CERTIFIED TEST, ADJUST AND BALANCE REPORT

DATE: June 16, 2025

PROJECT:

NAME: Condenser Water System Survey
Livingston County Library

ADDRESS: 450 Locust Street
Chillicothe, MO

ARCHITECT:

NAME: Not Applicable - Existing System Survey

ADDRESS:

HVAC DESIGN ENGINEER:

NAME: Not Applicable - Existing System Survey

ADDRESS:

GENERAL CONTRACTOR:

NAME: Not Applicable - Existing System Survey

ADDRESS:

MECHANICAL CONTRACTOR:

NAME: Not Applicable - Existing System Survey

ADDRESS:

SHEET METAL CONTRACTOR:

NAME: Not Applicable - Existing System Survey

ADDRESS:

NEBB CERTIFIED TAB FIRM:

NAME: Doyle Field Services, Inc.

ADDRESS: 8900 State Line Road, Suite 420
Leawood, KS.

NEBB Certification No.: 3158

Table of Contents

CERTIFICATION PAGE

PROJECT NAME: Condenser Water System Survey
ADDRESS: Livingston County Library
Chillicothe, MO

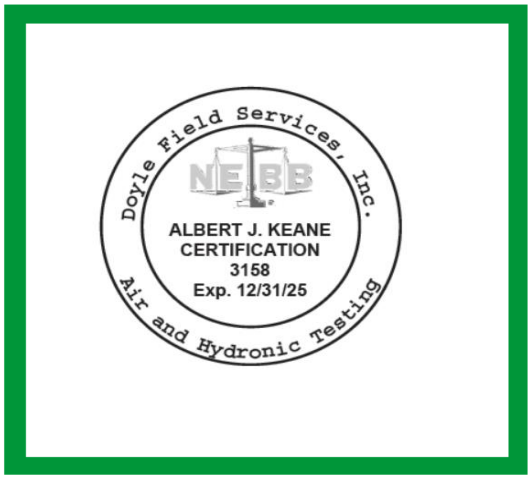
The data presented in this report is a record of system measurements and final adjustments that have been obtained in accordance with the current edition of the NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems. The measurements shown, and the information given, in this report are certified to be accurate and complete, at the time and date information was gathered. Any variances from design quantities, which exceed NEBB tolerances, are noted in the TAB report project summary.

NEBB TAB FIRM Doyle Field Services, Inc.
REG NO. 3158 CERTIFIED BY Albert Keane DATE 12/31/2025

SUBMITTED & CERTIFIED BY:

NEBB TAB FIRM Doyle Field Services, Inc.
TAB PROFESSIONAL Albert J. Keane
REG NO. 3158

CERTIFICATION EXPIRATION DATE: 12/31/2025
SUBMITTED REPORT DATE: **6/16/2025**



INSTRUMENT CALIBRATION LIST

Function		Range	Minimum Accuracy	Instrument Information	Instrument Serial Number	Calibration Date	12 Month Calibration Due Date
Air	AIR PRESSURE	0 in wg to 10 in wg	2% +/- 0.001 in wg	Shortridge Air Data Multimeter ADM 860C	M020358	1/24/2025	1/24/2026
	AIR VELOCITY INSTRUMENT	50 fpm to 3900 fpm	+/- 5 % +/- 7 fpm	Shortridge Air Data Multimeter ADM 860C	M020358	1/24/2025	1/24/2026
	DIRECT HOOD READING	100 cfm to 2000 cfm	+/- 5 % +/- 7 cfm	Shortridge Air Data Multimeter ADM 860C	M020358	1/24/2025	1/24/2026
TEMPERATURE	AIR METER	-20 F to 240 F	+/- .5 % 2 F	Cooper SRH77A	102110023	10/28/2024	10/28/2025
	AIR PROBE	-20 F to 240 F	+/- .5 % 2 F	Cooper 1075	N/A	10/28/2024	10/28/2025
	IMMERSION METER	-20 F to 240 F	+/- .5 % 2 F	Cooper SRH77A	102110023	10/28/2024	10/28/2025
	IMMERSION PROBE	-20 F to 240 F	+/- .5 % 2 F	Cooper 1075	N/A	10/28/2024	10/28/2025
	CONTACT METER	-20 F to 240 F	+/- .5 % 2 F	Cooper SRH77A	102110023	10/28/2024	10/28/2025
	CONTACT PROBE	-20 F to 240 F	+/- .5 % 2 F	Cooper 4011	N/A	10/28/2024	10/28/2025
HUMIDITY	HUMIDITY PROBE	10 % RH to 90 % RH	3% of reading	Cooper 5028	N/A	10/28/2024	10/28/2025
ELECTRICAL	VOLTAGE MEASUREMENT	0 VAC to 600 VAC	2 % reading +/- 5 digits	Fluke 324	36300001WS	10/28/2024	10/28/2025
	AMPERAGE MEASUREMENT	0 Amperes to 100 Amperes	2 % reading +/- 5 digits	Fluke 324	36300001WS	10/28/2024	10/28/2025
ROTATION	ROTATION MEASUREMENT	60 rpm to 5000 rpm	2 % reading 2 rpm	Shimpo DT-205L	C02A0251	10/28/2024	10/28/2025
HYDRONIC	PRESSURE MEASUREMENT	-30 in Hg to 200 psi	±2% of reading +/- 1 psi	HDM-250	W10129	6/20/2024	6/20/2025
	DIFFERENTIAL PRESSURE MEASUREMENT	0 psi - 80 psi	±2% of reading +/- 1 psi	HDM-250	W10129	6/20/2024	6/20/2025
Sound	SOUND MEASUREMENT	SEE NEBB Appendix A	SEE NEBB Appendix A	Larson Davis LxT2	0005213	11/14/2024	11/14/2025

ABBREVIATIONS LIST

ABBREVIATIONS	
AHU	AIR HANDLING UNIT
AMP	AMPERAGE
AFMS	AIR FLOW MONITORING STATION
BD	BALANCING DAMPER
BHP	BRAKE HORSE POWER
BTU	BRITISH THERMAL UNIT
BTUh	BTU PER HOUR
BV	BALANCING VALVE
CF	CORRECTION FACTOR (Ak)
CFLA	CORRECTED FULL LOAD AMPS
CFM	CUBIC FEET PER MINUTE
CNR	CAN NOT READ (Obstructed View)
CV	CONSTANT VOLUME
DB	DRY BULB
DFC	DAMPER FULLY CLOSED
D.P.	Differential Pressure
DWO	DAMPER WIDE OPEN
EF	EXHAUST FAN
EG	EXHAUST GRILLE
ER	EXHAUST REGISTER
ESP	EXTERNAL STATIC PRESSURE
EA	EXHAUST AIR
F	FAN
FD	FIRE DAMPER
FLA	FULL LOAD AMPS
FPM	FEET PER MINUTE
GPM	GALLONS PER MINUTE
LS	LINEAR SLOT
MBH	1000 BTU PER HOUR
MVD	MANUAL VOLUME DAMPER
N/A	NOT APPLICABLE
N/ACC	NO REASONABLE ACCESS
NDI	NO DAMPER INSTALLED
NG	NOT GIVEN
NF	NO FLOW
NPSH	NET POSITIVE SUCTION HEAD
NPSHA	NPSH AVAILABLE
NPSHR	NPSH REQUIRED
OA	OUTSIDE AIR
OBD	OPPOSED BLADE DAMPER
OED	OPEN ENDED DUCT
P	PUMP
PD	PRESSURE DROP
PH	PHASE
PSI	POUNDS PER SQUARE INCH
PSIA	PSI ABSOLUTE
PSIG	PSI GAUGE
RA	RETURN AIR
RAF	RETURN AIR FAN
RG	RETURN GRILLE
RPM	ROTATIONS PER MINUTE
RR	RETURN REGISTER
SA	SUPPLY AIR
SD	SPLITTER DAMPER
SG	SUPPLY GRILLE
SP	STATIC PRESSURE
SR	SUPPLY REGISTER
TB	TERMINAL BOX
TD	TEMPERATURE DIFFERENTIAL
TDH	TOTAL DYNAMIC HEAD
TP	THERMALLY PROTECTED
TSP	TOTAL STATIC PRESSURE
WB	WET BULB
VAV	VARIABLE AIR VOLUME
VEL	VELOCITY

Technicians	
JC	James Coin
TD	Tom Doyle
DG	Daniel Godden
JH	Jaden Henry
CK	Colten Kaplanis
AK	Albert Keane
DN	Danny Noble
GN	Garrett Noble
BW	Bobby Womack

EXECUTIVE SUMMARY / REPORT REMARKS

PROJECT NAME:	**Condenser Water System Survey**
REPORT DATE:	6/16/2025

PROJECT SUMMARY

This project consists of the investigation of the efficiency of the condenser water system including the cooling tower, dedicated pumps and heat exhcanger. This system is used for heat rejection for the heat pumps throughout the library.

There are several things that can lead to Water Source Heat Pump (WSHP) loop temperatures become greater than desired. Doyle Field Services, Inc. (DFSI) payed special attention to the pumps, heat transfer surfaces and the cooling tower and measured flow temperature differentials.

Scope of Services:

DFSI will provide a hydronic survey to obtain sufficient performance information on the existing cooling tower, plate and frame heat exchanger and the primary loop pumps.

Deiverables:

Condenser loop total flow
Pressure drops across the pumps and heat exchangers will be used to determine flow.
Secondary loop total flow
Pressure drops across the pumps and heat exchangers will be used to determine flow.
Temperature differentials
Entering and leaving the tower
Entering and leaving the heat exchanger (Both Hot and Cold sides)
Manufacturer's nameplate data
Equipment performance test report
Photos of equipment
Summary of any deficiencies

Observations:
5-15-2025: At the time of testing the outside air temperature is about 80°F @ 35%RH

We believe there are a number of factors that could be contributing to the effectiveness of the condenser water system.

The tower pumps are low in flow. TP-2 has slightly more water flow than TP-1.

The tower and loop pumps were installed in the opposite location (per the construction documents). Most ikely this occurred during construction.

EXECUTIVE SUMMARY / REPORT REMARKS

PROJECT NAME:	**Condenser Water System Survey**
REPORT DATE:	6/16/2025

PROJECT SUMMARY

Observations continued:

The cooling tower fan discharge does not have the proper clearance per the manufacturer's specifications. Marley indicates that SPX Aquatower Model 494 requires 6.0' of clearance at the fan discharge. This tower has only 49" of clearance.
Marley does make an attachment for the tower to allow for vertical discharge and it appears that the enclosure does have enough clearance for this to be installed.

Initially, the system fill pressure was not full enough to reach the top of the system. The standing pressure was 38' and we believe the distance from the LP centerline to the top of the system is closer to 50' at the attic piping. In addition, the fill pressure should be 5 PSI greater than the height of the system.

The expansion tank was initially flooded with water and the make up water pressure reducing valve was set to 20 PSI. DFSI disabled the pumping system, isolated the make up valve, released system water and charged the expansion tank with 30 PSI (forcing the water out). Next, we set the make up water pressure reducing valve to 30 PSI to be in line with the height of the system.

Eric Woster, with Blackmore & Glunt (Lenexa, KS), assisted Doyle Field Services, Inc. with the analysis of the HX and pumps.

Recommendations:

DFSI believes all of the following recommendations will improve heat transfer yet all recommendations may not be necessary at this time. The following recommendation are listed in the order of need first.

We believe the HX is fouled as determined by the elevated tower pump discharge pressure. This is also reinforced by the measured brake horsepower of the pump.

1. Cleaning the HX is recommended as preventative maintenance. Fortunately, the configuration of the HX allows for easy separation of the plates for cleaning. Installing new gaskets between the plates will most likely be necessary and/or new plate pack (including gaskets) to clean the HX. These can be purchased from Blackmore & Glunt in Lenexa, KS (local manufacturer's rep.).

EXECUTIVE SUMMARY / REPORT REMARKS

PROJECT NAME:	**Condenser Water System Survey**
REPORT DATE:	6/16/2025

PROJECT SUMMARY

Recommendations - continued:

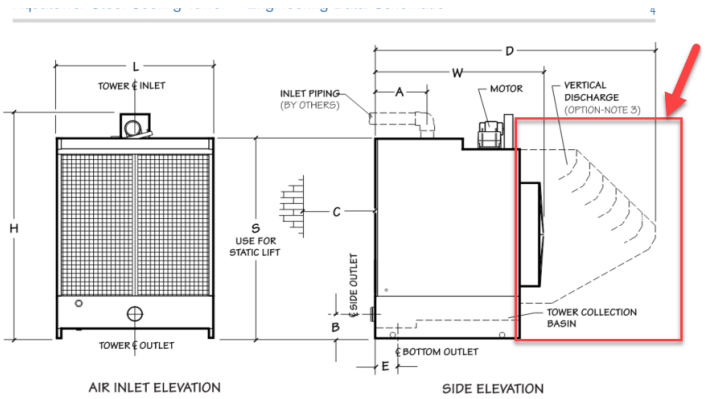
2. Per normal preventative maintenance, the nozzles on the tower have a tendancy to clog. If this is not already a normal PM requirement, it should be added to the schedule. This is a recommendation from Spencer Kauffman - Midwest Machinery, who originally supplied the tower in 4/10/2009)

3. The enclosure around the cooling tower is causing recirculation of hot, saturated air from the outlet, back around to the inlet. So on hot summer days, I can see why the loop temps would creep up. The cooling tower can't perform as it is designed without fresh ambient intake air.
.
Per Spencer Kauffman, there are 3 ways to do this and two options are not aesthetically pleasing.

