report & Tips
- ✓ Replacing Other OEM Towers Parts

Post-Startup 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

Great opportunity to make your first sale!

Inspection - Report

- Release October 2015 - **Offline** Inspection Report Tool

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.

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?

Ask and learn…

Agenda

- ✓ Site visit –Preparation
- ✓ Start-up - Process & Report
- ✓ Inspection – Process & Examples
- ✓ Site visit – Post Start-up and Inspection – Report & Tips
- ✓ Replacing Other OEM Towers Parts

Education for Success

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

Marley has a replacement option for nearly all parts!

Replacing Other OEM Parts

Fill Change

a. Crossflow - BAC DIMENSIONS FOR MBX REPLC helps outline the specific dimensions we need to perform a pack replacement on a BAC tower
b. Counterflow - need to know cubic feet volume requirement, basic pack sizes currently on tower, and locations of fill support beams

Gearbox/Driveshaft Replacement

a. Existing gearbox serial number, model number, ratio, and if any options (oil level switch, special paint, etc.) are required
b. Motor HP, speed, and frame size.
c. Drawing or photos w/critical dimensions of supporting steel
d. Driveshaft/coupling manufacturer, model, DBSE and/or OAL, bores and keyways (fill out Driveshaft Data Sheet 09-1329)
e. 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.

$$\frac{583.00\,\frac{Gal}{Min}}{108\ Nozzles} = 5.4\ \frac{Gal}{Min\!-\!Nozzle}$$

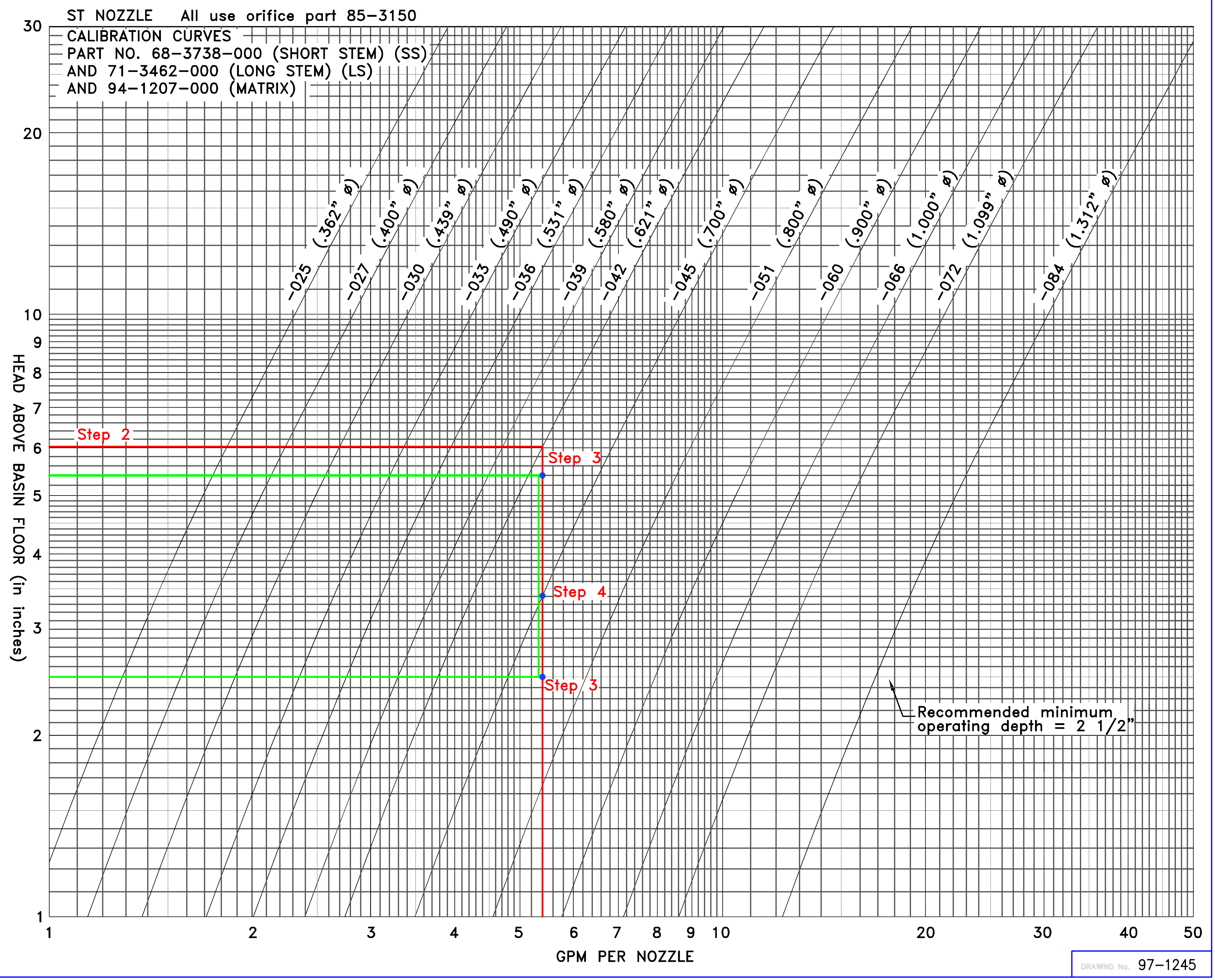
Step 2 – Draw a vertical line from 5.4 GPM PER NOZZLE on the horizontal axis till you intersect the operating line of the -042 nozzles. From the point of intersection, draw a horizontal line to the vertical axis and compare the HEAD ABOVE BASIN FLOOR to the 5.4" maximum water level you determined from 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)
-025 (.362" ø)
-027 (.400" ø)
-030 (.439" ø)
-033 (.490" ø)
-036 (.531" ø)
-039 (.580" ø)
-042 (.621" ø)
-045 (.700" ø)
-051 (.800" ø)
-060 (.900" ø)
-066 (1.000" ø)
-072 (1.099" ø)
-084 (1.312" ø)
Step 2
Step 3
Step 4
Step 3
Recommended minimum operating depth = 2 1/2"
HEAD ABOVE BASIN FLOOR (in inches)
GPM PER NOZZLE
1
2
3
4
5
6
7
8
9
10
20
30
40
50
DRAWING No. 97-1245

Name
Company
Address
City, State
Office, Cell, Fax, or phone number
e-mail address

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: ______________________
(Please print)

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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.

MARLEY

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.