Manitowoc®

SERVICE TECHNICIAN'S HANDBOOK

Q-Model Ice Machines

P/N 80-1099-9 8/03

Safety Notices

As you work on a Q Model Ice Machine, be sure to pay close attention to the safety notices in this handbook. Disregarding the notices may lead to serious injury and/or damage to the ice machine.

Throughout this handbook, you will see the following types of safety notices:

> **⚠ Warning**
>
> Text in a Warning box alerts you to a potential personal injury situation. Be sure to read the Warning statement before proceeding, and work carefully.

> **⚠ Caution**
>
> Text in a Caution box alerts you to a potential personal injury situation. Be sure to read the Caution statement before proceeding, and work carefully.

Procedural Notices

As you work on a Q Model Ice Machine, be sure to read the procedural notices in this handbook. These notices supply helpful information that may assist you as you work.

Throughout this handbook, you will see the following types of procedural notices:

> **Important**
>
> Text in an Important box provides you with information that may help you perform a procedure more efficiently. Disregarding this information will not cause damage or injury, but may slow you down as you work.

NOTE: Text set off as a Note provides you with simple, but useful extra information about the procedure you are performing.

Read These Before Proceeding:

⚠ Caution

Proper installation, care and maintenance are essential for maximum ice production and trouble free operation of your Manitowoc Ice Machine. If you encounter problems not covered by this manual, **do not proceed**; contact Manitowoc Ice, Inc. We will be happy to provide assistance.

Important

Routine adjustments and maintenance procedures outlined in this manual are not covered by the warranty.

We reserve the right to make product improvements at any time. Specifications and design are subject to change without notice.

⚠ Warning

PERSONAL INJURY POTENTIAL

Do not operate equipment that has been misused, abused, neglected, damaged, or altered/modified from that of original manufactured specifications.

⚠ Warning

PERSONAL INJURY POTENTIAL

The ice machine head section contains refrigerant charge. Installation and brazing of the line sets must be performed by a properly trained refrigeration technician aware of the **dangers of dealing with refrigerant** charged equipment. The technician must also be U.S. Government Environmental Protection Agency (EPA) certified in proper refrigerant handling and servicing procedures.

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Refrigeration System

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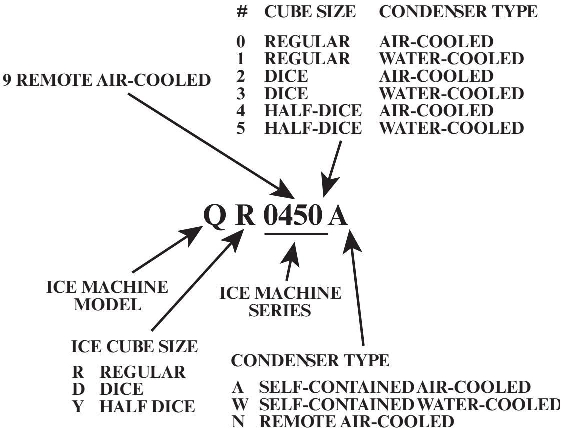
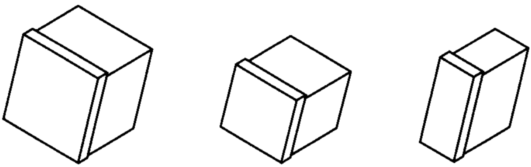
General Information

HOW TO READ A MODEL NUMBER



ICE CUBE SIZES



Regular	Dice	Half Dice
1-1/8" x 1-1/8" x 7/8"	7/8" x 7/8" x 7/8"	3/8" x 1-1/8" x 7/8"
2.86 x 2.86 x 2.22 cm	2.22 x 2.22 x 2.22 cm	0.95 x 2.86 x 2.22 cm

MODEL/SERIAL NUMBER LOCATION

These numbers are required when requesting information from your local Manitowoc Distributor, service representative, or Manitowoc Ice, Inc. The model and serial number are listed on the OWNER WARRANTY REGISTRATION CARD. They are also listed on the MODEL/SERIAL NUMBER DECAL affixed to the ice machine.

ICE MACHINE WARRANTY INFORMATION

Owner Warranty Registration Card

Warranty coverage begins the day the ice machine is installed.

Important

Complete and mail the OWNER WARRANTY REGISTRATION CARD as soon as possible to validate the installation date.

If the OWNER WARRANTY REGISTRATION CARD is not returned, Manitowoc will use the date of sale to the Manitowoc Distributor as the first day of warranty coverage for your new ice machine.

Warranty Coverage

GENERAL

The following Warranty outline is provided for your convenience. For a detailed explanation, read the warranty bond shipped with each product.

Contact your local Manitowoc representative or Manitowoc Ice, Inc. if you need further warranty information.

> **Important**
>
> This product is intended exclusively for commercial application. No warranty is extended for personal, family, or household purposes.

PARTS

1. Manitowoc warrants the ice machine against defects in materials and workmanship, under normal use and service for three (3) years from the date of original installation.
2. The evaporator and compressor are covered by an additional two (2) year (five years total) warranty beginning on the date of the original installation.

LABOR

1. Labor required to repair or replace defective components is covered for three (3) years from the date of original installation.
2. The evaporator is covered by an additional two (2) year (five years total) labor warranty beginning on the date of the original installation.

EXCLUSIONS

The following items are not included in the ice machine’s warranty coverage:

1. Normal maintenance, adjustments and cleaning as outlined in this manual.
2. Repairs due to unauthorized modifications to the ice machine or use of non-standard parts without prior written approval from Manitowoc Ice, Inc.

3. Damage caused by improper installation of the ice machine, electrical supply, water supply or drainage, or damage caused by floods, storms, or other acts of God.
4. Premium labor rates due to holidays, overtime, etc.; travel time; flat rate service call charges; mileage and miscellaneous tools and material charges not listed on the payment schedule. Additional labor charges resulting from the inaccessibility of equipment are also excluded.
5. Parts or assemblies subjected to misuse, abuse, neglect or accidents.
6. Damage or problems caused by installation, cleaning and/or maintenance procedures inconsistent with the technical instructions provided in this manual.

This product is intended exclusively for commercial application. No warranty is extended for personal, family, or household purposes.

AUTHORIZED WARRANTY SERVICE

To comply with the provisions of the warranty, a refrigeration service company qualified and authorized by your Manitowoc Distributor, or a Contracted Service Representative must perform the warranty repair.

NOTE: If the dealer you purchased the ice machine from is not authorized to perform warranty service, contact your Manitowoc Distributor or Manitowoc Ice, Inc. for the name of the nearest authorized service representative.

SERVICE CALLS

Normal maintenance, adjustments and cleaning as outlined in this manual are not covered by the warranty. If you have followed the procedures listed in this manual, and the ice machine still does not perform properly, call your Local Distributor or the Service Department at Manitowoc Ice, Inc.

Installation

LOCATION OF ICE MACHINE

The location selected for the ice machine head section must meet the following criteria. If any of these criteria are not met, select another location.

- The location must be free of airborne and other contaminants.
- The air temperature must be at least 35°F (1.6°C), but must not exceed 110°F (43.4°C).
- The location must not be near heat-generating equipment or in direct sunlight.
- The location must not obstruct air flow through or around the ice machine. Refer to chart below for clearance requirements.
- The ice machine must be protected if it will be subjected to temperatures below 32°F (0°C). Failure caused by exposure to freezing temperatures is not covered by the warranty. See “Removal from Service/Winterization”

ICE MACHINE HEAD SECTION CLEARANCE REQUIREMENTS

Q370	Self-Contained Air-Cooled	Water-Cooled
Top/Sides	12" (30.5 cm)	5" (12.7 cm)
Back	5" (12.7 cm)	5" (12.7 cm)

Q1300 Q1600 Q1800	Self-Contained Air-Cooled	Water-Cooled and Remote
Top/Sides	24" (61 cm)	8" (20.3 cm)
Back	12" (30.5 cm)	5" (12.7 cm)

All other Q models	Self-Contained Air-Cooled	Water-Cooled and Remote
Top/Sides	8" (20.3 cm)	5" (12.7 cm)
Back	5" (12.7 cm)	5" (12.7 cm)

Q1600 is not available as an air-cooled model.

STACKING TWO ICE MACHINES ON A SINGLE STORAGE BIN

A stacking kit is required for stacking two ice machines. Installation instructions are supplied with the stacking kit.

Q450/Q600/ Q800/Q1000	Stacked Self-Contained Air-Cooled	Stacked Water-Cooled and Remote
Top/Sides	16" (40.64 cm)	5" (12.70 cm)
Back	5" (12.70 cm)	5" (12.70 cm)

Q1300 Q1600 Q1800	Stacked Self-Contained Air-Cooled	Stacked Water-Cooled and Remote
Top/Sides	48" (121.92 cm)	24" (60.96 cm)
Back	12" (30.48 cm)	12" (30.48 cm)

Q1600 is not available as an air-cooled model.

Calculating Remote Condenser Installation Distances

LINE SET LENGTH

The maximum length is 100' (30.5 m).

The ice machine compressor must have the proper oil return. The receiver is designed to hold a charge sufficient to operate the ice machine in ambient temperatures between -20°F (-28.9°C) and 120°F (49°C), with line set lengths of up to 100' (30.5 m).

LINE SET RISE/DROP

The maximum rise is 35' (10.7 m).

The maximum drop is 15' (4.5 m).

⚠ Caution

If a line set has a rise followed by a drop, another rise cannot be made. Likewise, if a line set has a drop followed by a rise, another drop cannot be made.

CALCULATED LINE SET DISTANCE

The maximum calculated distance is 150' (45.7 m).

Line set rises, drops, horizontal runs (or combinations of these) in excess of the stated maximums will exceed compressor start-up and design limits. This will cause poor oil return to the compressor.

Make the following calculations to make sure the line set layout is within specifications.

1. Insert the **measured rise** into the formula below. Multiply by 1.7 to get the **calculated rise.** (Example: A condenser located 10 feet above the ice machine has a **calculated rise** of 17 feet.)
2. Insert the **measured drop** into the formula below. Multiply by 6.6 to get the **calculated drop.** (Example. A condenser located 10 feet below the ice machine has a **calculated drop** of 66 feet.)
3. Insert the **measured horizontal distance** into the formula below. No calculation is necessary.
4. Add together the **calculated rise, calculated drop,** and **horizontal distance** to get the **total calculated distance.** If this total exceeds 150' (45.7 m), move the condenser to a new location and perform the calculations again.

MAXIMUM LINE SET DISTANCE FORMULA

Step 1.
Measured Rise ____ X 1.7 = ______Calculated Rise
(35 ft. Max)

Step 2.
Measured Drop ____ X 6.6 = ______Calculated Drop
(15 ft. Max.)

Step 3.
Measured Horizontal Distance = _________Horizontal Distance
(100 ft. Max.)

Step 4.
Total Calculated Distance = ________Total Calculated Distance
(150 ft. Max.)

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Removal from Service/Winterization

GENERAL

Special precautions must be taken if the ice machine is to be removed from service for an extended period of time or exposed to ambient temperatures of 32°F (0°C) or below.

> ⚠ **Caution**
>
> If water is allowed to remain in the ice machine in freezing temperatures, severe damage to some components could result. Damage of this nature is not covered by the warranty.

Follow the applicable procedure below.

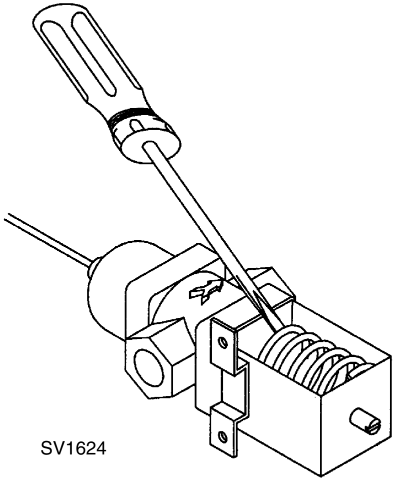
SELF-CONTAINED AIR-COOLED ICE MACHINES

1. Disconnect the electric power at the circuit breaker or the electric service switch.
2. Turn off the water supply.
3. Remove the water from the water trough.
4. Disconnect and drain the incoming ice-making water line at the rear of the ice machine.
5. Blow compressed air in both the incoming water and the drain openings in the rear of the ice machine until no more water comes out of the inlet water lines or the drain.
6. Make sure water is not trapped in any of the water lines, drain lines, distribution tubes, etc.

WATER-COOLED ICE MACHINES

1. Perform steps 1-6 under “Self-Contained Air-Cooled Ice Machines.”
2. Disconnect the incoming water and drain lines from the water-cooled condenser.

3. Insert a large screwdriver between the bottom spring coils of the water regulating valve. Pry upward to open the valve.



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4. Hold the valve open and blow compressed air through the condenser until no water remains.

REMOTE ICE MACHINES

1. Move the ICE/OFF/CLEAN switch to OFF.
2. “Frontseat” (shut off) the receiver service valves. Hang a tag on the switch as a reminder to open the valves before restarting.
3. Perform steps 1-6 under “Self-Contained Air-Cooled Ice Machines.”