A. Remove the enclosure

B. Duct the outlet, from the fan discharge, outside of the tower enclosure.

C. Marley has a vertical discharge duct, designed specifically for this unit, that will discharge the air up and out of the enclosure. This will ensure that the air through the tower is replaced with fresh ambient air, ideal heat transfer. DFSI was aware of this option when we were on site and measured the distance from the fan and the brick wall. It appears that this attachment will fit into the enclosure, but it will be tight. DFSI recommends remeasurement by a mechanical contractor prior to purchasing to confirm for logistics and clearance.



Deficiency Issues Log

Condenser Water System Survey

Item #	Created		System	Deficiency Issue	Corrective Action	Open / Closed	Closed	
	Date	By					Date	By
001	4/21/2025	AK	Cooling Tower	The cooling tower discharge is directly into a block wall. This configuration encourages short-cycling of the discharge air back into the inlet of the tower. Operating in this fashion can lead to low temperature differential across the tower.	Recommendation: Allow for proper flow out of the tower and away from the unit. Marley (current cooling tower manufacturer) makes a fitting for this specific tower (Aquatower 494C) that redirects the airflow from horizontal to vertical.			
002	4/21/2025	AK	Expansion Tank	The expansion / compression tank appears to be flooded.	DFSI determined the height of the system to be ~50 feet from the pump centerline to the highest point in the system (attic over old courthouse room). We drained a portion of the system and charged the expansion tank to 30 PSI.	Closed	5/16/2025	AK
003	5/15/2025	AK	HHW	There is an imersion sytle temperature sensor installed on the outside of the pipe, held up by zip-straps.	Recommendation: This sensor should be located inside the pipe. At a minimum, insulation should be placed around the sensor for a more accurate measurement of the water temperature.			
					Recommendation:The zip-straps will eventually break and sensor will fall out. Consider securing with permanenet solution if the previous recommendation is not taken.			
004	5/15/2025	AK	Tower Pumps	Tower Pumps (TP-1 & 2) installed are actually the Loop Pumps. Per the construction drawings, these pumps should provide 180 GPM @ 42' of Head (7.125" impellar). Currently installed pump is 180 GPM @ 45' of Head (7.25").	The pumps are similarly sized and only the impellar size is different, by 0.125".			
005	5/15/2025	AK	Loop Pumps	Loop Pumps (LP-1 & 2) installed are actually the Boiler Pumps. Per the construction drawings, these pumps should provide 180 GPM @ 45' of Head (7.25" impellar). Currently installed pump is 180 GPM @ 42' of Head (7.125").	The pumps are similarly sized and only the impellar size is different, by 0.125".			
006	5/15/2025	AK	Make Up Water	The make up water valve was initially set at 20 PSI.	DFSI determined the height of the system (See Item #2). After charging the system, DFSI adjusted the Pressure reducing valve to 30 PSI. This value is the height of the system plus 5 PSI (standard).	Closed	5/16/2025	AK
007	5/15/2025	AK	Temp Gauge	Thermometer entering hot side of HX is not accurate. The other 3 thermometers are within 3 degrees of the actual temperature.				

COOLING TOWER TEST REPORT

PROJECT NAME:	**Condenser Water System Survey**		
Technician(s):	Albert Keane Jaden Henry	Date:	5/16/2025
EQUIPMENT/SYSTEM:	**CT-1**		

UNIT INFORMATION		
	DESIGN	***ACTUAL***
MANUFACTURER	Marley	Marley
MODEL #	Aquatower 494C	Aquatower 494C
SERIAL #	8555 494C	8555 494C
LOCATION / SERVICE	Condenser Water	Condenser Water

OPERATIONAL DATA		
	DESIGN	***ACTUAL***
Final Flow (GPM)	178 GPM	180.0°F
Entering Air Temp (°F DB)	78°F	75.4°F
Entering Air Temp (°F WB)	67°F	62.0°F
Leaving Air Temp (°F DB)	Not Provided	68.2°F
Entering Water Temp (°F)	91°F	82.8°F
Leaving Water Temp (°F)	85°F	72.3°F
Water PD	Not Provided	Not Applicable
Fan Speed (RPM)	Not Provided	Constant Volume
Airflow (CFM)	23,640 CFM'	Did not measure
Inlet SP	Not Provided	Not Applicable
Discharge SP	Not Provided	Not Applicable
	886.8 MBH	

MOTOR DATA				
	DESIGN	***ACTUAL***		
Voltage / Phase	208 / 3	204	206	205
Full Load Amps	17.5 A	11	10.8	10.4
Power (HP)	5 HP	5 HP		
Motor Speed (RPM)	Not Provided	Not Applicable		

Comments: Tower design per schedule: 91°F EWT, 85°F LWT while OAT = 78°F @ 50% RH

5-15-2025: OAT ~80°F @ 35%RH

DOYLE FIELD SERVICES, INC.
Commissioning, Validation Balancing Agents
8900 State Line Road, Suite 420, Leawood, KS. 66206
Office - 913.677.3374 Fax - 913.671.7483 www.dfstesting.com

HEAT EXCHANGER TEST REPORT

(water-to-water)

PROJECT NAME:	**Condenser Water System Survey**				
Technician(s):	Albert Keane			Date:	5/16/2025
EQUIPMENT/SYSTEM:					
UNIT INFORMATION					
Unit Tag		HX-1		HX-2	
Location / Service		Basement Mech, Condenser Wtr.			
Manufacturer		Bell and Gossett			
Model Number **(B&G Part Number)**		%BY541500106100 5-415-23-026-007			
Serial Number		122824.02			
TEST DATA					
		DESIGN	***ACTUAL***	***DESIGN***	***ACTUAL***
Primary Flow (GPM)		180	140		
Primary PD (ft, schedule)		9	*1		
Entering Water Pressure (ft)		150 Max	*1		
Leaving Water Pressure (ft)		150 Max	*1		
Entering Water Temp (°F)		85	72.3		
Leaving Water Temp (°F)		93	82.8		
Secondary Flow (GPM)		180	180		
Secondary PD (ft, schedule)		9	15.2		
Entering Water Pressure (ft)		150 Max	82.2		
Leaving Water Pressure (ft)		150 Max	67		
Entering Water Temp (°F)		96	99.8		
Leaving Water Temp (°F)		88	94.1		

Comments: Was only able to measure the pressure drop on the hot side of the HX as the tower side is not equipped with pressure taps. Flow determined by pump flow.

HX Hot side = 99.8 entering, 94.1 leaving - 88.2' entering, 67' leaving

HX Cold side = 72.3 entering, 82.8 leaving - Tower side of HX does not have pressure taps

PUMP TEST REPORT

PROJECT NAME:	**Condenser Water System Survey**					
Technician(s):	Albert Keane			Date:	5/16/2025	
EQUIPMENT/SYSTEM:	**TP-1**					
UNIT INFORMATION						
		DESIGN		***ACTUAL***		
MANUFACTURER		Bell & Gosset		Bell & Gosset		
MODEL #		80 7.25 BF 3x9.5B		80 7.25 BF 3x9.5B		
SERIAL #		XXXXXX L80		XXXXXX L80		
LOCATION / SERVICE		Cooling Tower		Cooling Tower		
OPERATIONAL DATA						
		DESIGN		***ACTUAL***		
Final Flow (GPM)		180		130		
Total Connected Load (GPM)		180		130		
Final Flow Discharge Pressure (FT)		Not Given		57.10		
Final Flow Suction Pressure (FT)		Not Given		2.40		
Final Flow Total Head (Ft)		42		54.70		
Full Flow (GPM)		Not Given		NA - Constant Volume		
Full Flow Discharge Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Suction Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Total Head (Ft)		Not Given		NA - Constant Volume		
Block-Off Discharge Pressure (FT)		Not Given		56.90		
Block-Off Suction Pressure (FT)		Not Given		6.30		
Block-Off Total Head (Ft)		50		50.60		
Impeller Size (inches)		7.125		7.25		
Standing Pressure / Pump Off (Ft)		Not Provided		6.20		
MOTOR INFORMATION						
		DESIGN		***ACTUAL NAMEPLATE***		
Manufacturer / Frame - Nameplate		Not Provided		Baldor		
Horse Power (HP)		5.00		5.00		
Brake Horse Power (BHP)		NA		1.88		
Volts	Phase	208-230, 460	3	204	205	206
Full Load Amps		15 - 13.2, 6.6		5.60	5.30	5.60
Corrected Nameplate Amps		-		-		
Motor Speed (RPM / Setpoint)		1,725		1,725		
Service Factor		-		1.15		
Current Overload Size/Setting		-		17		

Comments: TP and LP pumps were installed in the opposite locations (LP's installed at the TP location and vice versa).

Horsepower measured indicates about 140 gpm.

PUMP TEST REPORT

PROJECT NAME:	**Condenser Water System Survey**					
Technician(s):	Albert Keane			Date:	5/16/2025	
EQUIPMENT/SYSTEM:	**TP-2**					
UNIT INFORMATION						
	DESIGN			***ACTUAL***		
MANUFACTURER	Bell & Gosset			Bell & Gosset		
MODEL #	80 7.25 BF 3x9.5B			80 7.25 BF 3x9.5B		
SERIAL #	XXXXXX L80			XXXXXX L80		
LOCATION / SERVICE	Cooling Tower			Cooling Tower		
OPERATIONAL DATA						
	DESIGN			***ACTUAL***		
Final Flow (GPM)	180			140		
Total Connected Load (GPM)	180			140		
Final Flow Discharge Pressure (FT)	Not Given			45.70		
Final Flow Suction Pressure (FT)	Not Given			-5.70		
Final Flow Total Head (Ft)	42			51.40		
Full Flow (GPM)	Not Given			NA - Constant Volume		
Full Flow Discharge Pressure (FT)	Not Given			NA - Constant Volume		
Full Flow Suction Pressure (FT)	Not Given			NA - Constant Volume		
Full Flow Total Head (Ft)	Not Given			NA - Constant Volume		
Block-Off Discharge Pressure (FT)	Not Given			57.00		
Block-Off Suction Pressure (FT)	Not Given			5.00		
Block-Off Total Head (Ft)	50			52.00		
Impeller Size (inches)	7.125			7.25		
Standing Pressure / Pump Off (Ft)	Not Provided			6.20		
MOTOR INFORMATION						
	DESIGN			***ACTUAL NAMEPLATE***		
Manufacturer / Frame - Nameplate	Not Provided			Baldor		
Horse Power (HP)	5.00			5.00		
Brake Horse Power (BHP)	NA			1.96		
Volts / Phase	208-230, 460	3		204	205	206
Full Load Amps	15 - 13.2, 6.6			5.50	5.90	5.80
Corrected Nameplate Amps	-			-		
Motor Speed (RPM / Setpoint)	1,725			1,725		
Service Factor	-			1.15		
Current Overload Size/Setting	-			17		

Comments: TP and LP pumps were installed in the opposite locations (LP's installed at the TP location and vice versa).

Horsepower measured indicates about 140 gpm.

PUMP TEST REPORT

PROJECT NAME:	**Condenser Water System Survey**					
Technician(s):	Albert Keane			Date:	5/16/2025	
EQUIPMENT/SYSTEM:	**LP-1**					
UNIT INFORMATION						
		DESIGN		***ACTUAL***		
MANUFACTURER		Bell & Gosset		Bell & Gosset		
MODEL #		80 7.25 BF 3x9.5B		80 7.25 BF 3x9.5B		
SERIAL #		XXXXX M80		XXXXX M80		
LOCATION / SERVICE		Boiler / Condenser Loop		Boiler / Condenser Loop		
OPERATIONAL DATA						
		DESIGN		***ACTUAL***		
Final Flow (GPM)		180		180		
Total Connected Load (GPM)		179.4		180		
Final Flow Discharge Pressure (FT)		Not Given		105.50		
Final Flow Suction Pressure (FT)		Not Given		60.00		
Final Flow Total Head (Ft)		45		45.50		
Full Flow (GPM)		Not Given		NA - Constant Volume		
Full Flow Discharge Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Suction Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Total Head (Ft)		Not Given		NA - Constant Volume		
Block-Off Discharge Pressure (FT)		Not Given		123.00		
Block-Off Suction Pressure (FT)		Not Given		72.10		
Block-Off Total Head (Ft)		52		50.90		
Impeller Size (inches)		7.25		7.125		
Standing Pressure / Pump Off (Ft)		Not Provided		was 36', increased to 30 PSI		
MOTOR INFORMATION						
		DESIGN		***ACTUAL NAMEPLATE***		
Manufacturer / Frame - Nameplate		Not Provided		Baldor		
Horse Power (HP)		5.00		5.00		
Brake Horse Power (BHP)		NA		2.62		
Volts	Phase	208-230, 460	3	206	205	207
Full Load Amps		15 - 13.2, 6.6		7.70	7.50	7.60
Corrected Nameplate Amps		-		-		
Motor Speed (RPM / Setpoint)		1,725		1,725		
Service Factor		-		1.15		
Current Overload Size/Setting		-		17		

Comments: TP and LP pumps were installed in the opposite locations (LP's installed at the TP location and vice versa).

Horsepower measured indicates about 180 gpm.

PUMP TEST REPORT

PROJECT NAME:	**Condenser Water System Survey**					
Technician(s):	Albert Keane			Date:	5/16/2025	
EQUIPMENT/SYSTEM:	**LP-2**					
UNIT INFORMATION						
		DESIGN		***ACTUAL***		
MANUFACTURER		Bell & Gosset		Bell & Gosset		
MODEL #		80 7.25 BF 3x9.5B		80 7.25 BF 3x9.5B		
SERIAL #		XXXXX M80		XXXXX M80		
LOCATION / SERVICE		Boiler / Condenser Loop		Boiler / Condenser Loop		
OPERATIONAL DATA						
		DESIGN		***ACTUAL***		
Final Flow (GPM)		180		180		
Total Connected Load (GPM)		179.4		180		
Final Flow Discharge Pressure (FT)		Not Given		107.60		
Final Flow Suction Pressure (FT)		Not Given		61.70		
Final Flow Total Head (Ft)		45		45.90		
Full Flow (GPM)		Not Given		NA - Constant Volume		
Full Flow Discharge Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Suction Pressure (FT)		Not Given		NA - Constant Volume		
Full Flow Total Head (Ft)		Not Given		NA - Constant Volume		
Block-Off Discharge Pressure (FT)		Not Given		121.60		
Block-Off Suction Pressure (FT)		Not Given		72.00		
Block-Off Total Head (Ft)		52		49.60		
Impeller Size (inches)		7.25		7.125		
Standing Pressure / Pump Off (Ft)		Not Provided		was 36', increased to 30 PSI		
MOTOR INFORMATION						
		DESIGN		***ACTUAL NAMEPLATE***		
Manufacturer / Frame - Nameplate		Not Provided		Baldor		
Horse Power (HP)		5.00		5.00		
Brake Horse Power (BHP)		NA		2.69		
Volts	Phase	208-230, 460	3	205	206	205
Full Load Amps		15 - 13.2, 6.6		7.50	8.00	8.00
Corrected Nameplate Amps		-		-		
Motor Speed (RPM / Setpoint)		1,725		1,725		
Service Factor		-		1.15		
Current Overload Size/Setting		-		16.5		

Comments: TP and LP pumps were installed in the opposite locations (LP's installed at the TP location and vice versa). Horsepower measured indicates about 180 gpm.
HX Hot side = 99.8 entering, 94.1 leaving - 88.2' entering, 67' leaving
HX Cold side = 72.3 entering, 82.8 leaving - Tower side of HX does not have pressure taps

Doyle Field Services, Inc.

Instrument Calibration Certificates

AIRDATA MULTIMETER CERTIFICATE OF RECALIBRATION

Customer ID: 013495 — S/N: M20358
Customer: DOYLE FIELD SERVICES, INC. — City: LEAWOOD — State: KS
As-Received Model #: ADM-860C — Converted to Model #: — Order #: R242755
PO #: — Customer Eqpt ID#: — Calibration Due Date: ________

This instrument has been calibrated using Calibration Standards which are traceable to NIST (National Institute of Standards and Technology). Test accuracy ratio is 4:1 for pressures and temperature. Quality Assurance Program and calibration procedures meet the requirements for ANSI/NCSL Z540-1, ISO 17025, MIL-STD 45662A and manufacturer's specifications. Calibration accuracy is certified when meters are used with properly functioning accessories only. All Uncertainties are expressed in expanded terms (twice the calculated uncertainty). This report shall not be reproduced, except in full, without the written approval of Shortridge Instruments, Inc. Results relate only to the item calibrated. For limitations on use, see Shortridge Instruments, Inc. Instruction Manual for the use of AirData Multimeters. Procedure used: Procedure for Differential Pressure, Absolute Pressure and Temperature Recalibration of AirData Multimeters SIP-CP02 Revision: 30 Dated: 04/04/16

Calibration Technician(s): B.Pluckett A. Jaramillo Calibration Date: 01/24/2025
Calibration Approved by: Diana Smith Title: QA Mgr Date: 01/24/2025

As-Received By: B.Pluckett	Final Test By: A. Jaramillo	Test By: N/A
Date 12/19/2024 Rh 24 %	Date 01/24/2025 Rh 25 %	Date ____ Rh ____ %
Ambient Temperature 75 °F	Ambient Temperature 73 °F	Ambient Temperature ____ °F
Barometric Pressure 28.56 in Hg	Barometric Pressure 28.56 in Hg	Barometric Pressure ____ in Hg
All within spec YES NO (NA)	All within spec (YES) NO	All within spec YES NO

ABSOLUTE PRESSURE TEST (in Hg)

TEST METER TOLERANCE = ± 2.0 % ± .1 in Hg AS-RECEIVED TEST WITHIN SPEC YES NO (N/A) (See Notes)

Pressure Standard: Heise #02-R	S/N: 41741/42451	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #12A-R	S/N: 45605/48491	(As-Rcvd)	Test 2	Test 3
Pressure Standard: Heise #04-R	S/N: 41743/42453	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #14-R	S/N: 43412/45043-3	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #06-R	S/N: 41742/42452-1	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #16-R	S/N: 43413/45044	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #08-R	S/N: 42186/43328	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #18-R	S/N: 44581/46845-2	As-Rcvd	(Test 2)	Test 3
Pressure Standard: Heise #10-R	S/N: 42203/43352	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #20-R	S/N: 44582/46847	(As-Rcvd)	Test 2	Test 3

Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
14.0	N/A			14.05	14.1	.36			
28.4	28.56	28.5	-.21	28.56	28.7	.49			
40.0	N/A			40.02	40.1	.20		N/A	

DIFFERENTIAL PRESSURE TEST (in wc)

TEST METER TOLERANCE = ± 2.0 % ± 0.001 in wc AS-RECEIVED TEST WITHIN SPEC YES NO (N/A) (See Notes)

Pressure Standard: Heise #01-L	S/N: 41739/42449	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #11-L	S/N: 43165/44551-1	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #01-R	S/N: 41739/42446	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #11-R	S/N: 43165/44730	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #02-L	S/N: 41741/42454	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #12A-L	S/N: 45605/48490-1	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #03A-L	S/N: 45570/48461	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #13-L	S/N: 43415/45041	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #03A-R	S/N: 45570/48460	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #13-R	S/N: 43415/45039	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #04-L	S/N: 41743/42456	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #14-L	S/N: 43412/45045	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #05-L	S/N: 41740/42450	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #15-L	S/N: 43416/45042	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #05-R	S/N: 41740/42447	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #15-R	S/N: 43416/45040-1	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #06-L	S/N: 41742/42455	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #16-L	S/N: 43413/45046	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #07-L	S/N: 42185/42186	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #17-L	S/N: 44579/46842	As-Rcvd	(Test 2)	Test 3
Pressure Standard: Heise #07-R	S/N: 42185/43326	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #17-R	S/N: 44579/46841	As-Rcvd	(Test 2)	Test 3
Pressure Standard: Heise #08-L	S/N: 42186/43329	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #18-L	S/N: 44581/46846	As-Rcvd	(Test 2)	Test 3
Pressure Standard: Heise #09-L	S/N: 42202/43351	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #19-L	S/N: 44580/46844	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #09-R	S/N: 42202/43350	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #19-R	S/N: 44580/46843	As-Rcvd	Test 2	Test 3
Pressure Standard: Heise #10-L	S/N: 42203/43353	As-Rcvd	Test 2	Test 3	Pressure Standard: Heise #20-L	S/N: 44582/46848	As-Rcvd	Test 2	Test 3

Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
0.0500				.0500	.0500	.00			
0.1250				.1256	.1253	-.24		N/A	
0.2250				.2252	.2250	-.09			
1.000				1.004	1.002	-.20			
2.000		N/A		2.006	2.003	-.15			
3.600				3.609	3.605	-.11			
4.400				4.402	4.410	.18			
27.00				27.05	27.06	.04			
50.00				50.02	49.98	-.08			
Overange	NA		NA	NA	✓	NA	NA		NA

Shortridge Instruments, Inc.
7855 East Redfield Road Scottsdale, Arizona 85260
(480) 991-6744 • Fax (480) 443-1267 • www.shortridge.com

AIRDATA MULTIMETER CERTIFICATE OF RECALIBRATION

S/N: M20358
Order #: R242755

LOW VELOCITY CONFIRMATION (FPM)

TEST METER TOLERANCE = ± 3.0% ± 7 FPM AS-RECEIVED TEST WITHIN SPEC YES NO (N/A) (See Notes)

Vel Eqv Trans Std: S/N: M02009	As-Rcvd	Test 2	Test 3	Vel Eqv Trans Std: S/N: M10897	As-Rcvd	Test 2	Test 3
Vel Eqv Trans Std: S/N: M02903	As-Rcvd	Test 2	Test 3	Vel Eqv Trans Std: S/N: M10901	As-Rcvd	Test 2	Test 3
Vel Eqv Trans Std: S/N: M10839	As-Rcvd	Test 2	Test 3	Vel Eqv Trans Std: S/N: M13492	As-Rcvd	Test 2	Test 3
Vel Eqv Trans Std: S/N: M10840	As-Rcvd	(Test 2)	Test 3	Vel Eqv Trans Std: S/N: M19325	As-Rcvd	Test 2	Test 3

Approx Set Point	Standard	Test Meter	Diff	Standard	Test Meter	Diff	Standard	Test Meter	Diff
100		N/A		111	111	0			
500				507	507	0		N/A	

ADM-880C, ADM-870/870C and ADM-860/860C models are read in AirFoil Mode. ADM-850/850L models are read in Pitot Tube Mode.

TEMPERATURE TEST - AIRDATA MULTIMETER (° F)

TEST METER TOLERANCE = ± 0.2° F AS-RECEIVED TEST WITHIN SPEC (YES) NO N/A See Notes

RTD Simulator: S/N 249	(As-Rcvd)	(Test 2)	Test 3	Set Point: (35.6° F)	95° F	154.4° F
RTD Simulator: S/N 250	(As-Rcvd)	(Test 2)	Test 3	Set Point: 35.6° F	(95° F)	154.4° F
RTD Simulator: S/N 253	(As-Rcvd)	(Test 2)	Test 3	Set Point: 35.6° F	95° F	(154.4° F)
RTD Simulator: S/N 254	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 256	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 257	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 292	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 293	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 294	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 313	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 314	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 315	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 316	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 317	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F
RTD Simulator: S/N 318	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F	95° F	154.4° F

RTD Simulator Temperature Equivalent Set Point	Test Meter	Difference	Test Meter	Difference	Test Meter	Difference
35.60	35.6	.0	35.6	.0		
95.00	94.9	-.1	94.9	-.1		
154.40	154.4	.0	154.4	.0	N/A	

There were no additions to or deviations from the specified calibration procedure during the calibration process.

Any calibration due date shown is specified by the customer.

The enclosed ADM Calibration Standards for Pressure and Temperature form(s) is/are an integral part of this calibration and must remain with this Certificate of Calibration. There may be more than one such form included that pertains to this calibration.

Any additional information required pertaining to this calibration or to any repairs performed may be included in other documentation. If applicable, these documents may include, but not be limited to an AirData Multimeter Recalibration Notes form, and/or a Repair Record Notes form.

NOTES: ________

Shortridge Instruments, Inc.
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MICRO PRECISION

MICRO PRECISION CALIBRATION, INC. - KC
8647 LONG STREET
LENEXA KS 66215
913-541-0629

Certificate of Calibration

Date: Oct 29, 2024 **Cert No. 5523631031333432**

Customer:
DOYLE FIELD SERVICES
8900 STATE LINE RD STE 420
LEAWOOD KS LEAWOOD 66206

		Work Order #:	KC-41001431
		Purchase Order #:	CC
MPC Control #:	EV1516	Serial Number:	102110023
Asset ID:	N/A	Department:	N/A
Gage Type:	HUMIDITY/TEMPERATURE INSTRUMENT	Performed By:	BRIAN WOLFE
Manufacturer:	COOPER INSTRUMENT CORPORATION	Received Condition:	IN TOLERANCE
Model Number:	SRH77A	Returned Condition:	IN TOLERANCE
Size:	N/A	Cal. Date:	October 28, 2024
Temp/RH:	72.0°F / 41.0%	Cal. Interval:	12 MONTHS
Location:	Calibration performed at MPC facility	Cal. Due Date:	October 28, 2025

Calibration Notes:
See attached 2 pages of calibration data.

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
EP0707	REFERENCE THERMOMETER	1523	2659119	FLUKE	Mar 13, 2025	5523631030767424
EP0722	PRECISION HUMIDITY LAB	VAPORTRON H-100CL	VB2046	BUCK RESEARCH INST	Feb 27, 2025	5523631030724282
EP0728	MICRO-BATH	7103	B7C639	FLUKE	Feb 24, 2025	5523631030713109
EP6619	MICRO-BATH	7103	A0C222	HART SCIENTIFIC	Feb 24, 2025	5523631030715640
EP6621	MICRO-BATH	7103	A3C568	HART SCIENTIFIC	Feb 24, 2025	5523631030715624

Procedures Used in this Event

Procedure Name	Description
MPC-THD-001 Rev. 03	Temperature, Humidity and Dew Point Devices, General, Rev.03, Jul-15-2024

Calibrating Technician: Brian Wolfe
BRIAN WOLFE

QC Approval:
RAFAEL VENEGAS

MICRO PRECISION

Calibration Report of COOPER SRH77A HUMIDITY/TEMPERATURE INSTRUMENT

MPC Control #: EU6788 Serial Number: 092208039
Asset ID: N/A Calibration Date: October 28, 2024

Temperature Accuracy

TEMP 1

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
-40 to 300 °F	-20.0 °F	-21.9 °F	-19.9 °F	-19.9 °F	-18.1 °F	PASS
	-10.0 °F	-12.0 °F	-9.8 °F	-9.8 °F	-8.1 °F	PASS
	32.0 °F	29.8 °F	31.9 °F	31.9 °F	34.2 °F	PASS
	122.0 °F	119.4 °F	122.6 °F	122.6 °F	124.6 °F	PASS
	212.0 °F	208.9 °F	213.0 °F	213.0 °F	215.1 °F	PASS
	240.0 °F	236.8 °F	240.2 °F	240.2 °F	243.2 °F	PASS
	280.0 °F	276.6 °F	281.1 °F	281.1 °F	283.4 °F	PASS

TEMP 2

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
-40 to 300 °F	-20.0 °F	-21.9 °F	-19.8 °F	-19.8 °F	-18.1 °F	PASS
	-10.0 °F	-12.0 °F	-10.0 °F	-10.0 °F	-8.1 °F	PASS
	32.0 °F	29.8 °F	32.4 °F	32.4 °F	34.2 °F	PASS
	122.0 °F	119.4 °F	122.4 °F	122.4 °F	124.6 °F	PASS
	212.0 °F	208.9 °F	212.0 °F	212.0 °F	215.1 °F	PASS
	240.0 °F	236.8 °F	242.0 °F	242.0 °F	243.2 °F	PASS
	280.0 °F	276.6 °F	281.5 °F	281.5 °F	283.4 °F	PASS

Relative Humidity Accuracy @ 23 °C

TEMP 3

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
10 to 95 %RH	10 %RH	7 %RH	13 %RH	13 %RH	13 %RH	PASS
	25 %RH	22 %RH	26 %RH	26 %RH	28 %RH	PASS
	50 %RH	47 %RH	51 %RH	51 %RH	53 %RH	PASS
	75 %RH	72 %RH	77 %RH	77 %RH	78 %RH	PASS
	90 %RH	87 %RH	91 %RH	91 %RH	93 %RH	PASS

MICRO PRECISION

Calibration Report of COOPER SRH77A HUMIDITY/TEMPERATURE INSTRUMENT

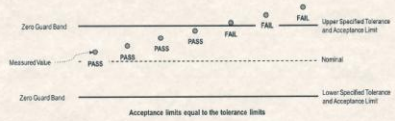
MPC Control #:	EU6788	Serial Number:	092208039
Asset ID:	N/A	Calibration Date:	October 28, 2024

Statements of Pass or Fail Conformance

The status of compliance with the acceptance criteria is reported as:

PASS — Compliant with specification.