AUCS® ACCESSORY

Refer to the AuCS® Accessory manual for winterization of the AuCS® Accessory.

Ice Making Sequence of Operation

SELF-CONTAINED AIR- AND WATER-COOLED

Initial Start-Up or Start-Up After Automatic Shut-Off

1. Water Purge

Before the compressor starts, the water pump and water dump solenoid are energized for 45 seconds to purge the ice machine of old water. This ensures that the ice-making cycle starts with fresh water.

The harvest valve(s) is also energized during the water purge, although it stays on for an additional 5 seconds (50-second total on time) during the initial refrigeration system start-up.

2. Refrigeration System Start-Up

The compressor starts after the 45 second water purge, and it remains on throughout the entire Freeze and Harvest Sequences. The water fill valve is energized at the same time as the compressor. It remains on until the water level sensor closes for 3 continuous seconds, or until a six-minute time period has expired. The harvest valve(s) remains on for 5 seconds during initial compressor start-up and then shuts off.

At the same time the compressor starts, the condenser fan motor (air-cooled models) is supplied with power throughout the entire Freeze and Harvest Sequences. The fan motor is wired through a fan cycle pressure control, therefore it may cycle on and off. (The compressor and condenser fan motor are wired through the contactor. As a result, anytime the contactor coil is energized, the compressor and fan motor are supplied with power.)

Freeze Sequence

3. Prechill

The compressor is on for 30 seconds prior to water flow to prechill the evaporator.

4. Freeze

The water pump restarts after the 30-second prechill. An even flow of water is directed across the evaporator and into each cube cell, where it freezes. The water fill valve will cycle on, then off one more time to refill the water trough.

When sufficient ice has formed, the water flow (not the ice) contacts the ice thickness probe. After approximately 7 seconds of continual water contact, the Harvest sequence is initiated. The ice machine cannot initiate a Harvest sequence until a 6-minute freeze lock has been surpassed.

Harvest Sequence

5. Water Purge

The water pump continues to run, and the water dump valve energizes for 45 seconds to purge the water in the sump trough. The water fill valve energizes (turns on) and de-energizes (turns off) strictly by time. The water fill valve energizes for the last 15 seconds of the 45-second water purge. The water purge must be at the factory setting of 45 seconds for the fill valve to energize during the last 15 seconds of the Water Purge. If set at less than 45 seconds the water fill valve does not energize during the water purge.

After the 45 second water purge, the water fill valve, water pump and dump valve de-energize. (Refer to “Water Purge Adjustment” for details.) The harvest valve also opens at the beginning of the water purge to divert hot refrigerant gas into the evaporator.

6. Harvest

The harvest valve(s) remains open and the refrigerant gas warms the evaporator causing the cubes to slide, as a sheet, off the evaporator and into the storage bin. The sliding sheet of cubes swings the water curtain out, opening the bin switch. The momentary opening and re-closing of the bin switch terminates the harvest sequence and returns the ice machine to the freeze sequence (Step 3 - 4.)

7. Automatic Shut-Off

When the storage bin is full at the end of a harvest sequence, the sheet of cubes fails to clear the water curtain and will hold it open. After the water curtain is held open for 7 seconds, the ice machine shuts off. The ice machine remains off for 3 minutes before it can automatically restart.

The ice machine remains off until enough ice has been removed from the storage bin to allow the ice to fall clear of the water curtain. As the water curtain swings back to the operating position, the bin switch re-closes and the ice machine restarts (steps 1 - 2), provided the 3 minute delay period is complete.

Energized Parts Chart

Ice Making Sequence of Operation	Control Board Relays					Contactor		Length of Time
	1 Water Pump	2 Water Fill Valve	3 Harvest Valve	4 Water Dump Valve	5 Contactor Coil	5A Compressor	5B Condenser Fan Motor	
Initial Start-Up								
1. Water Purge	**On**	**Off**	**On**	**On**	**Off**	**Off**	**Off**	*45 Seconds*
2. Refrigeration System Start-up	**Off**	**On**	**On**	**Off**	**On**	**On**	May Cycle **On/Off**	*5 Seconds*
Freeze Sequence								
3. Prechill	**Off**	May Cycle **On/Off** during first 45 sec.	**Off**	**Off**	**On**	**On**	May Cycle **On/Off**	*30 Seconds*
4. Freeze	**On**	Cycles **On** then **Off** one more time	**Off**	**Off**	**On**	**On**	May Cycle **On/Off**	*Unit 7 Sec. Water Contact w/Ice Thickness Probe*

Energized Parts Chart (Continued)

Ice Making Sequence of Operation	Control Board Relays					Contactor		Length of Time
	1 Water Pump	2 Water Fill Valve	3 Harvest Valve	4 Water Dump Valve	5 Contactor Coil	5A Compressor	5B Condenser Fan Motor	
Harvest Sequence 5. Water Purge	**On**	30 sec. **Off** 15 sec. **On**	**On**	**On**	**On**	**On**	May Cycle **On/Off**	*Factory Set at 45 Seconds*
6. Harvest	**Off**	**Off**	**On**	**Off**	**On**	**On**	May Cycle **On/Off**	*Bin Switch Activation*
7. Automatic Shut-Off	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**	*Until Bin Switch Re-closes*

REMOTE

Initial Start-Up or Start-Up After Automatic Shut-Off

1. Water Purge

Before the compressor starts, the water pump and water dump solenoid are energized for 45 seconds, to completely purge the ice machine of old water. This feature ensures that the ice making cycle starts with fresh water.

The harvest valve and harvest pressure regulating (HPR) solenoid valves also energize during water purge, although they stay on for an additional 5 seconds (50 seconds total on time) during the initial refrigeration system start-up.

2. Refrigeration System Start-Up

The compressor and liquid line solenoid valve energize after the 45 second water purge and remain on throughout the entire Freeze and Harvest Sequences. The water fill valve is energized at the same time as the compressor. It remains on until the water level sensor closes for 3 continuous seconds, or until a six-minute time period has expired. The harvest valve and HPR solenoid valves remain on for 5 seconds during initial compressor start-up and then shut off.

The remote condenser fan motor starts at the same time the compressor starts and remains on throughout the entire Freeze and Harvest Sequences.

Freeze Sequence

3. Prechill

The compressor is on for 30 seconds prior to water flow, to prechill the evaporator.

4. Freeze

The water pump restarts after the 30 second prechill. An even flow of water is directed across the evaporator and into each cube cell, where it freezes. The water fill valve will cycle on and then off one more time to refill the water trough.

When sufficient ice has formed, the water flow (not the ice) contacts the ice thickness probe. After approximately 7 seconds of continual water contact, the harvest sequence is initiated. The ice machine cannot initiate a harvest sequence until a 6 minute freeze lock has been surpassed.

Harvest Sequence

5. Water Purge

The water pump continues to run, and the water dump valve energizes for 45 seconds to purge the water in the sump trough. The water fill valve energizes (turns on) and de-energizes (turns off) strictly by time. The water fill valve energizes for the last 15 seconds of the 45-second water purge. The water purge must be at the factory setting of 45 seconds for the fill valve to energize during the last 15 seconds of the Water Purge. If set at less than 45 seconds the water fill valve does not energize during the water purge.

After the 45 second water purge, the water fill valve, water pump and dump valve de-energize. (Refer to “Water Purge Adjustment”) The harvest valve(s) and HPR solenoid valve also open at the beginning of the water purge.

6. Harvest

The HPR valve and the harvest valve(s) remain open and the refrigerant gas warms the evaporator causing the cubes to slide, as a sheet, off the evaporator and into the storage bin. The sliding sheet of cubes swings the water curtain out, opening the bin switch. The momentary opening and re-closing of the bin switch terminates the harvest sequence and returns the ice machine to the freeze sequence (Step 3 - 4.)

Automatic Shut-Off

7. Automatic Shut-Off

When the storage bin is full at the end of a harvest sequence, the sheet of cubes fails to clear the water curtain and will hold it open. After the water curtain is held open for 7 seconds, the ice machine shuts off. The ice machine remains off for 3 minutes before it can automatically restart.

The ice machine remains off until enough ice has been removed from the storage bin to allow the ice to drop clear of the water curtain. As the water curtain swings back to the operating position, the bin switch re-closes and the ice machine restarts (steps 1 - 2) provided the 3 minute delay period is complete.

Remote Energized Parts Chart

Ice Making Sequence of Operation	Control Board Relays					Contactor		Length of Time
	1 Water Pump	2 Water Fill Valve	3 a. Harvest Valve(s) b. HPR Solenoid	4 Water Dump Valve	5 a. Contactor Coil b. Liquid Line Solenoid	5A Compressor	5B Condenser Fan Motor	
Initial Start-Up								
1. Water Purge	**On**	**Off**	**On**	**On**	**Off**	**Off**	**Off**	*45 Seconds*
2. Refrigeration System Start-up	**Off**	**On**	**On**	**Off**	**On**	**On**	**On**	*5 Seconds*
Freeze Sequence								
3. Prechill	**Off**	May Cycle **On/Off** during first 45 sec.	**Off**	**Off**	**On**	**On**	**On**	*30 Seconds*
4. Freeze	**On**	Cycles **On** then **Off** one more time	**Off**	**Off**	**On**	**On**	**On**	*Unit 7 Sec. Water Contact w/Ice Thickness Probe*

Remote Energized Parts Chart (Continued)

Ice Making Sequence of Operation	Control Board Relays					Contactor		Length of Time
	1 Water Pump	2 Water Fill Valve	3 a. Harvest Valve(s) b. HPR Solenoid	4 Water Dump Valve	5 a. Contactor Coil b. Liquid Line Solenoid	5A Compressor	5B Condenser Fan Motor	
Harvest Sequence 5. Water Purge	**On**	30 sec. **Off** 15 sec. **On**	**On**	**On**	**On**	**On**	**On**	*Factory Set at 45 Seconds*
6. Harvest	**Off**	**Off**	**On**	**Off**	**On**	**On**	**On**	*Bin Switch Activation*
7. Automatic Shut-Off	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**	**Off**	*Until Bin Switch Recloses*

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Electrical System

WIRING DIAGRAMS

The following pages contain electrical wiring diagrams. Be sure you are referring to the correct diagram for the ice machine which you are servicing.

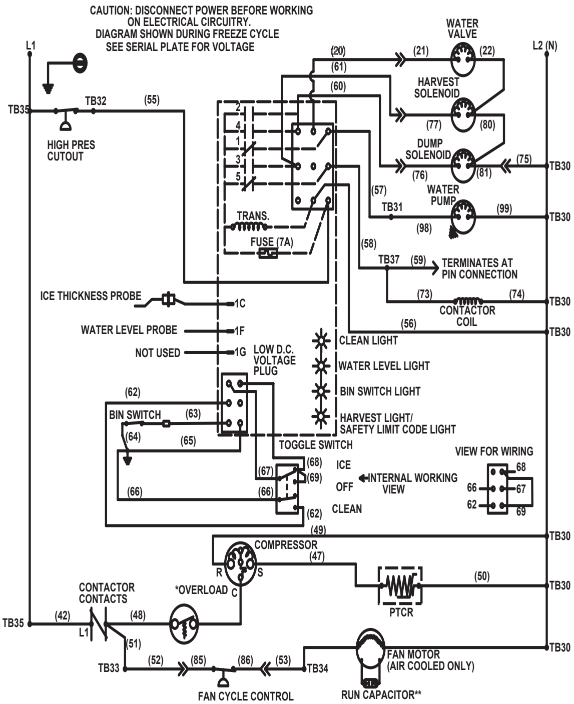
> ⚠ **Warning**
>
> Always disconnect power before working on electrical circuitry.