FAIL — Not compliant with specification.



Acceptance limits equal to the tolerance limits

- End of Calibration Report -

MICRO PRECISION

MICRO PRECISION CALIBRATION, INC. - KC
8647 LONG STREET
LENEXA KS 66215
913-541-0629

Certificate of Calibration

Date: Oct 28, 2024 **Cert No.** 5523631031331037

Customer:
DOYLE FIELD SERVICES
8900 STATE LINE RD STE 420
LEAWOOD KS LEAWOOD 66206

		Work Order #:	KC-41001431
		Purchase Order #:	CC
MPC Control #:	EV1515	Serial Number:	36300001WS
Asset ID:	N/A	Department:	N/A
Gage Type:	TRUE RMS CLAMP METER	Performed By:	BRIAN WOLFE
Manufacturer:	FLUKE	Received Condition:	LIMITED
Model Number:	324	Returned Condition:	LIMITED USE
Size:	N/A	Cal. Date:	October 28, 2024
Temp/RH:	71.0°F / 41.0%	Cal. Interval:	12 MONTHS
Location:	Calibration performed at MPC facility	Cal. Due Date:	October 28, 2025

Calibration Notes:
See attached 2 pages of calibration data.
Out of tolerance at 10 ohms and 300 ohms.

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
EP0702	CURRENT COIL	9100-200 10/50	29101-10	WAVETEK	Feb 26, 2025	5523631030720229
EP0716	MULTI-PRODUCT CALIBRATOR	5522A	3277903	FLUKE	Nov 29, 2024	EV1931435

Procedures Used in this Event

Procedure Name	Description
FLUKE 32X Rev. SUPP. ISS.3	Clamp Meter, Fluke 32X, Supp. Iss.3, Jan-20-2022

Calibrating Technician: Brian Wolfe — BRIAN WOLFE

QC Approval: RAFAEL VENEGAS

STATEMENTS OF PASS OR FAIL CONFORMANCE: The uncertainty of measurement has been taken into account when determining compliance with specification. All measurements and test results guard banded to ensure the probability of false-accept does not exceed 2% in compliance with ANSI/NCSL Z540.3-2006.

THE CALIBRATION REPORT STATUS:
PASS - Term used when compliance statement is given, and the measurement result is PASS.
PASS* - Term used when compliance statement is given, and the measurement result is conditional passed or PASS*.
FAIL - Term used when compliance statement is given, and the measurement result is FAIL.
FAIL* - Term used when compliance statement is given, and the measurement result is conditional failed or FAIL*.
REPORT OF VALUE - Term used when reported measurement is not requiring compliance statement in report.
ADJUSTED - When adjustments are made to an instrument which changes the value of measurement from what was measured as found to new value as left.
LIMITED - When an instrument fails calibration but is still functional or is limited manner.

This expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%, unless otherwise stated.
This calibration report complies with ISO/IEC 17025:2017, ANSI/NCSL Z540.2-2006 and ANSI/NCSL Z540.1-1994. Calibration dates and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. All standards are traceable to SI through the National Institute of Standards and Technology (NIST) and/or recognized national or international standards laboratories. Services reviewed include proper manufacturer's service instruction and are warranted for no less than thirty (30) days. The information on this report pertains only to the instrument identified; this may not be reproduced in part or in a whole without the prior written approval of the issuing MPI Calibration Laboratory.

MICRO PRECISION

Calibration Report of FLUKE 324 TRUE RMS CLAMP METER

MPC Control #:	EU2379	Serial Number:	60112043MV
Asset ID:	Y-22440	Calibration Date:	October 28, 2024

Temperature Accuracy

Function Tested	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
400 °C	-5.0 °C	-5.9 °C	-5.5 °C	-5.5 °C	-4.2 °C	PASS
400 °C	0.0 °C	-0.8 °C	0.1 °C	0.1 °C	0.8 °C	PASS
400 °C	100.0 °C	98.2 °C	100.0 °C	100.0 °C	101.8 °C	PASS
400 °C	400.0 °C	396.2 °C	399.9 °C	399.9 °C	404.8 °C	PASS

AC Voltage Accuracy

Function Tested	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
50 Hz	10.0 V	9.3 V	10.0 V	10.0 V	10.7 V	PASS
50 Hz	500.0 V	492.0 V	499.8 V	499.8 V	508.0 V	PASS
500 Hz	500.0 V	492.0 V	499.5 V	499.5 V	508.0 V	PASS

DC Voltage Accuracy

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
600 V	-500.0 V	-505.5 V	-499.8 V	-499.8 V	-494.5 V	PASS
600 V	10.0 V	9.4 V	10.0 V	10.0 V	10.6 V	PASS
600 V	500.0 V	494.5 V	499.8 V	499.8 V	505.5 V	PASS

Resistance Accuracy

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
400 Ω	10.0 Ω	9.4 Ω	3.4 Ω	3.4 Ω	10.6 Ω	FAIL
400 Ω	300.0 Ω	296.5 Ω	293.3 Ω	293.3 Ω	303.5 Ω	FAIL
4000 Ω	1000 Ω	985 Ω	993 Ω	993 Ω	1015 Ω	PASS
4000 Ω	3000 Ω	2965 Ω	2993 Ω	2993 Ω	3035 Ω	PASS

Capacitance Accuracy

Range	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
100 µF	10.0 µF	9.5 µF	10.0 µF	10.0 µF	10.5 µF	PASS
1000 µF	500 µF	491 µF	507 µF	507 µF	509 µF	PASS
1000 µF	900 µF	887 µF	913 µF	913 µF	913 µF	PASS

MICRO PRECISION

Calibration Report of FLUKE 324 TRUE RMS CLAMP METER

MPC Control #:	EU2379	Serial Number:	60112043MV
Asset ID:	Y-22440	Calibration Date:	October 28, 2024

AC Current Accuracy (with 50-Turn Coil)

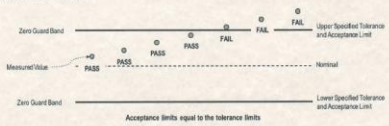
Applied	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result
0.004 A @ 50 Hz	0.20 A	0.15 A	0.20 A	0.20 A	0.25 A	PASS
0.2 A @ 50 Hz	10.00 A	9.80 A	10.05 A	10.05 A	10.20 A	PASS
0.6 A @ 50 Hz	30.00 A	29.50 A	30.13 A	30.13 A	30.50 A	PASS
2 A @ 50 Hz	100.0 A	97.5 A	100.4 A	100.4 A	102.5 A	PASS
6 A @ 50 Hz	300.0 A	293.5 A	301.3 A	301.3 A	306.5 A	PASS

Statements of Pass or Fail Conformance

The status of compliance with the acceptance criteria is reported as:

PASS — Compliant with specification.

FAIL — Not compliant with specification.



Acceptance limits equal to the tolerance limits

- End of Calibration Report -

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MICRO PRECISION

MICRO PRECISION CALIBRATION, INC. - KC
8847 LONG STREET
LENEXA KS 66215
913-541-0629

Certificate of Calibration

Date: Oct 28, 2024 **Cert No. 5523631031331275**

Customer:
DOYLE FIELD SERVICES
8900 STATE LINE RD STE 420
LEAWOOD KS LEAWOOD 66206

		Work Order #:	KC-41001431
		Purchase Order #:	CC
MPC Control #:	EV1518	Serial Number:	C02A0251
Asset ID:	N/A	Department:	N/A
Gage Type:	TACHOMETER	Performed By:	BRIAN WOLFE
Manufacturer:	SHIMPO	Received Condition:	LIMITED
Model Number:	DT-205L	Returned Condition:	LIMITED USE
Size:	N/A	Cal. Date:	October 28, 2024
Temp/RH:	73.0°F / 41.0%	Cal. Interval:	12 MONTHS
Location:	Calibration performed at MPC facility	Cal. Due Date:	October 28, 2025

Calibration Notes:
See attached page of calibration data.
Out of tolerance at contact accuracy.

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
EP0715	TACHOMETER CALIBRATOR	MT2013	6469	COMPACT INSTRUMENTS	Feb 8, 2025	5523631030679845

Procedures Used in this Event

Procedure Name	Description
MPC-TAC-001 Rev. 03	Tachometers, General, Rev.03, Jun-06-2024

Calibrating Technician: Brian Wolfe
BRIAN WOLFE

QC Approval:
RAFAEL VENEGAS

Page 1 of 1 (CERT, Rev 9)

HDM-250 HYDRODATA MULTIMETER CERTIFICATE OF RECALIBRATION

CO ID: 013495 S/N: W10129
Customer: DOYLE FIELD SERVICES, INC. City: LEAWOOD State: KS
PO #: Customer Eqpt ID#: Calibration Due Date: Order #: R241327

Test meter is zeroed prior to taking pressure readings.

As-Received	Final	(crossed out)
As-Received By B. Lw	Final Test By B. Lw	Test By
Date 06/05/2024 Rh 30 %	Date 06/20/2024 Rh 37 %	Date Rh %
Ambient Temperature 74 °F	Ambient Temperature 72 °F	Ambient Temperature N/A °F
Barometric Pressure 28.32 in Hg	Barometric Pressure 29.21 in Hg	Barometric Pressure in Hg
All within spec YES (NO) NA	All within spec (YES) NO	All within spec YES NO

Standard	Set Points	S/N			
HDM Pressure Standard Heise #1-L	Used at Set Points: 3.0; 14.0	S/N 41744/42459	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #3-L	Used at Set Points: 3.0; 14.0	S/N 41745/42460	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #11-L	Used at Set Points: 3.0; 14.0	S/N 45651/48600	(As-Rcvd)	(Test 2)	Test 3
HDM Pressure Standard Heise #1-R	Used at Set Points: 25.0; 31.0; 140.0	S/N 41744/42457-1	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #3-R	Used at Set Points: 25.0; 31.0; 140.0	S/N 41745/42458	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #11-R	Used at Set Points: 25.0; 31.0; 140.0	S/N 45651/48599	(As-Rcvd)	(Test 2)	Test 3
HDM Pressure Standard Heise #2-L	Used at Set Points: 225.0; 275.0; 1025	S/N 41747/42464	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #4A-L	Used at Set Points: 225.0; 275.0; 1025	S/N 44806/47224	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #12-L	Used at Set Points: 225.0; 275.0; 1025	S/N 45652/48602	(As-Rcvd)	(Test 2)	Test 3
HDM Pressure Standard Heise #2-R	Used at Set Points: 1620; 2000; 4500; 6930	S/N 41747/42462	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #4A-R	Used at Set Points: 1620; 2000; 4500; 6930	S/N 44806/47216	As-Rcvd	Test 2	Test 3
HDM Pressure Standard Heise #12-R	Used at Set Points: 1620; 2000; 4500; 6930	S/N 45652/48601	(As-Rcvd)	(Test 2)	Test 3

DIFFERENTIAL PRESSURE (Pd) TEST (in wc)

TEST METER TOLERANCE = ± 2.0 % ± 0.3 in wc AS-RCVD TEST WITHIN SPEC (YES) NO N/A See Notes

Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
3.0	3.08	3.1	.65	3.04	3.1	1.97			
14.0	14.07	14.2	.92	14.07	14.2	.92			
25.0	25.07	25.4	1.32	25.07	25.0	-.28			
31.0	31.03	31.1	.23	31.04	31.1	.19			
140.0	146.85	148.4	1.06	144.24	145.4	.80		N/A	
225.0	225.3	227.0	.75	225.0	226.9	.84			
275.0	281.8	283.0	.43	285.0	286.1	.39			
1025	1033.7	1037	.32	1034.8	1037	.21			
1620	1626	1629	.18	1624	1625	.06			
2000	2009	2021	.60	2028	2031	.15			
4500	4508	4525	.38	4537	4549	.26			
6930	6957	6977	.29	6937	6952	.22			

GAGE PRESSURE (P_g) TEST (in wc)

TEST METER TOLERANCE = ± 2.0 % ± 0.3 in wc AS-RCVD TEST WITHIN SPEC (YES) NO N/A See Notes

Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
3.0	3.07	2.9	-5.54	3.04	3.0	-1.32			
14.0	14.07	14.2	.92	14.05	14.1	.36			
25.0	25.03	25.3	1.08	25.09	25.2	.44			
31.0	31.03	31.3	.87	31.03	31.2	.55			
140.0	142.91	145.6	1.88	145.54	146.6	.73		N/A	
225.0	225.0	226.2	.53	225.0	226.2	.53			
275.0	281.9	282.4	.18	283.0	283.0	.00			
1025	1033.8	1034	.02	1034.4	1034	-.04			
1620	1627	1626	-.06	1631	1627	-.25			
2000	2021	2019	-.10	2037	2034	-.15			
4500	4500	4500	.00	4510	4506	-.09			
6930	6960	6937	-.33	6930	6904	-.38			

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MICRO PRECISION

Calibration Report of Shimpo DT-205L Digital Tachometer

MPC Control #:	EV1518	Serial Number:	C02A0251
Asset ID:	N/A	Calibration Date:	October 28, 2024

Contact Accuracy

Function Tested	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result	Uncertainty (±)	TUR
0.8 to 25,000 rpm	6000 RPM	5999 RPM	4561 RPM	4561 RPM	6001 RPM	FAIL	0.57 RPM	1.8 : 1
	12000 RPM	11998 RPM	10454 RPM	10454 RPM	12002 RPM	FAIL	0.57 RPM	3.5 : 1
	18000 RPM	17998 RPM	13859 RPM	13859 RPM	18002 RPM	FAIL	0.57 RPM	3.5 : 1
	22500 RPM	22498 RPM	15002 RPM	15002 RPM	22502 RPM	FAIL	0.57 RPM	3.5 : 1

Non-Contact Accuracy

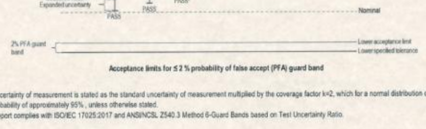
Function Tested	Nominal	Lower Limit	As Found	As Left	Upper Limit	Result	Uncertainty (±)	TUR
6 to 99,999 rpm	25000 RPM	24994 RPM	25002 RPM	25002 RPM	25006 RPM	PASS	0.57 RPM	≥ 4.0 : 1
	50000 RPM	49994 RPM	50004 RPM	50004 RPM	50006 RPM	PASS	0.57 RPM	≥ 4.0 : 1
	75000 RPM	74994 RPM	75002 RPM	75002 RPM	75006 RPM	PASS	0.57 RPM	≥ 4.0 : 1
	90000 RPM	89994 RPM	90002 RPM	90002 RPM	90006 RPM	PASS	0.57 RPM	≥ 4.0 : 1

Statements of Pass or Fail Conformance

The uncertainty of measurement has been taken into account when determining compliance with specification, as per ILAC-G8:03/2009.
All measurements and test results guard banded to ensure the probability of false-accept does not exceed 2% in compliance with ANSI/NCSL Z540.3-2006.

The status of compliance with the acceptance criteria is reported as:

PASS - Compliant with specification
FAIL - Not compliant with specification
FAIL² - The measured value is not within the acceptance limits. However, a portion of the expanded uncertainty of measurement at 95% is within the specified tolerance.
PASS² - The measured value is within acceptance limits. However, a portion of the expanded uncertainty of measurement at 95% exceeds the specified tolerance.



Acceptance limits for ≤ 2 % probability of false accept (PFA) guard band

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%, unless otherwise stated.
This calibration report complies with ISO/IEC 17025:2017 and ANSI/NCSL Z540.3 Method 6-Guard Bands based on Test Uncertainty Ratio.

- End of Calibration Report -

Shortridge Instruments, Inc. HydroData Multimeter Calibration Equipment

Order Number: R241327 Serial Number: W10129 Test Type: Initial (As-Received) (Final)

DIFFERENTIAL / GAGE PRESSURE STANDARDS

HDM #01-L S/N: 41744/42459 Heise Model: PPM-1 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 08/25/23 Due Date: 08/2024
HDM #03-L S/N: 41745/42460 Heise Model: PPM-1 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 07/07/23 Due Date: 06/2024
HDM #11-L S/N: 45651/48600 Heise Model: PPM-1 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 04/24/24 Due Date: 04/2025
Rated Accuracy: 0.06% fs Range: 0.0 to 15.0 in wc Resolution: 0.001 in wc Uncertainty: < 0.00651 in wc
Used at Set Points: 3.0; 14.0 for all models.

HDM #01-R S/N: 41744/42457-1 Heise Model: PPM-1 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 08/28/23 Due Date: 08/2024
HDM #03-R S/N: 41745/42458 Heise Model: PPM-1 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 07/07/23 Due Date: 06/2024
HDM #11-R S/N: 45651/48599 Heise Model: PPM-1 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 04/25/24 Due Date: 04/2025
Rated Accuracy: 0.06% fs Range: 0.0 to 150.0 in wc Resolution: 0.01 in wc Uncertainty: < 0.07540 in wc
Used at Set Points: 25.0; 31.0; 140.0 for all models.

HDM #02-L S/N: 41747/42464 Heise Model: PPM-2 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 08/25/23 Due Date: 08/2024
HDM #04A-L S/N: 44806/47224 Heise Model: PPM-2 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 06/27/23 Due Date: 06/2024
HDM #12-L S/N: 45652/48602 Heise Model: PPM-2 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 04/22/24 Due Date: 04/2025
Rated Accuracy: 0.05% fs Range: 0.0 to 1400 in wc Resolution: 0.1 in wc Uncertainty: < 0.479 in wc
Used at Set Points: 225.0; 275.0; 1025 for HDM-250 and HDM-300 Used at Set Points: 250.0; 305.0 for HDM-150

HDM #02-R S/N: 41747/42462 Heise Model: PPM-2 Mfgd by Dresser Industries Calibrated by Ashcroft Calibration Date: 08/25/23 Due Date: 08/2024
HDM #04A-R S/N: 44806/47216 Heise Model: PPM-2 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 06/27/23 Due Date: 06/2024
HDM #12-R S/N: 45652/48601 Heise Model: PPM-2 Mfgd & Calibrated by Ashcroft, Inc. Calibration Date: 04/22/24 Due Date: 04/2025
Rated Accuracy: 0.05% fs Range: 0.0 to 8320 in wc Resolution: 1 in wc Uncertainty: < 2.77 in wc
Used at Set Points: 1620; 2000; 4500; 6930 for HDM-250 Used at Set Points: 1620; 2000; 4500; 8300 for HDM-300 Used at Set Points: 2000; 4150 for HDM-150

TEMPERATURE STANDARDS

RTD Simulator S/N: 249 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 04/11/24 Due Date: 04/2028
RTD Simulator S/N: 250 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 04/11/24 Due Date: 04/2028
RTD Simulator S/N: 253 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 04/11/24 Due Date: 04/2028
RTD Simulator S/N: 254 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 05/04/20 Due Date: 08/2024
RTD Simulator S/N: 256 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 05/04/20 Due Date: 08/2024
RTD Simulator S/N: 257 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 05/04/20 Due Date: 08/2024
RTD Simulator S/N: 292 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 01/15/24 Due Date: 01/2028
RTD Simulator S/N: 293 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 01/15/24 Due Date: 01/2028
RTD Simulator S/N: 294 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 01/15/24 Due Date: 01/2028
RTD Simulator S/N: 313 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 03/25/22 Due Date: 03/2026
RTD Simulator S/N: 314 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 03/25/22 Due Date: 03/2026
RTD Simulator S/N: 315 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 03/25/22 Due Date: 03/2026
RTD Simulator S/N: 316 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 06/06/22 Due Date: 05/2026
RTD Simulator S/N: 317 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 05/23/22 Due Date: 05/2026
RTD Simulator S/N: 318 Model RTD-1000/500 Mfgd by General Resistance Calibrated by IET Labs Calibration Date: 05/23/22 Due Date: 05/2026
Rated Accuracy: 0.025% of setting Range: 100.00 Ω to 11111.10 Ω Resolution: 0.01 Ω Uncertainty: ≤ 32 ppm

Thermometer #1 S/N 8A089/Thermistor S/N A410660 Model 1504/5610 Mfgd by Hart Scientific Calibrated by Fluke Calibration Date: 04/09/24 Due Date: 04/2026
Thermometer #2 S/N 8B104/Thermistor S/N 871507 Model 1504/5610 Mfgd by Hart Scientific Calibrated by Fluke Calibration Date: 12/07/22 Due Date: 11/2024
Thermometer #5 S/N B11780/Thermistor S/N B10505 Model 1504/5610 Mfgd by Hart Scientific Calibrated by Fluke Calibration Date: 05/16/22 Due Date: 05/2024
Thermometer #6 S/N B11782/Thermistor S/N B10509 Model 1504/5610 Mfgd by Hart Scientific Calibrated by Fluke Calibration Date: 06/09/22 Due Date: 08/2024
Thermometer #7 S/N B49938/Thermistor S/N B482202 Model 1504/5610 Mfgd and Calibrated by Fluke Calibration Date: 02/05/24 Due Date: 02/2026
Rated Accuracy (combined): 0.0324° F Range: 32° F to 176° F Resolution: 0.001° F Combined Uncertainty with Baths: ≤ 0.040° F

Temp Transfer Standard S/N M00136 Model ADM-870 Mfgd & Calibrated by Shortridge Instruments, Inc. Calibration Date: 10/25/23 Due Date: 10/2024
Temp Transfer Standard S/N M96100 Model ADM-870 Mfgd & Calibrated by Shortridge Instruments, Inc. Calibration Date: 03/21/24 Due Date: 03/2025
Rated Accuracy: 0.03° F Range: 33° F to 158° F Resolution: 0.01° F Uncertainty: < 0.023° F
Total combined Uncertainty for MultiTemp and TemProbe testing : ≤ 0.046° F

This form must remain with the Certificate of Calibration corresponding to the Order Number listed above.

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HDM-250 HYDRODATA MULTIMETER CERTIFICATE OF RECALIBRATION

S/N: W10129
Order #: R241327

TEMPERATURE TEST - HYDRODATA MULTIMETER (° F)

TEST METER TOLERANCE = ± 0.2° F AS-RCVD TEST WITHIN SPEC YES (NO) N/A See Notes

RTD Simulator: S/N 249	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 250	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 253	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 254	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 256	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 257	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 292	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 293	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 294	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 313	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 314	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 315	As-Rcvd	Test 2	Test 3	Set Point: 35.6° F 95° F 154.4° F
RTD Simulator: S/N 316	(As-Rcvd)	(Test 2)	Test 3	Set Point: 35.6° F 95° F (154.4° F)
RTD Simulator: S/N 317	(As-Rcvd)	(Test 2)	Test 3	Set Point: 35.6° F (95° F) 154.4° F
RTD Simulator: S/N 318	(As-Rcvd)	(Test 2)	Test 3	Set Point: (35.6° F) 95° F 154.4° F

RTD Simulator Temperature Equivalent Set Point	Test Meter	Diff	Test Meter	Diff	Test Meter	Diff
35.60	33.2	-2.4	35.6	.0		N/A
95.00	90.9	-4.1	95.1	.1		
154.40	147.7	-6.7	154.4	.0		

NOTES: ______________________

Procedure used: Procedure for Differential Pressure, Gage Pressure, and Temperature Recalibration of HydroData Multimeters SIP-CP11 Revision: 05 Dated: 07/31/14. There were no additions to or deviations from the specified calibration procedure during the calibration process.

This instrument has been calibrated using Calibration Standards which are traceable to NIST (National Institute of Standards and Technology). Calibration accuracy ratio is 4:1 for pressures and temperature. Quality Assurance Program and calibration procedures meet the requirements for ANSI/NCSL Z540-1, ISO 17025, MIL-STD 45662A and manufacturer's specifications. Calibration accuracy is certified when meters are used with properly functioning accessories only. Uncertainties are expressed in expanded terms (twice the calculated uncertainty). This report shall not be reproduced, except in full, without the written approval of Shortridge Instruments, Inc. Results relate only to the item calibrated.

Limitations on use: See Shortridge Instruments, Inc. Instruction Manual for the use of HydroData Multimeters

The enclosed HDM Calibration Standards form(s) is/are an integral part of this calibration and must remain with this Certificate of Calibration. Note: There may be more than one such form included that pertains to this calibration. Any calibration due date shown is specified by the customer.

Calibration Technician(s): ______ Calibration Date: 06/20/2024

Calibration Approved by: ______ Title: Cal. Tech. Date: 06/26/2024

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HYDRODATA MULTIMETER NEGATIVE GAGE PRESSURE RECALIBRATION

Customer ID: 013495 Order #: R241327 S/N #: W10129

Customer: DOYLE FIELD SERVICES, INC. City: LEAWOOD State: KS

Procedure used: Procedure for Negative Gage Pressure Testing of HydroData Multimeters SIP-CP19 Revision: 01 Dated: 05/04/17. There were no additions to or deviations from the calibration procedures during the calibration process. Any calibration due date shown is specified by the customer.

NEGATIVE PRESSURE STANDARDS

HDM #07 S/N: 45522/48374 Heise Model: PPM-2 Calibration Date: 08/25/23 Calibration Due Date: 08/2024

HDM #09 S/N: 45571/48463 Heise Model: PPM-2 Calibration Date: 03/22/24 Calibration Due Date: 03/2025

Manufactured and calibrated by Ashcroft, Inc. Used at all specified set points.

Accuracy: 0.025 % of full range Range: 0 / -388.21 in wc Resolution: 0.01 Uncertainty: As stated at Set Points

AS-RECEIVED TEST CONDITIONS

Calibration Standard: (HDM #07) HDM #09
Relative Humidity: 30 %
Ambient Temperature: 74 °F
Barometric Pressure: 28.32 in Hg
Calibrated By: ______
Calibration Date: 06/05/2024
Within Spec: (Yes) No NA See Notes
HydroData MultiMeter Model Number: HDM-250

FINAL TEST CONDITIONS

Calibration Standard: (HDM #07) HDM #09
Relative Humidity: 37 %
Ambient Temperature: 72 °F
Barometric Pressure: 28.21 in Hg
Calibrated By: ______
Calibration Date: 06/20/2024
Within Spec: (Yes) No NA See Notes
HydroData MultiMeter Model Number: HDM-250

NEGATIVE GAGE PRESSURE TEST (P_2) TEST (in wc)

Test Meter Tolerance = ± 2.0 % ± 0.3 in wc Test Meter is zeroed prior to taking pressure readings.