Wiring Diagram Legend

The following symbols are used on all of the wiring diagrams:

*	Internal Compressor Overload (Some models have external compressor overloads)
**	Fan Motor Run Capacitor (Some models do not incorporate fan motor run capacitor)
TB	Terminal Board Connection (Terminal board numbers are printed on the actual terminal board)
( )	Wire Number Designation (The number is marked at each end of the wire)
—>>—	Multi-Pin Connection (Electrical Box Side) —>>— (Compressor Compartment Side)

Q200/Q280/Q320 - Self Contained - 1 Phase With Terminal Board



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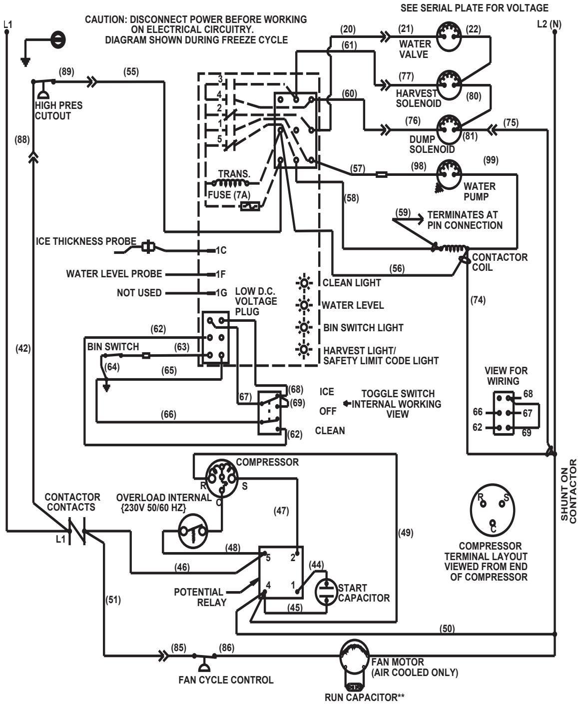
Q280/Q370 - Self Contained - 1 Phase Without Terminal Board



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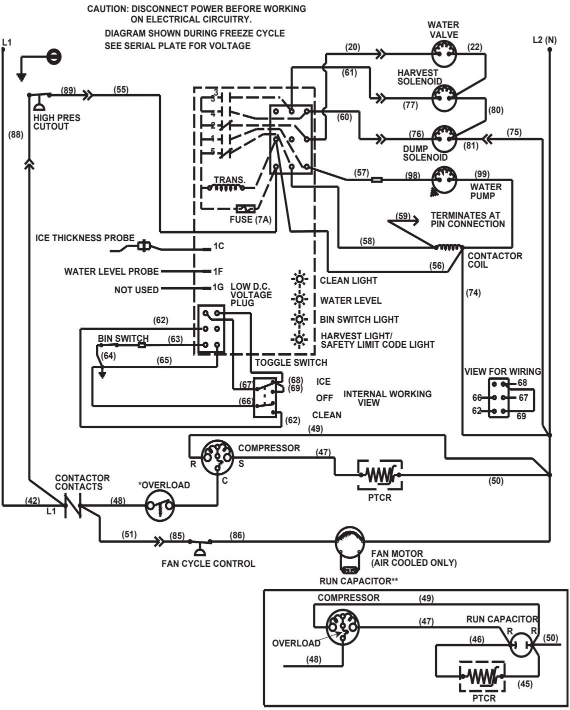
Q320 - Self Contained -
1 Phase Without Terminal Board



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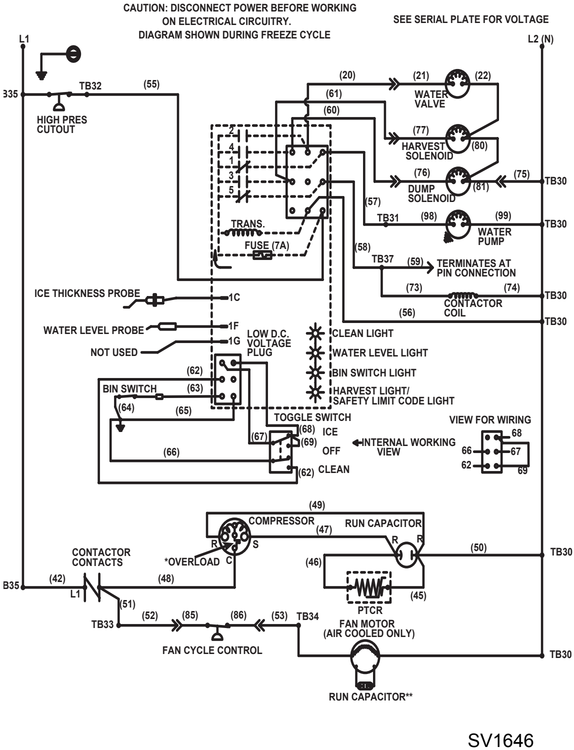
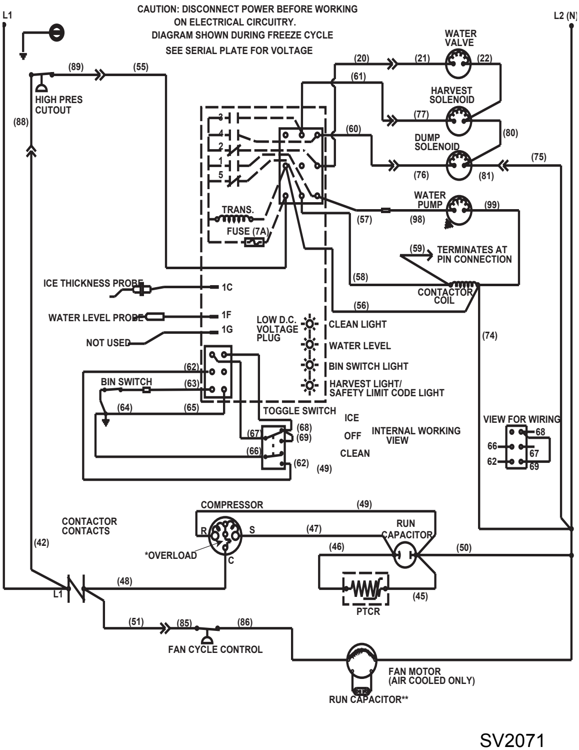
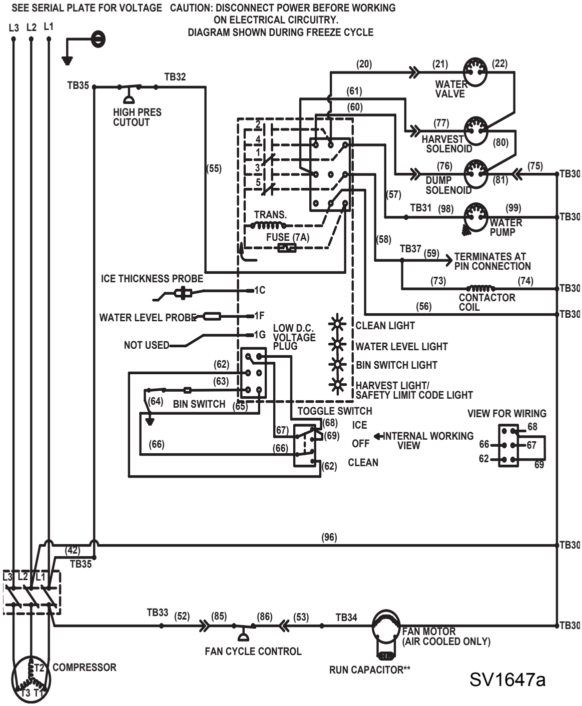
Q420/Q450/Q600/Q800/Q1000 - Self Contained-
1 Phase With Terminal Board



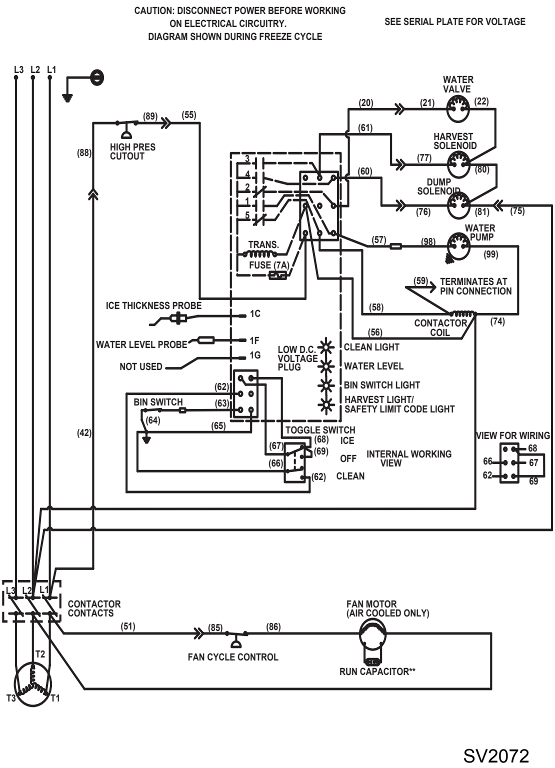
Q420/Q450/Q600/Q800/Q1000 - Self Contained- 1 Phase Without Terminal Board



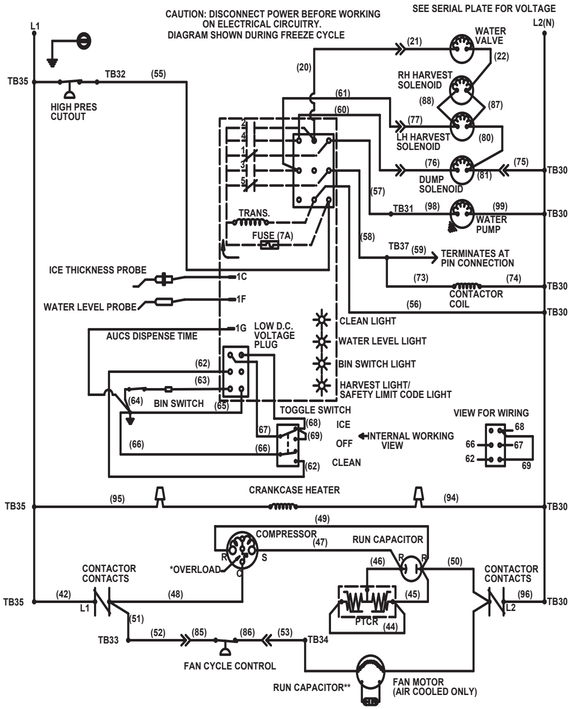
Q800/Q1000 - Self Contained - 3 Phase With Terminal Board



Q800/Q1000 - Self Contained -
3 Phase Without Terminal Board



Q1300/Q1800 - Self Contained - 1 Phase With Terminal Board



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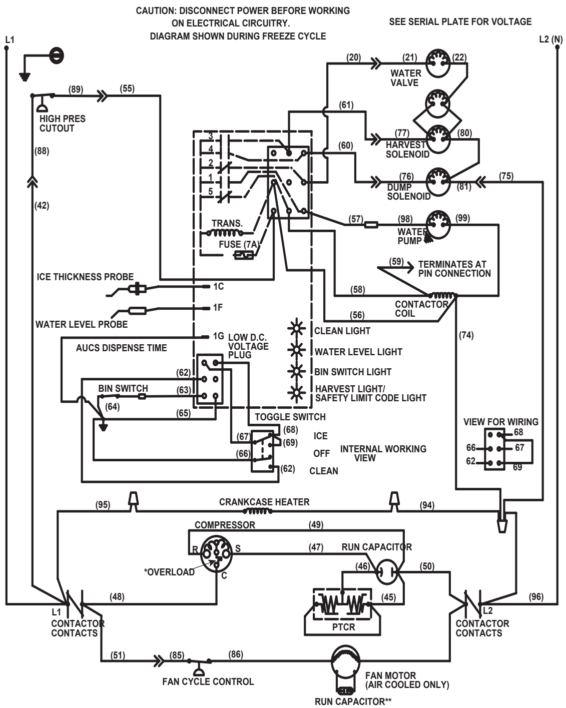
Q1300/Q1600/Q1800 - Self Contained - 1 Phase Without Terminal Board



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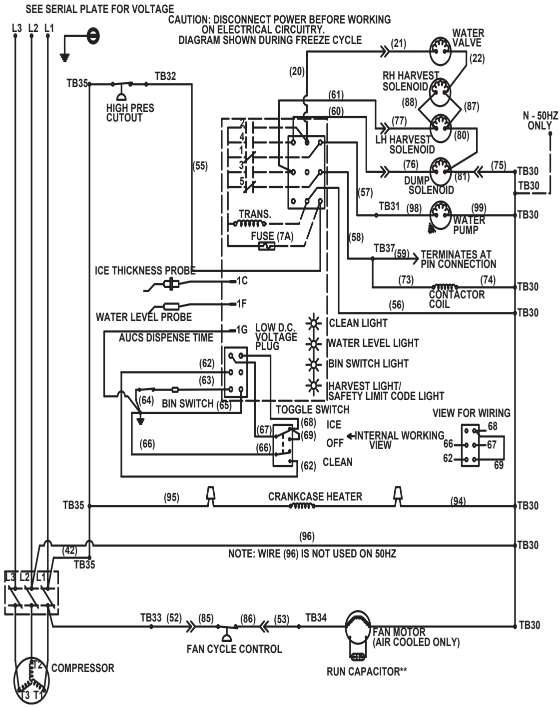
Q1300/Q1800 - Self Contained - 3 Phase With Terminal Board



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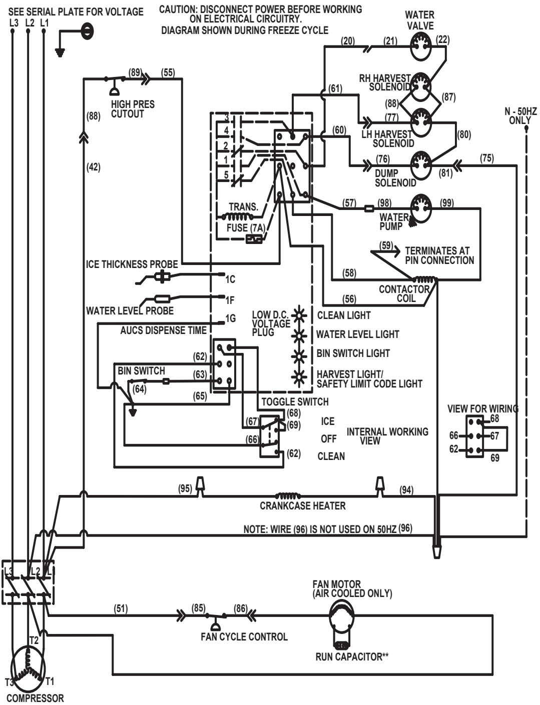
Q1300/Q1600/Q1800 - Self Contained - 3 Phase Without Terminal Board