Approximate Set Point	Set Point Uncertainty (in wc)	As-Received Test			Final Test		
		Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
-14.0	± 0.01	-14.31	-14.4	.63	-14.30	-14.4	.70
-140.0	± 0.01	-140.60	-140.6	.00	-140.59	-140.6	.01
-335.0	± 0.11	-339.70	-341.6	.56	-339.67	-341.5	.54

NOTES: ______________________

This instrument has been calibrated using Calibration Standards which are traceable to NIST (National Institute of Standards and Technology). Quality Assurance Program and calibration procedures meet the requirements for ANSI/NCSL Z540-1, ISO 17025, MIL-STD 45662A and manufacturer's specifications.

Calibration accuracy is certified when meters are used with properly functioning accessories only. This report shall not be reproduced, except in full, without the written approval of Shortridge Instruments, Inc. Results relate only to the item calibrated.

Test Accuracy Ratio is 3:1 for HDM Negative Gage Pressure.

Limitations on use: See Shortridge Instruments, Inc. Instruction Manual for the use of HydroData Multimeters.

Calibration Approved by: ______ Title: Cal. Tech. Date: 06/26/2024

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Doyle Field Services, Inc.

NEBB Certification Certificates

Firm Certification

DOYLE FIELD SERVICES, INC.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED
STATUS IN THE FOLLOWING DISCIPLINE

Testing, Adjusting and Balancing of Environmental Systems

3158
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Firm Certification

DOYLE FIELD SERVICES, INC.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED
STATUS IN THE FOLLOWING DISCIPLINE

Sound and Vibration Measurement

3158
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Firm Certification

DOYLE FIELD SERVICES, INC.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED
STATUS IN THE FOLLOWING DISCIPLINE

Whole Building Technical Commissioning of New Construction

3158
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Certification

DENNIS T. DOYLE, P.E.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

Whole Building Technical Commissioning of New Construction

This Certificate, as well as individual affiliation with a NEBB Certified Firm and associated NEBB Certification Stamp are REQUIRED to provide a NEBB Certified Report. Participation in the NEBB Quality Assurance Program requires the Certificant be affiliated with a NEBB Certified Firm

CP-23150
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Certification

DENNIS T. DOYLE, P.E.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

Testing, Adjusting and Balancing of Environmental Systems

This Certificate, as well as individual affiliation with a NEBB Certified Firm and associated NEBB Certification Stamp are REQUIRED to provide a NEBB Certified Report. Participation in the NEBB Quality Assurance Program requires the Certificant be affiliated with a NEBB Certified Firm

CP-23150
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Certification

DENNIS T. DOYLE, P.E.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

Sound Measurement

This Certificate, as well as individual affiliation with a NEBB Certified Firm and associated NEBB Certification Stamp are REQUIRED to provide a NEBB Certified Report. Participation in the NEBB Quality Assurance Program requires the Certificant be affiliated with a NEBB Certified Firm

CP-23150
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Certification

DENNIS T. DOYLE, P.E.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

Vibration Measurement

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CP-23150
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

NEBB President-Elect

Certification

ALBERT J. KEANE

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL
STATUS IN THE FOLLOWING DISCIPLINE

Testing, Adjusting and Balancing of Environmental Systems

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CP-23650
NEBB Certification Number

December 31, 2025
Expiration Date

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ALBERT J. KEANE

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December 31, 2025
Expiration Date

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Certification

EDWIN D. NOBLE

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STATUS IN THE FOLLOWING DISCIPLINE

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EDWIN D. NOBLE

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STATUS IN THE FOLLOWING DISCIPLINE

Whole Building Technical Commissioning of New Construction

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CT-22389
NEBB Certification Number

December 31, 2025
Expiration Date

NEBB President

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Certification

JAMES DWAYNE COIN

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

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Certification

DANIEL LEE GODDEN

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL STATUS IN THE FOLLOWING DISCIPLINE

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CP-24153
NEBB Certification Number

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Certification

COLTEN E. KAPLANIS

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED TECHNICIAN STATUS IN THE FOLLOWING DISCIPLINE

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CT-22636
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December 31, 2025
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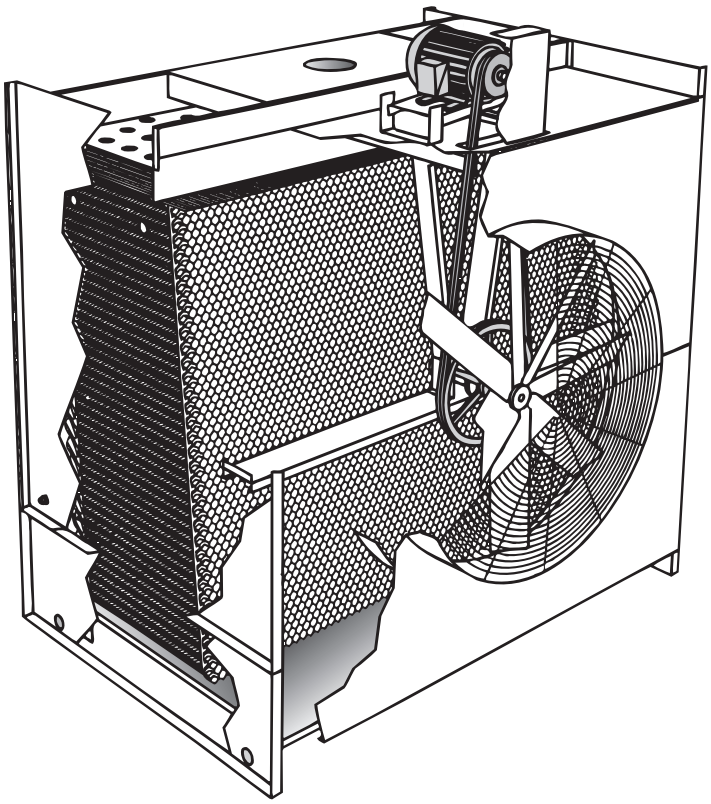
Aquatower®

STEEL COOLING TOWER

engineering data
and specifications

MARLEY®



- **Proven Performance.** CTI Certified. Plus SPX stands by its responsibility for reliable thermal performance. We designed it. We rate it. We guarantee it!
- **Induced-Draft Design.** Save on fan power. The fan will operate in a warm atmosphere even in winter, so you'll never have to work on frozen mechanical equipment.
- **Crossflow Design.** Save on pump power because you only pay to move the water to the top of the tower. Gravity does the rest. The mechanical equipment and water distribution system are out where you can easily maintain them.
- **All-Season Reliability.** Aquatowers perform as specified in the heat of summer. They respond well to energy management techniques in the spring and fall and with appropriate fan controls, they can operate virtually ice-free in the dead of winter. Plus they offer simple maintenance all year long.
- **Proven Corrosion Protection.** Thousands of users over more than 65 years confirm the value of heavy galvanizing. And Marley's G-235 is the most effective galvanizing used in the industry.
- **PVC Film Fill with Integral Drift Eliminators and Louvers.** If you've ever had to replace deteriorated eliminators or louvers, you'll appreciate this advantage. Integral honeycomb louvers keep the circulating water inside your tower.
- **Select Your Aquatower on Our Website.** The Marley UPDATE web-based selection software—available at spxcooling.com/update—provides Aquatower model recommendations based on your specific design requirements
- **Simple, Flexible Installation.** Just mount the motor, belts and belt guard, install the outlet connection that suits your needs—both side suction and bottom outlet are provided, complete with screens—and adjust the float valve and your Aquatower is ready for operation.

CTI CERTIFIED

Today's Aquatower may be the most space/energy-efficient cooling tower available. Your needs have dictated constant technological improvement. Thousands of Aquatower users enjoy the benefits of eight major redesigns and dozens of minor improvements in the past 65 years. For example, PVC film-fill enables the Aquatower to reject more heat per unit size. We also put the air inlet louvers and drift eliminators right on the fill sheets. This new arrangement saves you fan horsepower by improving airflow through the tower.

The Aquatower is a maintenance delight! You'll appreciate the way the Aquatower simplifies maintenance. No hidden spray systems, tiny nozzles, or enclosed basins here! You can easily replace and align V-belts from outside the tower.

All primary components of the Aquatower are open to view. You can easily remove any debris from the upper basin or nozzles while the tower is in operation.

Heavy mill galvanizing on all steel components prevents base metal corrosion. You won't have to worry about paint chips clogging your strainers and nozzles, because there is no paint to flake off. Heavy galvanizing also protects much better than paint.

You'll enjoy single source responsibility and reliability because we design and manufacture virtually all major cooling tower components.

All Marley components are designed and selected to be a part of an integrated system. For example, the spray pattern from nozzles and the pressure drop through drift eliminators both affect a fill's heat transfer capacity. So, we include that impact in our thermal analysis. Drift eliminators must be effective at the air velocities where fill is most efficient. So, we've carefully designed both components to work together efficiently.

How many other cooling tower companies can offer you this assurance? They may use one brand of nozzle with brand of fill and another manufacturer's drift eliminators. When they all come together, the whole may be less than the sum of the parts.

Our total system approach assures that all the parts work together to provide you the greatest total performance. And because we design specifically for cooling towers, all our components will provide many years of service with minimal maintenance.

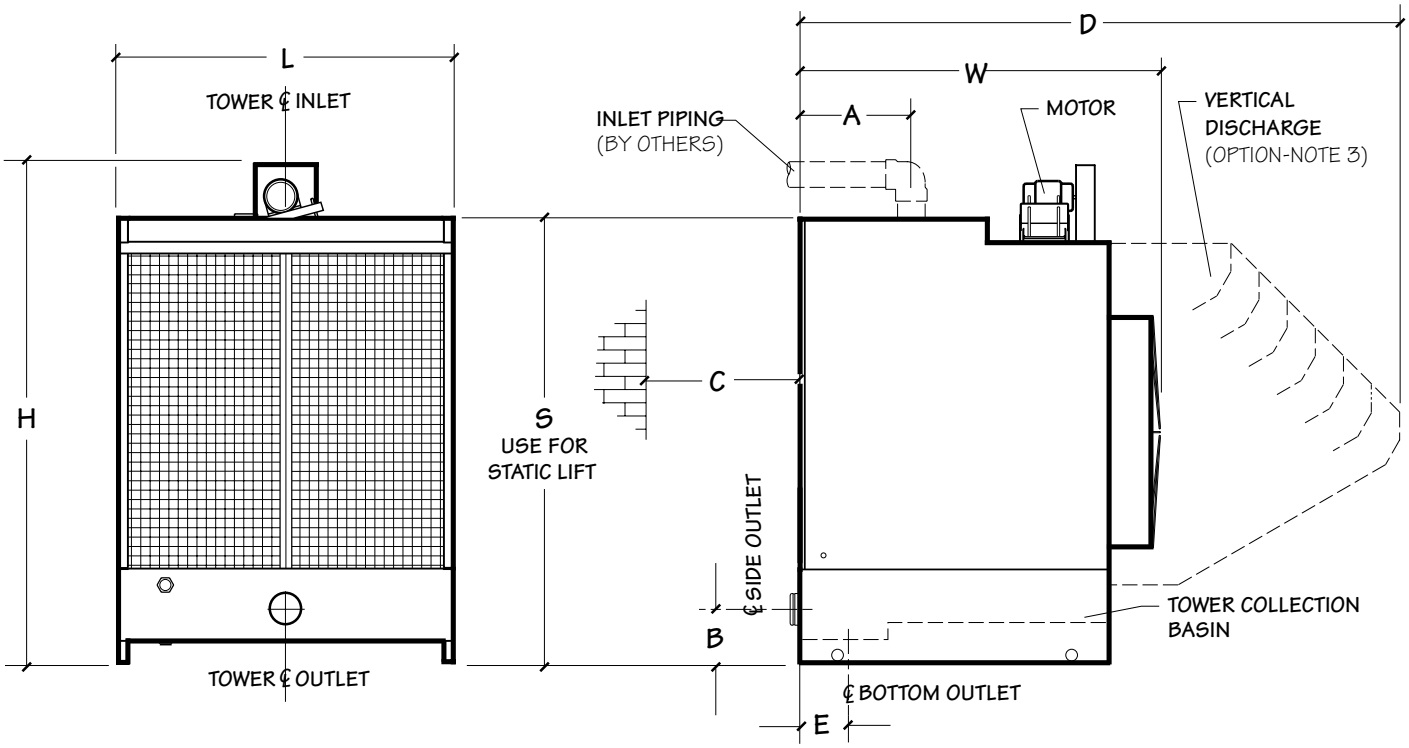
Every Aquatower cooling tower carries a full one-year warranty. The Aquatower you buy from us will work on your job or we'll make it right. Your warranty includes thermal performance and every component of the tower. The SPX Cooling Technologies warranty is your assurance of performance—for a full year.

Above all, the Aquatower is readily available. You won't have to wait around—or accept second best—when you need a cooling tower. We maintain an impressive stock of completed towers at our own plants. A growing number of local distributors can draw from that stock.

Since 1947 the Marley Aquatower has inspired many imitators. Only SPX Cooling Technologies can offer you the original.

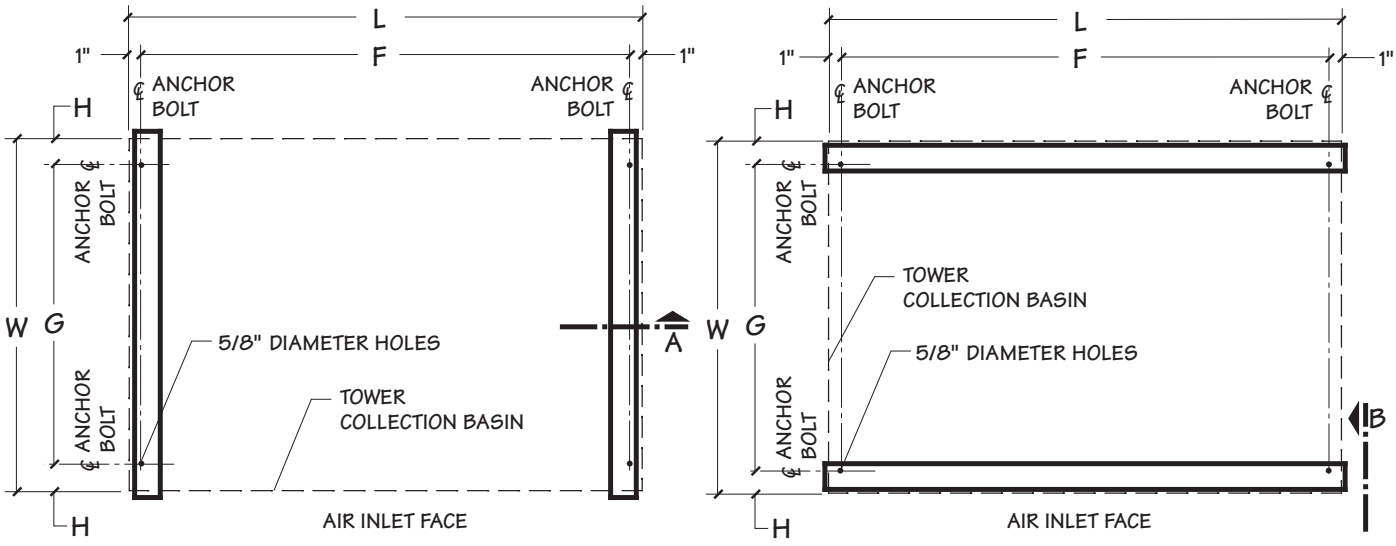
Contact your local distributor or Marley representative. They'll be glad to help you choose the proper model for your needs. They can also help you with your layout and piping.

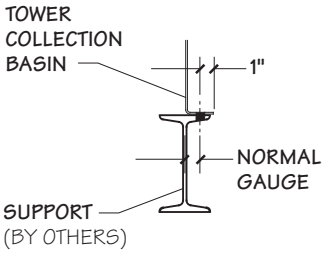
MARLEY®



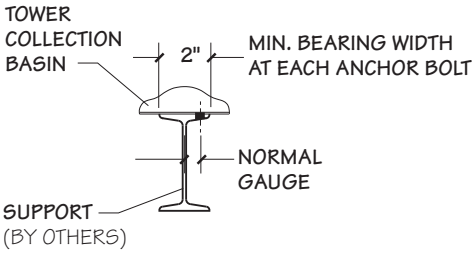
Tower Model	Nominal Tons note1	Dimensions									Motor hp	Piping Connection	
		L	W	H	A	B	C note 2	D	E	S		Inlet	Outlet note 6
490A	8	2'-11½"	4'-2⅞"	5'-3⅜"	1'-3 13/16"	6⅞"	2'-0"	note 3	note 6	4'-4"	⅓	2"	2" F
490D	10	2'-11½"	4'-2⅞"	5'-3⅜"	1'-3 13/16"	6⅞"	2'-0"	note 3	note 6	4'-4"	1	2"	2" F
492D	22	3'-11½"	5'-0¾"	7'-4½"	1'-5"	9½"	4'-0"	note 3	8"	6'-5"	1	4"	4" M
492G	28	3'-11½"	5'-0¾"	7'-4½"	1'-5"	9½"	4'-0"	note 3	8"	6'-5"	2	4"	4" M
493G	36	5'-11½"	5'-1"	7'-4½"	1'-5"	9½"	5'-0"	note 3	8"	6'-5"	2	4"	4" M
493H	42	5'-11½"	5'-1"	7'-4½"	1'-5"	9½"	5'-0"		8"	6'-5"	3	4"	4" M
494G	51	5'-11½"	6'-5⅝"	9'-0"	1'-11 15/16"	11½"	6'-0"	10'-8"	9¼"	7'-10½"	2	6"	6" MC
494H	57	5'-11½"	6'-5⅝"	9'-0"	1'-11 15/16"	11½"	6'-0"	10'-8"	9¼"	7'-10½"	3	6"	6" MC
494K	68	5'-11½"	6'-5⅝"	9'-0"	1'-11 15/16"	11½"	6'-0"	10'-8"	9¼"	7'-10½"	5	6"	6" MC
495K	80	7'-11½"	6'-5¾"	9'-0"	1'-11 15/16"	11½"	7'-0"	10'-8"	9¼"	7'-10½"	5	6"	6" MC
495M	91	7'-11½"	6'-5¾"	9'-0"	1'-11 15/16"	11½"	7'-0"	10'-8"	9¼"	7'-10½"	7½	6"	6" MC
496K	111	9'-11½"	6'-6⅛"	9'-8¼"	1'-11 3/16"	11½"	9'-0"	10'-11 1/16"	9¼"	8'-7"	5	6"	6" MC
496M	126	9'-11½"	6'-6⅛"	9'-8¼"	1'-11 3/16"	11½"	9'-0"	10'-11 1/16"	9¼"	8'-7"	7½	6"	6" MC

1. Nominal tons are based upon 95°F HW, 85°F CW, 78°F WB, and 3 gpm/ton. The Marley ***UPDATE*** web-based selection software provides Aquatower model recommendations based on specific design requirements.
2. Minimum clearance for adequate air supply. Consult your Marley sales representative or your local distributor if this clearance is impractical for your job.
3. Vertical discharge hood is for applications in restrictive enclosures or other locations where horizontal discharge is not desirable. CTI Certification does not apply when this option is selected. Available only on models 494 and larger.
4. Motors less than 1 hp are 115/230 volt, single-phase TENV. 1 hp through 7.5 hp motors are 230/460 volt, 3-phase TEFC.
5. Motor, belt and belt guard ship uninstalled. Installation by others.
6. Outlet sizes shown are side outlets. All models except 490A and 490D have connections for both side and bottom outlet. Install the desired connection and seal the unused opening with the coverplate provided. Pump suction should use side outlet. See page 9 for size and flow capacities of bottom outlets.
7. Overflow is a 2" F connection located in side of collection basin.
8. Drain is a 2" F connection located in collection basin floor.
9. Makeup valve connection is ¾" M located in tower side.





SECTION A



VIEW B

Tower Model	Dimensions					Shipping Weight lb	Maximum Operating lb	Maximum Operating Load at Anchor lb	Wind Load lb	
	L	W	F	G	H				Max. Vertical Reaction at Anchor	Max. Horizontal Reaction at Anchor
490	2'-11½"	3'-4⅛"	2'-9½"	3'-0"	2 1/16"	437	756	185	180	115
492	3'-11½"	4'-1⅝"	3'-9½"	3'-6"	3 13/16"	742	1396	349	355	210
493	5'-11½"	4'-1⅝"	5'-9½"	3'-6"	3 13/16"	982	1995	499	525	285
494	5'-11½"	5'-6⅛"	5'-9½"	5'-0"	3 1/16"	1398	2948	737	555	355
495	7'-11½"	5'-6⅛"	7'-9½"	5'-0"	3 1/16"	1758	3853	963	745	470
496	9'-11½"	5'-6⅛"	9'-9½"	5'-0"	3 1/16"	2096	4751	1188	1095	640
Models with Vertical Discharge Hood Option										
494	5'-11½"	5'-6⅛"	5'-9½"	5'-0"	3 1/16"	1798	3348	837	700	515
495	7'-11½"	5'-6⅛"	7'-9½"	5'-0"	3 1/16"	2133	4233	1058	745	515
496	9'-11½"	5'-6⅛"	9'-9½"	5'-0"	3 1/16"	2596	5251	1313	1095	640

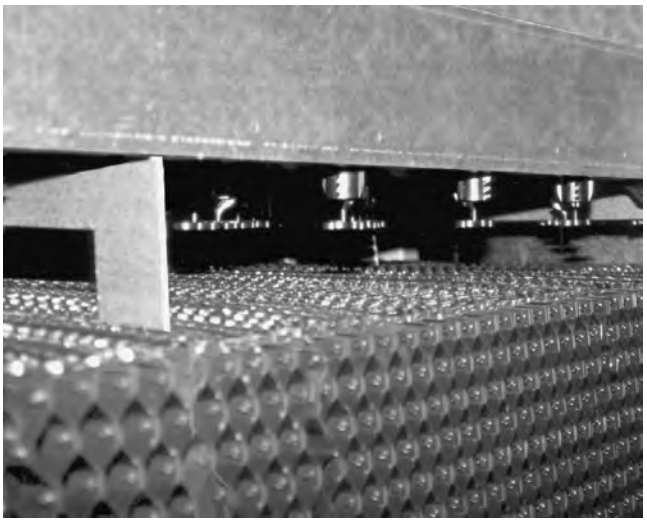
1. Use this bulletin for preliminary layouts only. Obtain current drawings from your Marley sales representative or your local distributor.
2. Purchaser to provide tower supports complete with holes and bolts for anchorage. All supports must be framed flush and level at top. Maximum deflection to be 1/360th of span, not to exceed ½".
3. Maximum weight occurs with basin full to overflow level at shutdown. Actual operating weight varies with flow and piping scheme.
4. Wind loads are based on 30 psf and are additive to operating loads. Reactions due to wind loads exceed those resulting from seismic loads based on the 1997 UBC code, Zone 4 and an Importance Factor of 1.00 per Section 1634—Towers Not on a Building.

Use this data for preliminary layouts only. Obtain current drawing from your Marley sales representative.

UPDATE™ web-based selection software, available at spxcooling.com/update provides Aquatower model recommendations based on customer's specific design requirements.

WATER DISTRIBUTION SYSTEM

Warm water flows through external piping (not included with the tower) into a splash box at the top of the Aquatower. This splash box contains the incoming water and helps provide uniform water distribution. Water then flows by gravity from the basin through nozzles located over the fill. Hot water distribution basin covers are provided as standard equipment to keep the distribution basin free from airborne debris and to reduce the likelihood of biological growth.



Eliminator air-seal removed showing nozzle distribution area above fill

All Aquatowers use Marley "Spiral Target" nozzles. These inert polypropylene nozzles are evenly spaced throughout the distribution basin to assure uniform water distribution over all portions of the fill. Their large openings resist clogging. Nozzles are easy to remove and replace if the design water flow rate needs to be changed.

Marley Spiral Target distribution nozzle

FILL/LOUVERS/DRIFT ELIMINATORS

Marley MX Fill features integral louvers and drift eliminators, designed to minimize resistance to airflow. This patented arrangement prevents water from escaping the fill, assuring proper heat transfer throughout wide variations in airflow. Users find MX fill operates ice-free even in extremely cold weather.

The thermoformed PVC fill sheets withstand hot water temperatures as high as 125°F. Fill sheets are immune to biological and corrosive decay and their flame spread rating is less than 25 per ASTM E-84. Galvanized structural tubes support and stabilize the fill. They also hold the bottom of the fill sheets above the cold water basin floor to simplify basin cleaning. Removable 1" x 1" mesh galvanized air inlet screens keep larger airborne trash out of the collection basin and fill area.

MX Fill

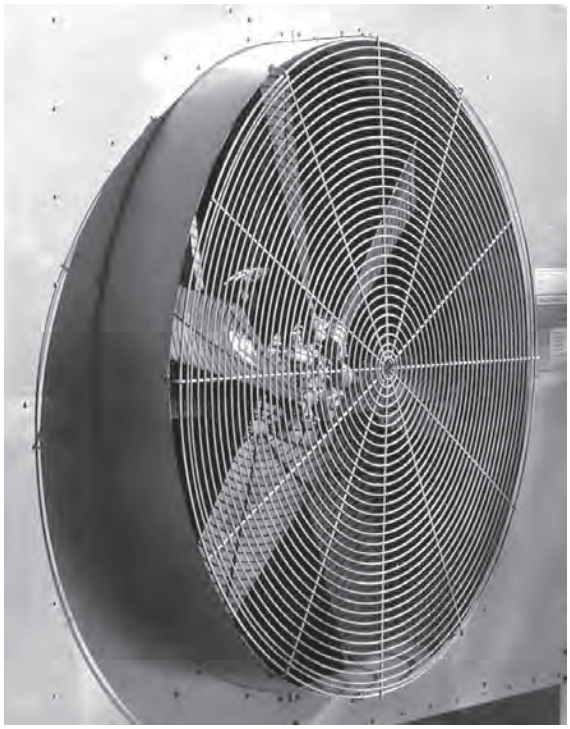
COLD WATER COLLECTION BASIN

The Aquatower's collection basin simplifies basin cleaning, and assures proper outflow. Water flows from the elevated area under the fill into the basin's rear depressed section, where side suction piping connects. A bottom outlet is also available for gravity flow applications.

Standard equipment on each tower basin includes: a screened suction connection; a threaded overflow connection, a threaded and plugged drain connection and a float-operated make-up valve. Models 492 through 496 also include a bottom outlet conforming to 125# flange specifications. A blank cover plate is provided to seal the outlet opening if not used.

MECHANICAL EQUIPMENT

Belt-drive propeller fans ensure design airflow at minimum horsepower. Fans are supported by a stainless steel fan shaft in a cast iron, oil-lubricated, tapered roller bearing assembly with remote oil reservoir. For ease of maintenance all drive components are accessible from outside the tower.