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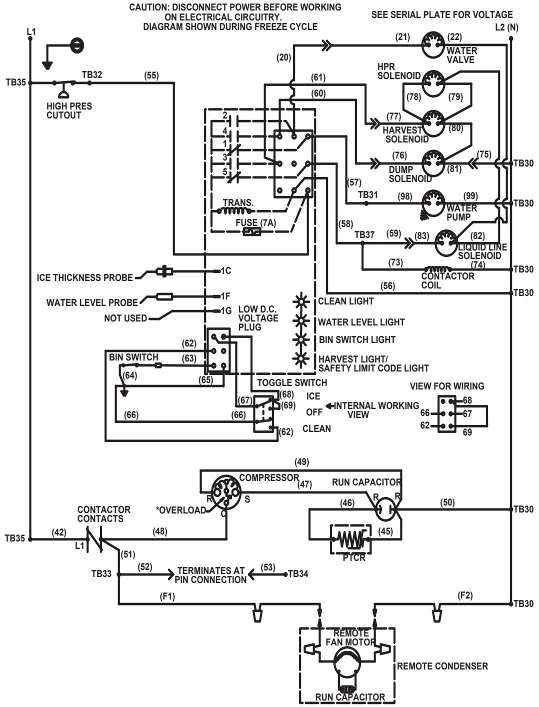
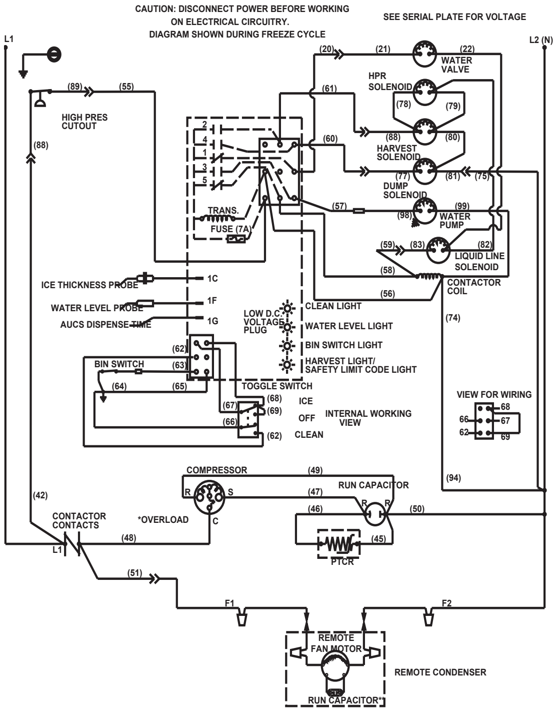
Q450/Q600/Q800/Q1000 - Remote - 1 Phase With Terminal Board



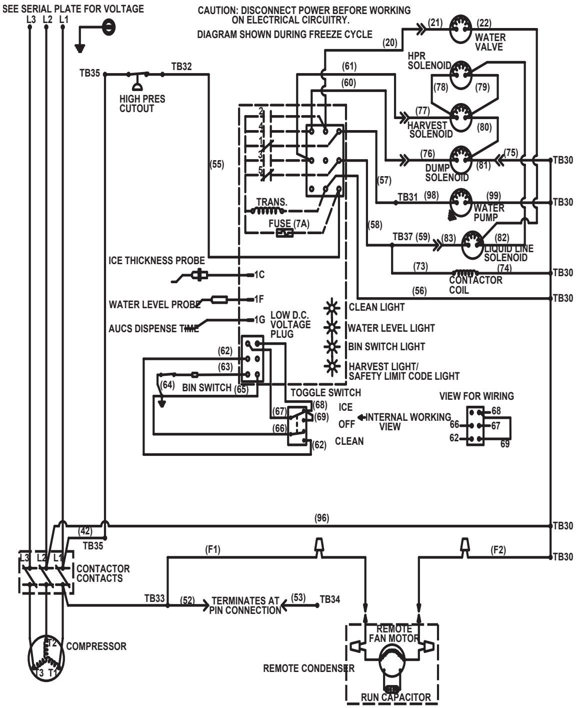
SV1648

Q450/Q600/Q800/Q1000 - Remote - 1 Phase Without Terminal Board



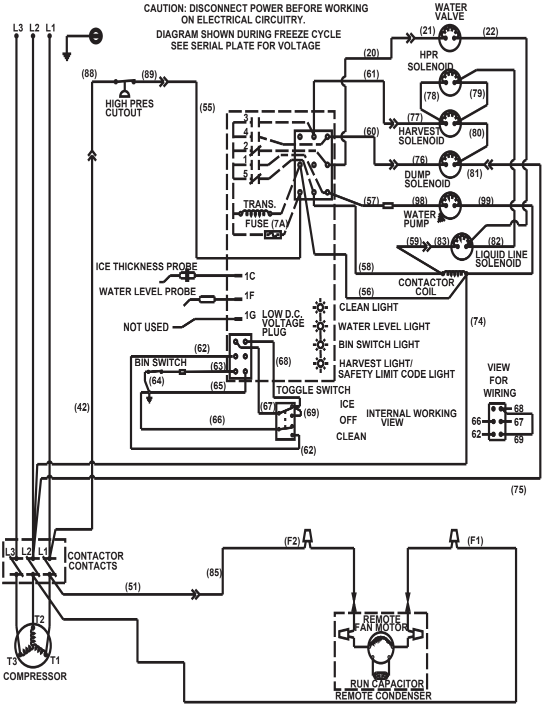
SV2073

Q800/Q1000 -Remote - 3 Phase With Terminal Board



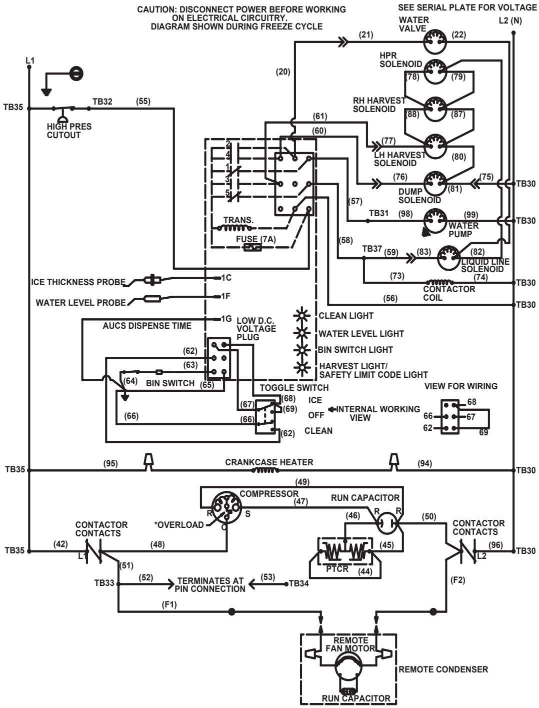
SV1649

Q800/Q1000 - Remote -
3 Phase Without Terminal Board



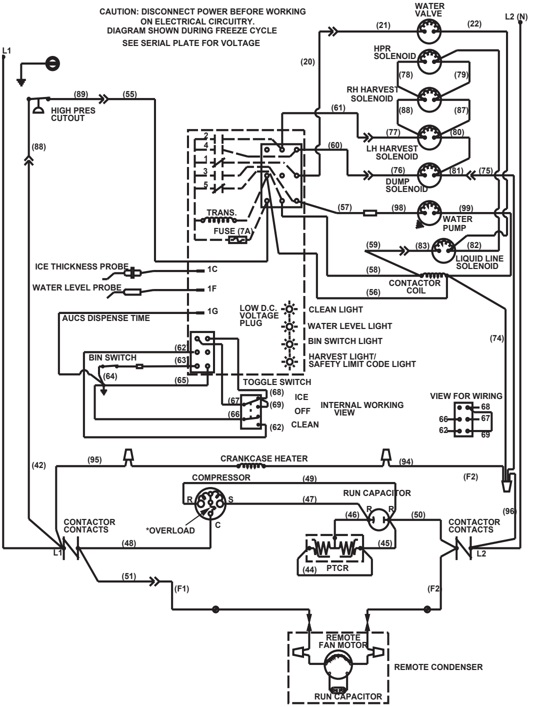
SV2074

Q1300/Q1800 - Remote -
1 Phase With Terminal Board



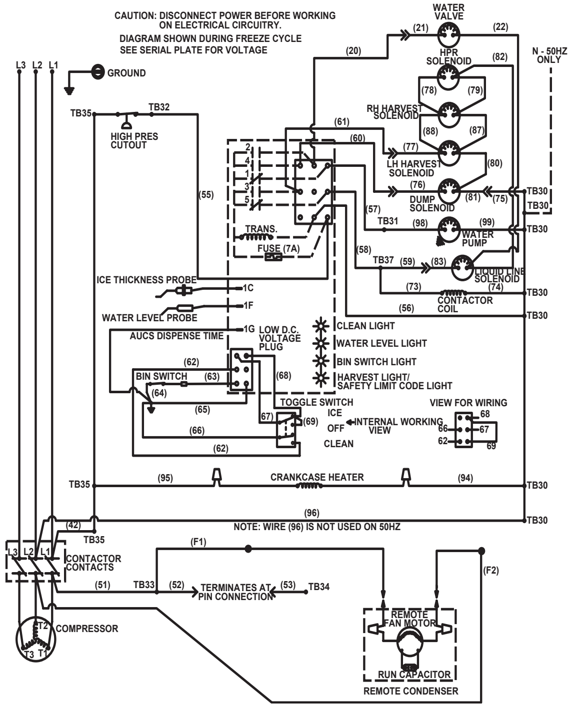
SV1650

Q1300/Q1600/Q1800 - Remote - 1 Phase Without Terminal Board



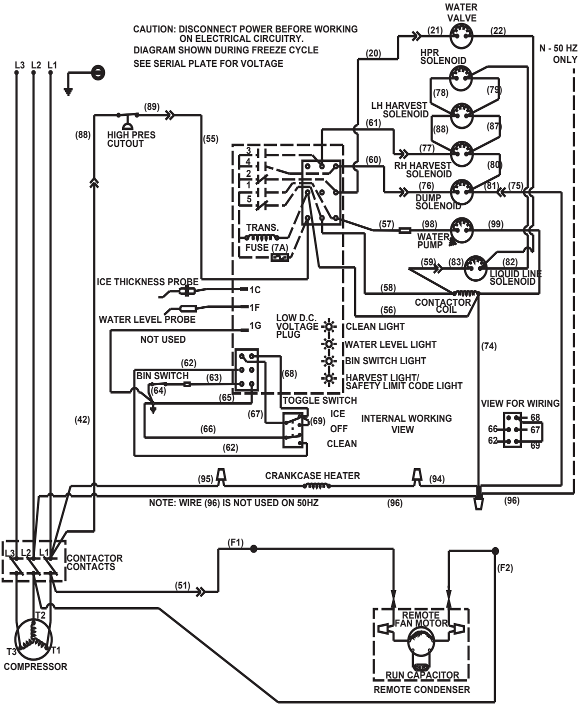
SV2076

Q1300/Q1800 - Remote - 3 Phase With Terminal Board



SV1651

Q1300/Q1600/Q1800 - Remote - 3 Phase Without Terminal Board



SV2077

COMPONENT SPECIFICATIONS AND DIAGNOSTICS

General

Q-Model control boards use a dual voltage transformer. This means only one control board is needed for both 115V and 208-230V use.

Safety Limits

In addition to standard safety controls, such as the high pressure cut-out, the control board has built-in safety limits.

These safety limits protect the ice machine from major component failures. For more information, see "Safety Limits"

Inputs

The control board, along with inputs, controls all electrical components, including the ice machine sequence of operation. Prior to diagnosing, you must understand how the inputs affect the control board operation.

Refer to specific component specifications (inputs), wiring diagrams and ice machine sequence of operation sections for details.

As an example, refer to "Ice Thickness Probe" for information relating to how the probe and control board function together.

This section will include items such as:

- How a harvest cycle is initiated
- How the harvest light functions with the probe
- Freeze time lock-in feature
- Maximum freeze time
- Diagnosing ice thickness control circuitry

Main Fuse

FUNCTION

The control board fuse stops ice machine operation if electrical components fail, causing high amp draw.

SPECIFICATIONS

The main fuse is 250 Volt, 7 amp.

⚠ Warning

High (line) voltage is applied to the control board (terminals #55 and #56) at all times. Removing the control board fuse or moving the toggle switch to OFF will not remove the power supplied to the control board.

CHECK PROCEDURE

1. If the bin switch light is on with the water curtain closed, the fuse is good.

⚠ Warning

Disconnect electrical power to the entire ice machine before proceeding.

2. Remove the fuse. Check for continuity across the fuse with an ohmmeter.

Reading	Result
Open (OL)	Replace fuse
Closed (O)	Fuse is good

Bin Switch

FUNCTION

Movement of the water curtain controls bin switch operation. The bin switch has two main functions:

1. Terminating the Harvest cycle and returning the ice machine to the Freeze cycle. This occurs when the bin switch is opened and closed again within 7 seconds during the Harvest cycle.
2. Automatic ice machine shut-off.
   If the storage bin is full at the end of a Harvest cycle, the sheet of cubes fails to clear the water curtain and holds it open. After the water curtain is held open for 7 seconds, the ice machine shuts off. The ice machine remains off until enough ice is removed from the storage bin to allow the sheet of cubes to drop clear of the water curtain. As the water curtain swings back to the operating position, the bin switch closes and the ice machine restarts, provide the 3-minute delay has expired.

> ⚠ **Caution**
>
> The water curtain must be ON (bin switch(s) closed) to start ice making.

SPECIFICATIONS

The bin switch is a magnetically operated reed switch. The magnet is attached to the lower right corner of the water curtain. The switch is attached to the evaporator-mounting bracket.

The bin switch is connected to a varying D.C. voltage circuit. (Voltage does not remain constant.)

NOTE: Because of a wide variation in D.C. voltage, it is not recommended that a voltmeter be used to check bin switch operation.

CHECK PROCEDURE

1. Set the toggle switch to OFF.
2. Watch the bin switch light on the control board.
3. Move the water curtain toward the evaporator. The bin switch must close. The bin switch light “on” indicates the bin switch has closed properly.
4. Move the water curtain away from the evaporator. The bin switch must open. The bin switch light “off” indicates the bin switch has opened properly.

OHM TEST

1. Disconnect the bin switch wires to isolate the bin switch from the control board.
2. Connect an ohmmeter to the disconnected bin switch wires.
3. Cycle the bin switch by opening and closing the water curtain.

NOTE: To prevent misdiagnosis:

- Always use the water curtain magnet to cycle the switch. Larger or smaller magnets will affect switch operation.
- Watch for consistent readings when the bin switch is open and closed. Bin switch failure could be erratic.

Water Curtain Removal Notes

The water curtain must be on (bin switch closed) to start ice making. While a Freeze cycle is in progress, the water curtain can be removed and installed at any time without interfering with the electrical control sequence.

If the ice machine goes into Harvest sequence while the water curtain is removed, one of the following will happen:

- Water curtain remains off:
  When the Harvest cycle time reaches 3.5 minutes and the bin switch is not closed, the ice machine stops as though the bin were full.
- Water curtain is put back on:
  If the bin switch closes prior to reaching the 3.5-minute point, the ice machine immediately returns to another Freeze sequence prechill.

ICE/OFF/CLEAN Toggle Switch

FUNCTION

The switch is used to place the ice machine in ICE, OFF or CLEAN mode of operation.

SPECIFICATIONS

Double-pole, double-throw switch. The switch is connected into a varying low D.C. voltage circuit.

CHECK PROCEDURE

NOTE: Because of a wide variation in D.C. voltage, it is not recommended that a voltmeter be used to check toggle switch operation.

1. Inspect the toggle switch for correct wiring.
2. Isolate the toggle switch by disconnecting all wires from the switch, or by disconnecting the Molex connector and removing wire #69 from the toggle switch.
3. Check across the toggle switch terminals using a calibrated ohmmeter. Note where the wire numbers are connected to the switch terminals, or refer to the wiring diagram to take proper readings.

Switch Setting	Terminals	Ohm Reading
ICE	66-62	Open
	67-68	Closed
	67-69	Open
CLEAN	66-62	Closed
	67-68	Open
	67-69	Closed
OFF	66-62	Open
	67-68	Open
	67-69	Open

4. Replace the toggle switch if ohm readings do not match all three switch settings.

Ice Thickness Probe (Harvest Initiation)

HOW THE PROBE WORKS

Manitowoc's electronic sensing circuit does not rely on refrigerant pressure, evaporator temperature, water levels or timers to produce consistent ice formation.

As ice forms on the evaporator, water (not ice) contacts the ice thickness probe. After the water completes this circuit across the probe continuously for 6-10 seconds, a Harvest cycle is initiated.

HARVEST/SAFETY LIMIT LIGHT

This light's primary function is to be on as water contacts the ice thickness probe during the freeze cycle, and remain on throughout the entire harvest cycle. The light will flicker as water splashes on the probes.

The light's secondary function is to continuously flash when the ice machine is shut off on a safety limit, and to indicate which safety limit shut off the ice machine.

FREEZE TIME LOCK-IN FEATURE

The ice machine control system incorporates a freeze time lock-in feature. This prevents the ice machine from short cycling in and out of harvest.

The control board locks the ice machine in the freeze cycle for six minutes. If water contacts the ice thickness probe during these six minutes, the harvest light will come on (to indicate that water is in contact with the probe), but the ice machine will stay in the freeze cycle. After the six minutes are up, a harvest cycle is initiated. This is important to remember when performing diagnostic procedures on the ice thickness control circuitry.

To allow the service technician to initiate a harvest cycle without delay, this feature is not used on the first cycle after moving the toggle switch OFF and back to ICE.

MAXIMUM FREEZE TIME

The control system includes a built-in safety which will automatically cycle the ice machine into harvest after 60 minutes in the freeze cycle.

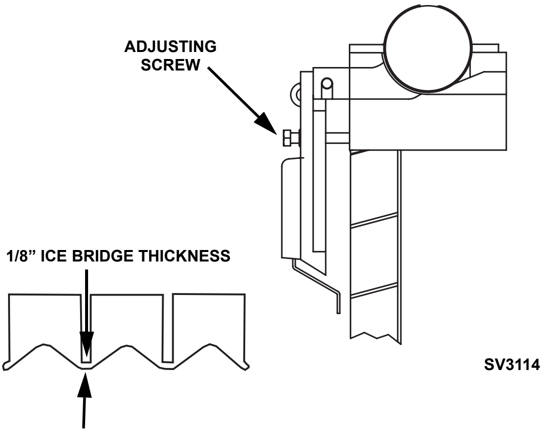
ICE THICKNESS CHECK

The ice thickness probe is factory-set to maintain the ice bridge thickness at 1/8 in. (.32 cm).

NOTE: Make sure the water curtain is in place when performing this check. It prevents water from splashing out of the water trough.

1. Inspect the bridge connecting the cubes. It should be about 1/8 in. (.32 cm) thick.
2. If adjustment is necessary, turn the ice thickness probe adjustment screw clockwise to increase bridge thickness or counterclockwise to decrease bridge thickness.

NOTE: Turning the adjustment 1/3 of a turn will change the ice thickness about 1/16 in. (.15 cm). The starting point before final adjustment is approximately a 3/16 in. gap.
Make sure the ice thickness probe wire and the bracket do not restrict movement of the probe



ICE THICKNESS ADJUSTMENT

Ice Thickness Probe Diagnostics

Before diagnosing ice thickness control circuitry clean the ice thickness probe using the following procedure.

1. Mix a solution of Manitowoc ice machine cleaner and water (2 ounces of cleaner to 16 ounces of water) in a container.
2. Soak ice thickness probe in container of cleaner/water solution while disassembling and cleaning water circuit components (soak ice thickness probe for 10 minutes or longer).
3. Clean all ice thickness probe surfaces including all plastic parts (do not use abrasives). Verify the ice thickness probe cavity is clean. Thoroughly rinse ice thickness probe (including cavity) with clean water, then dry completely. **Incomplete rinsing and drying of the ice thickness probe can cause premature harvest.**
4. Reinstall ice thickness probe, then sanitize all ice machine and bin/dispenser interior surfaces.

Diagnosing Ice Thickness Control Circuitry

ICE MACHINE DOES NOT CYCLE INTO HARVEST WHEN WATER CONTACTS THE ICE THICKNESS CONTROL PROBE

Step 1. Bypass the freeze time lock-in feature by moving the ICE/OFF/CLEAN switch to OFF and back to ICE. Wait until the water starts to flow over the evaporator.

Step 2. Clip the jumper wire leads to the ice thickness probe and any cabinet ground.

Monitor the Harvest light.

Harvest Light On

- The Harvest light comes on, and 6-10 seconds later, the ice machine cycles from Freeze to Harvest.

The ice thickness control circuitry is functioning properly. Do not change any parts.

- The Harvest light comes on, but the ice machine stays in the Freeze sequence.

The ice thickness control circuitry is functioning properly. The ice machine is in a six-minute freeze time lock-in. Verify step 1 of this procedure was followed correctly.

Harvest Light Off

- The Harvest light does not come on.

Proceed to step 3.

Step 3. Disconnect the ice thickness probe from the control board at terminal 1C. Clip the jumper wire leads to terminal 1C on the control board and any cabinet ground.

Monitor the Harvest light.

Harvest Light On

- The harvest light comes on, and 6-10 seconds later, the ice machine cycles from Freeze to Harvest.

The ice thickness probe is causing the malfunction.

- The Harvest light comes on, but the ice machine stays in the Freeze sequence.

The control circuitry is functioning properly. The ice machine is in a six-minute freeze time lock-in (verify step 1 of this procedure was followed correctly).

Harvest Light Off

- The Harvest light does not come on.

The control board is causing the malfunction.

ICE MACHINE CYCLES INTO HARVEST BEFORE WATER CONTACT WITH THE ICE THICKNESS PROBE

Step 1. Bypass the freeze time lock-in feature by moving the ICE/OFF/CLEAN switch to OFF and back to ICE. Wait until the water starts to flow over the evaporator, then monitor the Harvest light.

Step 2. Disconnect the ice thickness probe from the control board at terminal 1C

- The Harvest light stays off, and the ice machine remains in the Freeze sequence.

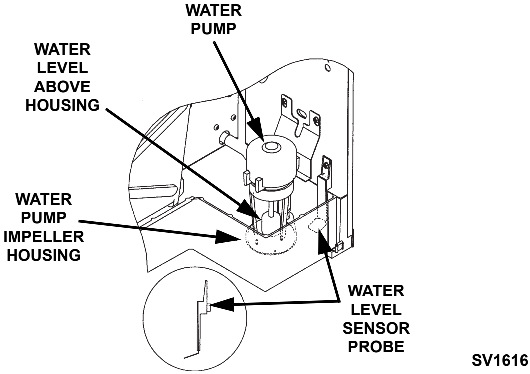
The ice thickness probe is causing the malfunction. Verify that the ice thickness probe is adjusted correctly and clean.

- The Harvest light comes on, and 6-10 seconds later, the ice machine cycles from Freeze to Harvest.

The control board is causing the malfunction.

Water Level Control Circuitry

The water level probe circuit can be monitored by watching the water level light. The water level light is on when water contacts the probe, and off when no water is in contact with the probe. The water level light functions any time power is applied to the ice machine, regardless of toggle switch position.



FREEZE CYCLE WATER LEVEL SETTING

During the Freeze cycle, the water level probe is set to maintain the proper water level above the water pump housing. The water level is not adjustable. If the water level is incorrect, check the water level probe for damage (probe bent, etc.). Repair or replace the probe as necessary.

WATER INLET VALVE SAFETY SHUT-OFF

In the event of a water level probe failure, this feature limits the water inlet valve to a six-minute on time. Regardless of the water level probe input, the control board automatically shuts off the water inlet valve if it remains on for 6 continuous minutes. This is important to remember when performing diagnostic procedures on the water level control circuitry.

FREEZE CYCLE CIRCUITRY

Manitowoc's electronic sensing circuit does not rely on float switches or timers to maintain consistent water level control. During the Freeze cycle, the water inlet valve energizes (turns on) and de-energizes (turns off) in conjunction with the water level probe located in the water trough.

During the first 45 seconds of the Freeze cycle: The water inlet valve is ON when there is no water in contact with the water level probe.

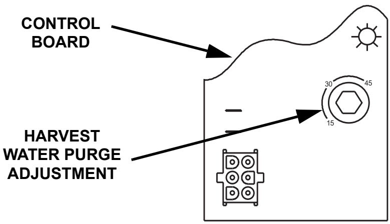
- The water inlet valve turns OFF after water contacts the water level probe for 3 continuous seconds.
- The water inlet valve will cycle ON and OFF as many times as needed to fill the water trough.

After 45 seconds into the Freeze cycle: The water inlet valve will cycle ON, and then OFF one more time to refill the water trough. The water inlet valve is now OFF for the duration of the Freeze sequence.

HARVEST CYCLE CIRCUITRY

The water level probe does not control the water inlet valve during the Harvest cycle. During the Harvest cycle water purge, the water inlet valve energizes (turns on) and de-energizes (turns off) strictly by time. The harvest water purge adjustment dial may be set at 15, 30 or 45 seconds.