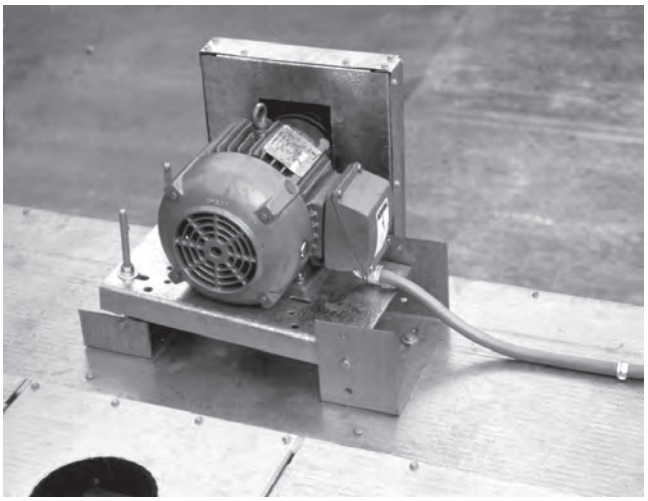


Fan guard is easily removed for access to fan and drive belts

Fan drive motors are TEFC designed specifically for cooling tower use. Standard motor horsepower appears in the table on page 4. Other types of motors are available. Typical options appear under Optional Accessories on page 10.

⚠ CAUTION

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



Fan drive motor showing adjustable base and belt guard

HOISTING AND HANDLING

Hoisting instructions on each tower explains how to use a spreader-bar and slings beneath the cold water basin floor to hoist the Aquatower. The tower's design also allows easy handling with a forklift.

SAFETY

Standard Aquatower safety features include fan guards and belt guards. Fan guards consist of welded heavy gauge steel wire hoops and spokes, hot dip galvanized after fabrication. The galvanized steel belt guard encloses both belts and pulleys. Guards are easily removed for servicing.

CONSTRUCTION AND FINISH

Aquatowers offer the corrosion protection of G-235 galvanized steel—providing a zinc thickness of 2.35 oz/ft^2 per ASTM A-653—providing long term protection for the steel. Assembly hardware is also galvanized.

U.S. GREEN BUILDING COUNCIL MEMBER

When the ambient air temperature falls below 32°F, the water in a cooling tower can freeze. *Marley Technical Report #H-003* "Operating Cooling Towers in Freezing Weather" describes how to prevent freezing during operation. Ask your Marley sales representative for a copy or download from our website.

Water collects and is stored in the cold water basin during shutdowns, and may freeze solid. You can prevent freezing by adding heat to the water left in the tower or, you can drain the tower and all exposed piping at shutdown.

ELECTRIC BASIN HEATERS

Two types of automatic basin heater systems are available based on your site conditions and preferences.

You may choose a heater system consisting of these components (shipped separately for installation by others):

- Stainless steel electric immersion heater element(s). Threaded couplings are provided for installation.
- NEMA 4 enclosure containing these components:
  –Magnetic contactor to energize heater.
  –Transformer to convert power supply to 24 volts for control circuit.
  –Solid state circuit board for heater control and low-water cutoff.
  Enclosure may be mounted on the side of the tower.
- Control probe to monitor water temperature and water level. Threaded couplings are provided for installation.

Or you may prefer a pre-assembled submersible tank-type heater which requires no tower modification and can plug into a standard grounded 3-prong 120V outlet.

The Incoloy heater element was chosen for its long life in submerged environments. A built-in thermostat senses water temperature and controls the supply of electricity to maintain proper water temperature. A built-in safety switch cuts off power whenever the element is exposed to air. The element mounts in the tower basin on a stainless steel plate.

Any exposed piping that is still filled with water at shutdown—including the makeup water line—should be electrically traced and insulated (by others).

INDOOR TANK METHOD

With this system, water flows from an indoor tank, through the load system, and back to the tower, where it is cooled. The cooled water flows by gravity from the tower to the tank located in a heated space. At shutdown, all exposed water drains into the tank, where it is safe from freezing.

The table on page 9 lists typical drain-down capacities for all Aquatower models. Although we do not produce tanks, many of our representatives offer tanks supplied by reputable manufacturers.

The amount of water needed to successfully operate the system depends on the tower size, GPM and the volume of water contained in the piping system to and from the tower. You must select a tank large enough to contain those combined volumes—plus a level sufficient to maintain a flooded suction on your pump. Control makeup water according to the level where the tank stabilizes during operation.

You should always use a bottom outlet for this type of piping system. The table on page 9 lists the flow capacities for bottom outlets.

Basin Heater Selection				
Tower Model	+10°F Ambient		-10°F Ambient	
	Tank Heater	Component Heater	Tank Heater	Component Heater
490	1.5 kW	3 kW	1.5 kW	3 kW
492	1.5 kW	3 kW	1.5 kW	3 kW
493	1.5 kW	3 kW	2 @ 1.5 kW	3 kW
494	2 @ 1.5 kW	3 kW	2 @ 1.5 kW	3 kW
495	2 @ 1.5 kW	3 kW	3 @ 1.5 kW	4.5 kW
496	3 @ 1.5 kW	4.5 kW	4 @ 1.5 kW	6 kW

1. Required kW is the amount of heat needed to maintain +40°F basin water temperature at the indicated ambient air temperature.
2. Tank heaters shown are 120 volts, single-phase.
3. Component heaters shown are 480 volts, three-phase. Options or special heater selections may add several weeks to delivery.
4. Heaters do not operate continuously. Heaters cycle on and off automatically as basin water temperature dictates.
5. Contact your Marley sales representative for selections appropriate for other ambient conditions than those shown here.

Drain-Down Capacity		
Tower Model	Range of Tower Design GPM	Maximum Drain-Down gallons
490	15 - 26	28
	27 - 51	30
	52 - 85	33
	86 - 153	36
492	21 - 53	49
	54 - 92	54
	93 - 151	60
	152 - 211	65
493	33 - 83	77
	84 - 144	84
	145 - 238	94
	239 - 328	101
494	60 - 141	134
	142 - 227	145
	228 - 376	162
	377 - 563	178
495	82 - 192	182
	193 - 270	192
	271 - 513	219
	514 - 763	241
496	104 - 196	228
	197 - 286	243
	287 - 497	271
	498 - 963	320

Volumes shown are maximums for the GPM ranges indicated. Actual volumes will usually be less. Contact your local Marley sales representative for more specific information.

Bottom Outlet Maximum GPM				
Tower Model	Outlet Diameter			
	4"	6"	8"	10"
492	120	225	225	na
493	120	270	350	na
494	140	310	550	625
495	140	310	550	850
496	140	310	550	860

1. Maximum GPM applies to both pump and gravity flow piping systems. The outlet piping on gravity flow systems must have sufficient vertical drop to overcome all other head losses in the system.
2. Bottom outlet is not available on 490 models.

FIELD ASSEMBLY

If you choose to assemble your Aquatower at the job site, your Aquatower will be shipped unassembled with complete assembly instructions.

The following table shows the sizes and weights of the largest Aquatower components for each model. You can use this information to plan your rigging and transportation needs.

Unassembled tower shipment may add 3 to 5 weeks to normal lead times. Your Marley sales representative will be glad to help you plan for your unique needs.

Component Sizes and Weights			
Tower Model	Component	Size inches	Weight lb
490A 490B	Collection Basin End	12 x 13 x 36	15
	Collection Basin Floor	3 x 30 x 32	23
	Front Panel	2 x 36 x 44	21
	Casing Panel	2 x 40 x 52	43
	Distribution Basin	8 x 16 x 32	18
492	Collection Basin End	14 x 16 x 48	24
	Collection Basin Floor	3 x 36 x 44	37
	Front Panel	2 x 48 x 68	52
	Casing Panel	2 x 26 x 63	34
	Distribution Basin	8 x 16 x 44	24
493	Collection Basin End	14 x 16 x 72	37
	Collection Basin Floor	3 x 36 x 68	56
	Front Panel	2 x 37 x 72	35
	Casing	2 x 26 x 63	34
	Distribution	8 x 16 x 68	37
494	Collection Basin End	18 x 18 x 72	47
	Collection Basin Floor	4 x 34 x 68	56
	Front Panel	2 x 44 x 72	41
	Casing Panel	2 x 40 x 76	63
	Distribution Basin	8 x 28 x 68	52
	Optional Discharge Side	2 x 41 x 77	37
	Optional Discharge Floor	9 x 45 x 68	46
495	Collection Basin End	18 x 18 x 96	63
	Collection Basin Floor	4 x 34 x 92	75
	Front Panel	2 x 44 x 96	56
	Casing	2 x 40 x 76	63
	Distribution Basin	8 x 28 x 92	70
	Optional Discharge Side	2 x 41 x 77	37
	Optional Discharge Floor	9 x 45 x 63	41
496	Collection Basin End	18 x 18 x 120	79
	Collection Basin Floor	4 x 34 x 116	95
	Front Panel	2 x 46 x 120	71
	Casing Panel	2 x 40 x 84	69
	Distribution Basin	8 x 28 x 116	88
	Optional Discharge Side	2 x 45 x 77	38
	Optional Discharge Floor	9 x 45 x 77	54

OPTION	DESCRIPTION
200V Motor	Available for 1 hp thru 7.5 hp.
Special Motors	Two-speed, one-wind, 460 volt, 60 cycle, 3 phase, TEFC motors are available for 5 and 7.5 horsepower.
Field Assembly	Where unique space restrictions or rigging conditions demand, Aquatowers can be shipped ready for field assembly by others. Complete step-by-step assembly instructions are provided.

Vertical Discharge Hood	This option is available on Models 494 and larger. It provides vertical discharge of the air leaving the tower. Hoods are galvanized steel. They ship separately for installation by others. A large access door provides entry to the fan and mechanical equipment. For use in restrictive enclosures or other site situations where horizontal discharge is not desirable. CTI Certification does not apply when this option is selected.

OPTION	DESCRIPTION
Component Basin Heaters	Standard heater components consist of 3 or 5 kW, 3 phase, 460 volt, shielded immersion heater; solid state circuitry for cut-off at low water level or high temperature; a control probe to monitor basin water temperature and water level; and a magnetic contactor all housed in a weatherproof enclosure. Components are shipped separately for installation and wiring by others. Designed to prevent sump freezing during shutdown periods in winter operation. Unnecessary if you use an indoor tank. Special heater characteristics result in extended lead times.
Pre-assembled Basin Heaters	Tank-type submersible heaters are available for all models. No tower modifications are necessary and heater includes a 6-foot electrical cord with grounded 3-prong plug for connection to a standard 120V source. One or more 1.5 kW elements provide protection at most ambient conditions. The built-in thermostat maintains 40°F water while the built-in safety switch shuts off power if the heater element is not submerged.
Stainless Steel Construction	All Aquatower models are available with stainless steel structure. Or you can choose a galvanized tower with a stainless steel cold water collection basin. Your Marley sales representative can help you choose the amount of corrosion resistance necessary for your installation.
Control System	Factory-installed control center in NEMA 3R enclosure mounted on tower casing. Complete with thermostat controller for single or two-speed motors to maintain chosen cold water temperature.

BASE: Furnish and install an induced-draft, crossflow, factory-assembled, steel cooling tower of ____ cell(s), as shown on plans. Tower shall be similar and equal in all respects to Marley Aquatower, Model _____. Tower must be warranted by the manufacturer for one year from date of shipment.

PERFORMANCE: Tower shall cool ____ gpm of water from ____ °F to ____ °F at a design entering air wet-bulb temperature of ____ °F and its thermal rating shall be certified by the Cooling Technology Institute.

CONSTRUCTION: Structural components of the tower, including the cold water basin, framework, mechanical equipment supports, casing, hot water basin, and fan cylinder shall be fabricated of heavy-gauge steel, protected against corrosion by G-235 galvanizing per ASTM A-653. All components subjected to factory welding shall be hot dip galvanized after fabrication per ASTM A-123. Cold galvanizing is not acceptable.

MOTOR: Motor(s) shall be ____ hp, Totally Enclosed, specially insulated for cooling tower duty. Speed and electrical characteristics shall be 1800 (or 1800/900) RPM, single-winding, ____ phase, ____ hertz, ____ volts. The motor must be located out of the saturated discharge air stream.

MECHANICAL EQUIPMENT: Fan(s) shall be adjustable-pitch propeller type. Fan shall be driven through V-belt(s) with a minimum service factor of 1.5 based on full motor hp and protected with a belt guard. The fan and fan pulley shall be supported by oil lubricated tapered roller bearings in a cast iron housing with externally accessible remote oil reservoir for easy maintenance.

FILL, LOUVERS AND DRIFT ELIMINATOR: Fill shall be film-type, thermoformed PVC, with louvers and drift eliminator formed as part of each fill sheet. Fill shall be suspended from hot dip galvanized structural tubing supported from the upper tower structure, and shall be elevated above the floor of the cold water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash-out. Guaranteed drift losses shall not exceed 0.005% of the design gpm.

HOT WATER DISTRIBUTION SYSTEM: An open basin above the fill bank shall receive hot water piped to each cell of the tower. The basins shall be equipped with removable covers to keep out debris. This basin shall be installed and sealed at the factory. Water shall enter the basin through a removable wave-suppressor splash box. The basin shall be no less than 6⅜" deep to provide adequate freeboard against overflow and splash-out. Removable and replaceable polypropylene nozzles installed in the floor of the basin shall provide full coverage of the fill by gravity flow. Nozzles must all have the same orifice size and be spaced symmetrically in both longitudinal and transverse directions.

COLD WATER BASIN AND ACCESSORIES: The cold water basin shall be factory sealed. For maximum installation flexibility, basin accessories shall include both a side suction connection and a hole and bolt circle in the basin floor suitable for gravity flow. Both connections shall include a debris screen and anti-cavitation device. A factory-installed, float-operated, mechanical makeup valve shall be included, having a ¾" diameter inlet connection.

Aquatower

ENGINEERING DATA AND SPECIFICATIONS

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