NOTE: The water purge **must be at the factory setting** of 45 seconds for the water inlet valve to energize during the last 15 seconds of the water purge. If set at 15 or 30 seconds, the water inlet valve will not energize during the harvest water purge.



DIAGNOSING WATER LEVEL CONTROL CIRCUITRY

Problem: Water Trough Overfilling During the Freeze Cycle

Step 1. Start a new Freeze sequence by moving the ICE/OFF/CLEAN toggle switch to OFF and then back to ICE.

> **Important**
>
> This restart must be done prior to performing diagnostic procedures. This assures the ice machine is not in a Freeze cycle water inlet valve safety shut-off mode. You must complete the entire diagnostic procedure within 6 minutes of starting.

Step 2. Wait until the Freeze cycle starts (approximately 45 seconds – the Freeze cycle starts when the compressor energizes), then connect a jumper from the water level probe to any cabinet ground. Refer to the chart on the next page.

> **Important**
>
> For the test to work properly, you must wait until the Freeze cycle starts, prior to connecting the jumper wire. If you restart the test, you must disconnect the jumper wire, restart the ice machine (step 1), and then reinstall the jumper wire after the compressor starts.

Step 2. Jumper Wire Connected from Probe to Ground			
Is Water Flowing into the Water Trough?	**The Water Level Light Is:**	**The Water Inlet Valve Solenoid Coil Is:**	**Cause**
No	On	De-energized	This is normal operation. Do not change any parts.
Yes	On	De-energized	The water inlet valve is causing the problem.
Yes	Off	Energized	Proceed to step 3.

Step 3. Allow ice machine to run. Disconnect the water level probe from control board terminal 1F, and connect a jumper wire from terminal 1F to any cabinet ground.

Remember, if you are past 6 minutes from starting, the ice machine will go into a Freeze cycle water inlet valve safety shut-off mode, and you will be unable to complete this test. If past 6 minutes, you must restart this test by disconnecting the jumper wire, restarting the ice machine (step 1), and then reinstalling the jumper wire to terminal 1F after the compressor starts.

Step 3. Jumper Wire Connected from Control Board Terminal 1F to Ground			
Is Water Flowing into the Water Trough?	**The Water Level Light Is:**	**The Water Inlet Valve Solenoid Coil Is:**	**Cause**
No	On	De-energized	The water level probe is causing the problem. Clean or replace the water level probe.
Yes	Off	Energized	The control board is causing the problem.
Yes	Off	De-energized	The water fill valve is causing the problem.

Problem: Water Will Not Run into the Sump Trough During the Freeze Cycle

Step 1. Verify water is supplied to the ice machine, and then start a new Freeze sequence by moving the ICE/OFF/CLEAN toggle switch to OFF, then back to ICE.

> **Important**
>
> This restart must be done prior to performing diagnostic procedures. This assures the ice machine is not in a Freeze cycle water inlet valve safety shut-off mode. You must complete the entire diagnostic procedure within 6 minutes of starting.

Step 2. Wait until the Freeze cycle starts (approximately 45 seconds – the Freeze cycle starts when the compressor energizes), and then refer to the chart.

Step 2. Checking for Normal Operation			
Is Water Flowing into the Water Trough?	**The Water Level Light Is:**	**The Water Inlet Valve Solenoid Coil Is:**	**Cause**
Yes	Off	Energized	This is normal operation. Do not change any parts.
No	On or Off	Energized or De-energized	Proceed to step 3.

Step 3. Leave the ice machine run, and then disconnect the water level probe from control board terminal 1F.

> **Important**
>
> For the test to work properly you must wait until the Freeze cycle starts, prior to disconnecting the water level probe. If you restart the test, you must reconnect the water level probe, restart the ice machine (step 1), and then disconnect the water level probe after the compressor starts.

Step 3. Disconnect Probe from 1F

Is Water Flowing into the Water Trough?	The Water Level Light Is:	The Water Inlet Valve Solenoid Coil Is:	Cause
Yes	Off	Energized	The water level probe is causing the problem. Clean or replace the water level probe.
No	Off	Energized	The water inlet valve is causing the problem.
No	On or Off	De-energized	The control board is causing the problem.

Diagnosing an Ice Machine Head Section that Will Not Run

⚠ Warning

High (line) voltage is applied to the control board (terminals #55 and #56) at all times. Removing control board fuse or moving the toggle switch to OFF will not remove the power supplied to the control board.

1. Verify primary voltage is supplied to ice machine head section and the fuse/circuit breaker is closed.
2. Verify the High Pressure cutout is closed. The HPCO is closed if primary power voltage is present at terminals #55 and #56 on the control board.
3. Verify control board fuse is okay. If the bin switch or water level probe light functions, the fuse is okay.
4. Verify all bin switches function properly. A defective bin switch can falsely indicate a full bin of ice.
5. Verify ICE/OFF/CLEAN toggle switch functions properly. A defective toggle switch may keep the ice machine in the OFF mode.
6. Verify low DC voltage is properly grounded. Loose DC wire connections may intermittently stop the ice machine.
7. Replace the control board. Be sure steps 1-6 were followed thoroughly. Intermittent problems are not usually related to the control board.

Compressor Electrical Diagnostics

The compressor does not start or will trip repeatedly on overload.

Check Resistance (Ohm) Values

NOTE: Compressor windings can have very low ohm values. Use a properly calibrated meter.

Perform the resistance test after the compressor cools. The compressor dome should be cool enough to touch (below 120°F/49°C) to assure that the overload is closed and the resistance readings will be accurate.

<u>SINGLE PHASE COMPRESSORS</u>

1. Disconnect power from the condensing unit and remove the wires from the compressor terminals.
2. The resistance values must be within published guidelines for the compressor. The resistance values between C and S and between C and R, when added together, should equal the resistance value between S and R.
3. If the overload is open, there will be a resistance reading between S and R, and open readings between C and S and between C and R. Allow the compressor to cool, then check the readings again.

<u>THREE PHASE COMPRESSORS</u>

1. Disconnect power from the condensing unit and remove the wires from the compressor terminals.
2. The resistance values must be within published guidelines for the compressor. The resistance values between L1 and L2, between L2 and L3, and between L3 and L1 should all be equal.
3. If the overload is open, there will be open readings between L1 and L2, between L2 and L3, and between L3 and L1. Allow the compressor to cool, then check the readings again.

CHECK MOTOR WINDINGS TO GROUND

Check continuity between all three terminals and the compressor shell or copper refrigeration line. Scrape metal surface to get good contact. If continuity is present, the compressor windings are grounded and the compressor should be replaced.

To determine if the compressor is seized, check the amp draw while the compressor is trying to start.

COMPRESSOR DRAWING LOCKED ROTOR

The two likely causes of this are a defective starting component and a mechanically seized compressor.

To determine which you have:

- Install high and low side gauges.
- Try to start the compressor.
- Watch the pressures closely.

If the pressures do not move, the compressor is seized. Replace the compressor.

If the pressures move, the compressor is turning slowly and is not seized. Check the capacitors and relay.

COMPRESSOR DRAWING HIGH AMPS

The continuous amperage draw on start-up should not be near the maximum fuse size indicated on the serial tag.

The wiring must be correctly sized to minimize voltage drop at compressor start-up. The voltage when the compressor is trying to start must be within ±10% of the nameplate voltage.

Diagnosing Capacitors

- If the compressor attempts to start, or hums and trips the overload protector, check the starting components before replacing the compressor.
- Visual evidence of capacitor failure can include a bulged terminal end or a ruptured membrane. Do not assume a capacitor is good if no visual evidence is present.
- A good test is to install a known good substitute capacitor.
- Use a capacitor tester when checking a suspect capacitor. Clip the bleed resistor off the capacitor terminals before testing.

TROUBLESHOOTING PTCR'S

WHY A GOOD PTCR MAY FAIL TO START THE COMPRESSOR

A good PTCR might not operate properly at start-up because:

- The ice machine's 3-minute delay has been overridden. Opening and closing the service disconnect or cycling the toggle switch from OFF to ICE will override the delay period.
- The control box temperature is too high. Though rare, very high air temperatures (intense sunlight, etc.) can greatly increase the temperature of the control box and its contents. This may require a longer off time to allow the PTCR to cool.
- The compressor has short-cycled, or the compressor overload has opened. Move the toggle switch to OFF and allow the compressor and PTCR to cool.

- The voltage at the compressor during start-up is too low.
  Manitowoc ice machines are rated at ±10% of nameplate voltage at compressor start-up. (Ex: An ice machine rated at 208-230 should have a compressor start-up voltage between 187 and 253 volts.)
- The compressor discharge and suction pressures are not matched closely enough or equalized.
  These two pressures must be somewhat equalized before attempting to start the compressor. The harvest valve (and HPR valve on remotes) energizes for 45 seconds before the compressor starts, and remains on 5 seconds after the compressor starts. Make sure this is occurring and the harvest valve (and HPR solenoid) coil is functional before assuming that the PTCR is bad.

> **⚠ Warning**
>
> Disconnect electrical power to the entire ice machine at the building electrical disconnect box before proceeding.

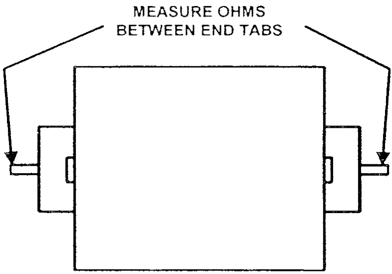
<u>CHECKING THE PTCR</u>

1. Visually inspect the PTCR. Check for signs of physical damage.

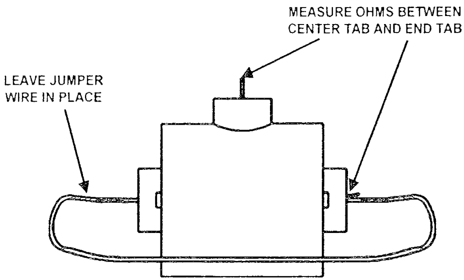
NOTE: The PTCR case temperature may reach 210°F (100°C) while the compressor is running. This is normal. Do not change a PTCR just because it is hot.

2. Wait at least 10 minutes for the PTCR to cool to room temperature.
3. Remove the PTCR from the ice machine.
4. Measure the resistance of the PTCR as shown on the next page. If the resistance falls outside of the acceptable range, replace it.

Model	Manitowoc Part Number	Cera-Mite Part Number	Room Temperature Resistance
Q200 Q280 Q320 Q420 Q450	8505003	305C20	22-50 Ohms
Q600 Q800 Q1000	8504993	305C19	18-40 Ohms
Q1300 Q1600 Q1800	8504913	305C9	8-22 Ohms



Manitowoc PTCR's 8505003 & 8504993



Manitowoc PTCR's 8504913

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Refrigeration System

REFRIGERATION SYSTEM DIAGNOSTICS

Before Beginning Service

Ice machines may experience operational problems only during certain times of the day or night. A machine may function properly while it is being serviced, but malfunctions later. Information provided by the user can help the technician start in the right direction, and may be a determining factor in the final diagnosis.

Ask these questions before beginning service:

- When does the ice machine malfunction? (night, day, all the time, only during the Freeze cycle, etc.)
- When do you notice low ice production? (one day a week, every day, on weekends, etc.)
- Can you describe exactly what the ice machine seems to be doing?
- Has anyone been working on the ice machine?
- During “store shutdown,” is the circuit breaker, water supply or air temperature altered?
- Is there any reason why incoming water pressure might rise or drop substantially?

Ice Production Check

The amount of ice a machine produces directly relates to the operating water and air temperatures. This means a condensing unit with a 70°F (21.2°C) outdoor ambient temperature and 50°F (10.0°C) water produces more ice than the same model condensing unit with a 90°F (32.2°C) outdoor ambient temperature and 70°F (21.2°C) water.

1. Determine the ice machine operating conditions:

   Air temp entering condenser:____°

   Air temp around ice machine:____°

   Water temp entering sump trough:____°

2. Refer to the appropriate 24-Hour Ice Production Chart. Use the operating conditions determined in step 1 to find published 24-Hour Ice Production:_____

- Times are in minutes.
  Example: 1 min. 15 sec. converts to 1.25 min.
  (15 seconds ÷ 60 seconds = .25 minutes)
- Weights are in pounds.
  Example: 2 lb. 6 oz. converts to 2.375 lb.
  (6 oz. ÷ 16 oz. = .375 lb.)

3. Perform an ice production check using the formula below.

1.	________ Freeze Time	+	________ Harvest Time	=	________ Total Cycle Time
2.	1440 Minutes in 24 Hrs.	÷	________ Total Cycle Time	=	________ Cycles per Day
3.	________ Weight of One Harvest	×	________ Cycles per Day	=	________ Actual 24-Hour Production

Weighing the ice is the only 100% accurate check. However, if the ice pattern is normal and the 1/8 in. thickness is maintained, the ice slab weights listed with the 24-Hour Ice Production Charts may be used.

4. Compare the results of step 3 with step 2. Ice production checks that are within 10% of the chart are considered normal. This is due to variances in water and air temperature. Actual temperatures will seldom match the chart exactly. If they match closely, determine if:

- Another ice machine is required.
- More storage capacity is required.
- Relocating the existing equipment to lower the load conditions is required.

Contact the local Manitowoc Distributor for information on available options and accessories.

Installation/Visual Inspection Checklist

Possible Problem List
- Corrective Action List

Ice machine is not level
- Level the ice machine

Condenser is dirty
- Clean the condenser

Water filtration is plugged (if used)
- Install a new water filter

Water drains are not run separately and/or are not vented
- Run and vent drains according to the Installation Manual

Line set is improperly installed
- Reinstall according to the Installation Manual

Water System Checklist

A water-related problem often causes the same symptoms as a refrigeration system component malfunction.

Example: A water dump valve leaking during the Freeze cycle, a system low on charge, and a starving TXV have similar symptoms.

Water system problems must be identified and eliminated prior to replacing refrigeration components.

Possible Problem List
- Corrective Action List

Water area (evaporator) is dirty
- Clean as needed

Water inlet pressure not between 20 and 80 psig
- Install a water regulator valve or increase the water pressure

Incoming water temperature is not between 35°F (1.7°C) and 90°F (32.2°C)
- If too hot, check the hot water line check valves in other store equipment

Water filtration is plugged (if used)
- Install a new water filter

Water dump valve leaking during the Freeze cycle
- Clean/replace dump valve as needed

Vent tube is not installed on water outlet drain
- See Installation Instructions

Hoses, fittings, etc., are leaking water
- Repair/replace as needed

Water fill valve is stuck open or closed
- Clean/replace as needed

Water is spraying out of the sump trough area
- Stop the water spray

Uneven water flow across the evaporator
- Clean the ice machine

Water is freezing behind the evaporator
- Correct the water flow

Plastic extrusions and gaskets are not secured to the evaporator
- Remount/replace as needed

Ice Formation Pattern

Evaporator ice formation pattern analysis is helpful in ice machine diagnostics.

Analyzing the ice formation pattern alone cannot diagnose an ice machine malfunction. However, when this analysis is used along with Manitowoc's Refrigeration System Operational Analysis Table, it can help diagnose an ice machine malfunction.

Any number of problems can cause improper ice formation.

Example: An ice formation that is "extremely thin on top" could be caused by a hot water supply, a dump valve leaking water, a faulty water fill valve, a low refrigerant charge, etc.

> **Important**
>
> Keep the water curtain in place while checking the ice formation pattern to ensure no water is lost.

1. Normal Ice Formation

Ice forms across the entire evaporator surface.

At the beginning of the Freeze cycle, it may appear that more ice is forming on the bottom of the evaporator than on the top. At the end of the Freeze cycle, ice formation on the top will be close to, or just a bit thinner than, ice formation on the bottom. The dimples in the cubes at the top of the evaporator may be more pronounced than those on the bottom. This is normal.

The ice thickness probe must be set to maintain the ice bridge thickness at approximately 1/8 in. If ice forms uniformly across the evaporator surface, but does not reach 1/8 in. in the proper amount of time, this is still considered normal.

2. Extremely Thin at Evaporator Outlet

There is no ice, or a considerable lack of ice formation, on the top of the evaporator (tubing outlet).

Examples: No ice at all on the top of the evaporator, but ice forms on the bottom half of the evaporator. Or, the ice at the top of the evaporator reaches 1/8 in. to initiate a harvest, but the bottom of the evaporator already has 1/2 in. to 1 in. of ice formation.

Possible cause: Water loss, low on refrigerant, starving TXV, hot water supply, faulty water fill valve, etc.

3. Extremely Thin at Evaporator Inlet

There is no ice, or a considerable lack of ice formation on the bottom of the evaporator (tubing inlet). Examples: The ice at the top of the evaporator reaches 1/8 in. to initiate a harvest, but there is no ice formation at all on the bottom of the evaporator.

Possible cause: Insufficient water flow, flooding TXV, etc.

4. Spotty Ice Formation

There are small sections on the evaporator where there is no ice formation. This could be a single corner or a single spot in the middle of the evaporator. This is generally caused by loss of heat transfer from the tubing on the backside of the evaporator.

5. No Ice Formation

The ice machine operates for an extended period, but there is no ice formation at all on the evaporator.

Possible cause: Water inlet valve, water pump, starving expansion valve, low refrigerant charge, compressor, etc.

Important

Q1300, Q1600, and Q1800 model machines have left and right expansion valves and separate evaporator circuits. These circuits operate independently from each other. Therefore, one may operate properly while the other is malfunctioning.

Example: If the left expansion valve is starving, it may not affect the ice formation pattern on the right side of the evaporator.

Safety Limits

GENERAL

In addition to standard safety controls, such as high pressure cut-out, the control board has two built in safety limit controls which protect the ice machine from major component failures. There are two control boards with different safety limit sequences. Original production control boards have a black micro-processor. Current production and replacement control boards have an orange label on the control board microprocessor.

Safety Limit #1: If the freeze time reaches 60 minutes, the control board automatically initiates a harvest cycle.

Control Board with Black Microprocessor

- If 3 consecutive 60-minute freeze cycles occur, the ice machine stops.

Control Board with Orange Label on Microprocessor

- If 6 consecutive 60-minute freeze cycles occur, the ice machine stops.

Safety Limit #2: If the harvest time reaches 3.5 minutes, the control board automatically returns the ice machine to the freeze cycle.

Control Board with Black Microprocessor

- If three consecutive 3.5 minute harvest cycles occur, the ice machine stops.

Control Board with Orange Label on Microprocessor

- If 500 consecutive 3.5 minute harvest cycles occur, the ice machine stops.

SAFETY LIMIT INDICATION

Control Board with Black Microprocessor

When a safety limit condition is exceeded for 3 consecutive cycles the ice machine stops and the harvest light on the control board continually flashes on and off. Use the following procedures to determine which safety limit has stopped the ice machine.

1. Move the toggle switch to OFF.
2. Move the toggle switch back to ICE.
3. Watch the harvest light. It will flash one or two times, corresponding to safety limits 1 and 2, to indicate which safety limit stopped the ice machine.

After safety limit indication, the ice machine will restart and run until a safety limit is exceeded again.

Control Board with Orange Label on Microprocessor

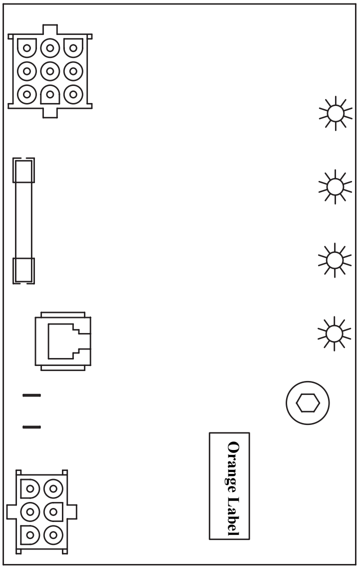
When a safety limit condition is exceeded for 3 consecutive cycles the control board enters the limit into memory and the ice machine continues to run. Use the following procedures to determine if the control board contains a safety limit indication.

1. Move the toggle switch to OFF.
2. Move the toggle switch back to ICE.
3. Watch the harvest light. If a safety limit has been recorded, the harvest light will flash one or two times, corresponding to safety limit 1 or 2.

When a safety limit condition is exceeded (6 consecutive cycles for Safety Limit #1 or 500 cycles for Safety Limit #2) the ice machine stops and the harvest light on the control board continually flashes on and off. Use the following procedures to determine which safety limit has stopped the machine.

1. Move the toggle switch to OFF.
2. Move the toggle switch back to ICE.
3. Watch the harvest light. It will flash one or two times, corresponding to safety limit 1 or 2 to indicate which safety limit stopped the ice machine.

After safety limit indication, the ice machine will restart and run until a safety limit is exceeded again.



CONTROL BOARD WTH ORANGE LABEL ON MICROPROCESSOR

ANALYZING WHY SAFETY LIMITS MAY STOP THE ICE MACHINE

According to the refrigeration industry, a high percentage of compressors fail as a result of external causes. These can include: flooding or starving expansion valves, dirty condensers, water loss to the ice machine, etc. The safety limits protect the ice machine (primarily the compressor) from external failures by stopping ice machine operation before major component damage occurs.

The safety limit system is similar to a high pressure cut-out control. It stops the ice machine, but does not tell what is wrong. The service technician must analyze the system to determine what caused the high pressure cut-out, or a particular safety limit, to stop the ice machine.

The safety limits are designed to stop the ice machine prior to major component failures, most often a minor problem or something external to the ice machine. This may be difficult to diagnose, as many external problems occur intermittently.

Example: An ice machine stops intermittently on safety limit #1 (long freeze times). The problem could be a low ambient temperature at night, a water pressure drop, the water is turned off one night a week, etc.

When a high pressure cut-out or a safety limit stops the ice machine, they are doing what they are supposed to do. That is, stopping the ice machine before a major component failure occurs.

Refrigeration and electrical component failures may also trip a safety limit. Eliminate all electrical components and external causes first. If it appears that the refrigeration system is causing the problem, use Manitowoc's Refrigeration System Operational Analysis Table, along with detailed charts, checklists, and other references to determine the cause.

The following checklists are designed to assist the service technician in analysis. However, because there are many possible external problems, do not limit your diagnosis to only the items listed.

SAFETY LIMIT NOTES

- Because there are many possible external problems, do not limit your diagnosis to only the items listed in these charts.
- A continuous run of 100 harvests automatically erases the safety limit code.
- The control board will store and indicate only one safety limit – the last one exceeded.
- If the toggle switch is moved to the OFF position and then back to the ICE position prior to reaching the 100-harvest point, the last safety limit exceeded will be indicated.
- If the Harvest light did not flash prior to the ice machine restarting, then the ice machine did not stop because it exceeded a safety limit.

SAFETY LIMIT CHECKLIST

The following checklists are designed to assist the service technician in analysis. However, because there are many possible external problems, do not limit your diagnosis to only the items listed.

Safety Limit #1

Refer to page 75 for control board identification and safety limit operation.

<u>Control Board with Black Microprocessor</u> - Freeze Time exceeds 60 minutes for 3 consecutive freeze cycles

or

<u>Control Board with Orange Label on Microprocessor</u> - Freeze time exceeds 60 minutes for 6 consecutive freeze cycles

Possible Cause Checklist

Improper Installation

- Refer to "Installation/Visual Inspection Checklist"

Water System

- Low water pressure (20 psig min.)
- High water pressure (80 psig max.)
- High water temperature (90°F/32.2°C max.)
- Clogged water distribution tube
- Dirty/defective water fill valve
- Dirty/defective water dump valve
- Defective water pump

Electrical System

- Ice thickness probe out of adjustment
- Harvest cycle not initiated electrically
- Contactor not energizing
- Compressor electrically non-operational
- Restricted condenser airflow
- High inlet air temperature (110°F/43.3°C max.)
- Condenser discharge air recirculation
- Dirty condenser fins
- Dirty condenser filter
- Defective fan cycling control
- Defective fan motor
- Restricted condenser water flow
- Low water pressure (20 psig min.)
- High water temperature (90°F/32.2°C max.)
- Dirty condenser
- Dirty/defective water regulating valve
- Water regulating valve out of adjustment

Refrigeration System

- Non-Manitowoc components
- Improper refrigerant charge
- Defective head pressure control (remotes)
- Defective harvest valve
- Defective compressor
- TXV starving or flooding (check bulb mounting)
- Non-condensable in refrigeration system
- Plugged or restricted high side refrigerant lines or component

Safety Limit #2

Refer to page 75 for control board identification and safety limit operation.

Control Board with Black Microprocessor - Harvest time exceeds 3.5 minutes for 3 consecutive harvest cycles.

or

Control Board with Orange Label on Microprocessor - Harvest time exceeds 3.5 minutes for 500 consecutive harvest cycles.

Possible Cause Checklist

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Water System

- Water area (evaporator) dirty
- Dirty/defective water dump valve
- Vent tube not installed on water outlet drain
- Water freezing behind evaporator
- Plastic extrusions and gaskets not securely mounted to the evaporator
- Low water pressure (20 psig min.)
- Loss of water from sump area
- Clogged water distribution tube
- Dirty/defective water fill valve
- Defective water pump

Electrical System

- Ice thickness probe out of adjustment
- Ice thickness probe dirty
- Bin switch defective
- Premature harvest

Refrigeration System

- Non-Manitowoc components
- Water regulating valve dirty/defective
- Improper refrigerant charge
- Defective head pressure control valve (remotes)
- Defective harvest valve
- TXV flooding (check bulb mounting)
- Defective fan cycling control

Analyzing Discharge Pressure

1. Determine the ice machine operating conditions:

   Air temp. entering condenser ______

   Air temp. around ice machine ______

   Water temp. entering sump trough ______

2. Refer to Operating Pressure Chart for ice machine being checked.

   Use the operating conditions determined in step 1 to find the published normal discharge pressures.

   Freeze Cycle ______

   Harvest Cycle ______

3. Perform an actual discharge pressure check.

	Freeze Cycle psig	Harvest Cycle psig
Beginning of Cycle	__________	__________
Middle of Cycle	__________	__________
End of Cycle	__________	__________

4. Compare the actual discharge pressure (step 3) with the published discharge pressure (step 2).

   The discharge pressure is normal when the actual pressure falls within the published pressure range for the ice machine’s operating conditions. It is normal for the discharge pressure to be higher at the beginning of the Freeze cycle (when load is greatest), then drop throughout the Freeze cycle.

DISCHARGE PRESSURE HIGH CHECKLIST

Problem

- Cause

Improper Installation

- Refer to "Installation/Visual Inspection Checklist"

Restricted Condenser Air Flow

- High inlet air temperature (110°F/43.3°C max.)
- Condenser discharge air recirculation
- Dirty condenser filter
- Dirty condenser fins
- Defective fan cycling control
- Defective fan motor

Restricted Condenser water flow

- Low water pressure (20 psi min.)
- High inlet water temperature (90°F/32.2°C max.)
- Dirty condenser
- Dirty/Defective water regulating valve
- Water regulating valve out of adjustment

Improper Refrigerant Charge

- Overcharged
- Non-condensable in system
- Wrong type of refrigerant

Other

- Non-Manitowoc components in system
- High side refrigerant lines/component restricted (before mid-condenser)
- Defective head pressure control valve

FREEZE CYCLE DISCHARGE PRESSURE LOW CHECKLIST

Problem

- Cause

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Improper Refrigerant Charge

- Undercharged
- Wrong type of refrigerant

Water regulating valve (water cooled condensers)

- Out of adjustment
- Defective

Other

- Non-Manitowoc components in system
- High side refrigerant lines/component restricted (after mid-condenser)
- Defective head pressure control valve
- Defective fan cycle control

NOTE: Do not limit your diagnosis to only the items listed in the checklists.

Analyzing Suction Pressure

The suction pressure gradually drops throughout the Freeze cycle. The actual suction pressure (and drop rate) changes as the air and water temperature entering the ice machine changes. These variables also determine the Freeze cycle times.

To analyze and identify the proper suction pressure drop throughout the Freeze cycle, compare the published suction pressure to the published Freeze cycle time.

NOTE: Analyze discharge pressure before analyzing suction pressure. High or low discharge pressure may be causing high or low suction pressure.

Procedure	
Step	**Example Using QY0454A Model Ice Machine**
1. Determine the ice machine operating conditions.	Air temp. entering condenser: 90°F/32.2°C Air temp. around ice machine: 80°F/26.7°C Water temp. entering water fill valve: 70°F/21.1°C
2A. Refer to "Cycle Time" and "Operating Pressure" charts for ice machine model being checked. Using operating conditions from step 1, determine published Freeze cycle time and published Freeze cycle suction pressure.	13.7-14.1 minutes Published Freeze cycle time: 55-36 psig Published Freeze cycle suction pressure:
2B. Compare the published Freeze cycle time and published Freeze cycle suction pressure. Develop a chart.	Published Freeze Cycle Time (minutes) **1 3 5 7 9 12 14** **55 52 48 44 41 38 36** Published Freeze Cycle Suction Pressure (psig) In the example, the proper suction pressure should be approximately 44 psig at 7 minutes; 41 psig at 9 minutes; etc.
3. Perform an actual suction pressure check at the beginning, middle and end of the Freeze cycle. Note the times at which the readings are taken.	Manifold gauges were connected to the example ice machine and suction pressure readings taken as follows: psig Beginning of Freeze cycle: 59 (at 1 min.) Middle of Freeze cycle: 48 (at 7 min.) End of Freeze cycle: 40 (at 14 min.)
4. Compare the actual Freeze cycle suction pressure (step 3) to the published Freeze cycle time and pressure comparison (step 2B). Determine if the suction pressure is high, low or acceptable.	In this example, the suction pressure is considered high throughout the Freeze cycle. It should have been: Approximately 55 psig (at 1 minute) – not 59 Approximately 44 psig (at 7 minutes) – not 48 Approximately 36 psig (at 14 minutes) – not 40

SUCTION PRESSURE HIGH CHECKLIST

Problem

- Cause

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Discharge Pressure

- Discharge pressure is too high and is affecting low side – refer to “Freeze Cycle Discharge Pressure High Checklist”

Improper Refrigerant Charge

- Overcharged
- Wrong type of refrigerant

Other

- Non-Manitowoc components in system
- HPR solenoid leaking
- Harvest valve leaking
- TXV flooding (check bulb mounting)
- Defective compressor

SUCTION PRESSURE LOW CHECKLIST

Problem

- Cause

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Discharge Pressure

- Discharge pressure is too low and is affecting low side – refer to “Freeze Cycle Discharge Pressure Low Checklist”

Improper Refrigerant Charge

- Undercharged
- Wrong type of refrigerant

Other

- Non-Manitowoc components in system
- Improper water supply over evaporator – refer to “Water System Checklist”
- Loss of heat transfer from tubing on back side of evaporator
- Restricted/plugged liquid line drier
- Restricted/plugged tubing in suction side of refrigeration system
- TXV starving

NOTE: Do not limit your diagnosis to only the items listed in the checklists.

Single Expansion Valve Ice Machines - Comparing Evaporator Inlet and Outlet Temperatures

NOTE: This procedure will not work on the dual expansion valve Q1300, Q1600, and Q1800 ice machines.

The temperatures of the suction lines entering and leaving the evaporator alone cannot diagnose an ice machine. However, comparing these temperatures during the freeze cycle, along with using Manitowoc's Refrigeration System Operational Analysis Table, can help diagnose an ice machine malfunction.

The actual temperatures entering and leaving the evaporator vary by model, and change throughout the freeze cycle. This makes documenting the "normal" inlet and outlet temperature readings difficult. The key to the diagnosis lies in the difference between the two temperatures five minutes into the freeze cycle. These temperatures must be within 7° of each other.

Use this procedure to document freeze cycle inlet and outlet temperatures.

1. Use a quality temperature meter, capable of taking temperature readings on curved copper lines.
2. Attach the temperature meter sensing device to the copper lines entering and leaving the evaporator.

Important

Do not simply insert the sensing device under the insulation. It must be attached to and reading the actual temperature of the copper line.

3. Wait five minutes into the freeze cycle.
4. Record the temperatures below and determine the difference between them.
5. Use this with other information gathered on the Refrigeration System Operational Analysis Table to determine the ice machine malfunction.

____
Inlet Temperature

____
Outlet Temperature

____
Difference
Must be within 7° at 5 minutes into freeze cycle

HARVEST VALVE ANALYSIS

Symptoms of a harvest valve remaining partially open during the freeze cycle can be similar to symptoms of either an expansion valve or compressor problem. The best way to diagnose a harvest valve is by using Manitowoc's Ice Machine Refrigeration System Operational Analysis Table.

Use the following procedure and table to help determine if a harvest valve is remaining partially open during the freeze cycle.

1. Wait five minutes into the freeze cycle.
2. Feel the inlet of the harvest valve(s).

> **Important**
>
> Feeling the harvest valve outlet or across the harvest valve itself will not work for this comparison.
>
> The harvest valve outlet is on the suction side (cool refrigerant). It may be cool enough to touch even if the valve is leaking.

3. Feel the compressor discharge line.
4. Compare the temperature of the inlet of the harvest valves to the temperature of the compressor discharge line.

> **⚠ Warning**
>
> The inlet of the harvest valve and the compressor discharge line could be hot enough to burn your hand. Just touch them momentarily.

Findings	Comments
The inlet of the harvest valve is cool enough to touch and the compressor discharge line is hot.	This is normal as the discharge line should always be too hot to touch and the harvest valve inlet, although too hot to touch during harvest, should be cool enough to touch after 5 minutes into the freeze cycle.
The inlet of the harvest valve is hot and approaches the temperature of a hot compressor discharge line.	This is an indication something is wrong, as the harvest valve inlet did not cool down during the freeze cycle. If the compressor dome is also entirely hot, the problem is not a harvest valve leaking, but rather something causing the compressor (and the entire ice machine) to get hot.
Both the inlet of the harvest valve and the compressor discharge line are cool enough to touch.	This is an indication something is wrong, causing the compressor discharge line to be cool to the touch. This is not caused by a harvest valve leaking.

Discharge Line Temperature Analysis

GENERAL

Knowing if the discharge line temperature is increasing, decreasing or remaining constant can be an important diagnostic tool. Maximum compressor discharge line temperature on a normally operating ice machine steadily increases throughout the freeze cycle. Comparing the temperatures over several cycles will result in a consistent maximum discharge line temperature.

Ambient air temperatures affect the maximum discharge line temperature.

Higher ambient air temperatures at the condenser = higher discharge line temperatures at the compressor.

Lower ambient air temperatures at the condenser = lower discharge line temperatures at the compressor.

Regardless of ambient temperature, the freeze cycle discharge line temperature will be higher than 160°F (71.1°C) on a normally operating ice machine.

PROCEDURE

Connect a temperature probe on the compressor discharge line with-in 6" (15.24 cm) of the compressor and insulate.

Observe the discharge line temperature for the last three minutes of the freeze cycle and record the maximum discharge line temperature.

DISCHARGE LINE TEMPERATURE ABOVE 160°F (71.1°C) AT END OF FREEZE CYCLE:

Ice machines that are operating normally will have consistent maximum discharge line temperatures above 160°F (71.1°C).

DISCHARGE LINE TEMPERATURE BELOW 160°F (71.1°C) AT END OF FREEZE CYCLE:

Ice machines that have a flooding expansion valve will have a maximum discharge line temperature that decreases each cycle.

Verify the expansion valve sensing bulb is 100% insulated and sealed airtight. Condenser air contacting an incorrectly insulated sensing bulb will cause overfeeding of the expansion valve.

Verify the expansion valve sensing bulb is positioned and secured correctly.

How to Use the Refrigeration System Operational Analysis Tables

GENERAL

These tables must be used with charts, checklists and other references to eliminate refrigeration components not listed on the tables and external items and problems which can cause good refrigeration components to appear defective.

The tables list five different defects that may affect the ice machine's operation.

NOTE: A low-on-charge ice machine and a starving expansion valve have very similar characteristics and are listed under the same column.

NOTE: Before starting, see "Before Beginning Service" for a few questions to ask when talking to the ice machine owner.

PROCEDURE

Step 1. Complete the "Operation Analysis" column.

Read down the left "Operational Analysis" column. Perform all procedures and check all information listed. Each item in this column has supporting reference material to help analyze each step.

While analyzing each item separately, you may find an "external problem" causing a good refrigerant component to appear bad. Correct problems as they are found. If the operational problem is found, it is not necessary to complete the remaining procedures.

Step 2. Enter check marks (√).

Each time the actual findings of an item in the "Operational Analysis" column matches the published findings on the table, enter a check mark.

Example: Freeze cycle suction pressure is determined to be low. Enter a check mark in the "low" box.

Step 3. Add the check marks listed under each of the four columns. Note the column number with the highest total and proceed to "Final Analysis."

NOTE: If two columns have matching high numbers, a procedure was not performed properly and/or supporting material was not analyzed correctly.

FINAL ANALYSIS

The column with the highest number of check marks identifies the refrigeration problem.

<u>COLUMN 1 - HARVEST VALVE LEAKING</u>

Replace the valve as required.

<u>COLUMN 2 - LOW CHARGE/TXV STARVING</u>

Normally, a starving expansion valve only affects the freeze cycle pressures, not the harvest cycle pressures. A low refrigerant charge normally affects both pressures. Verify the ice machine is not low on charge before replacing an expansion valve.

1. Add refrigerant charge in 2 to 4 oz. increments as a diagnostic procedure to verify a low charge. Do not add more than 30% of nameplate refrigerant charge. If the problem is corrected, the ice machine is low on charge. Find the refrigerant leak.
2. The ice machine must operate with the nameplate charge. If the leak cannot be found, proper refrigerant procedures must still be followed Change the liquid line drier. Then, evacuate and weigh in the proper charge.
3. If the problem is not corrected by adding charge, the expansion valve is faulty.

   On dual expansion valve ice machines, change only the TXV that is starving. If both TXV’s are starving, they are probably good, and are being affected by some other malfunction, such as low charge.

COLUMN 3 - TXV FLOODING

A loose or improperly mounted expansion valve bulb causes the expansion valve to flood. Check bulb mounting, insulation, etc., before changing the valve. On dual expansion valve machines, the service technician should be able to tell which TXV is flooding by analyzing ice formation patterns. Change only the flooding expansion valve.

COLUMN 4 - COMPRESSOR

Replace the compressor and start components. To receive warranty credit, the compressor ports must be properly sealed by crimping and soldering them closed. Old start components must be returned with the faulty compressor.

Refrigeration System Operational Analysis Tables

Q, J OR B MODELS SINGLE EXPANSION VALVE

Operational Analysis	1	2	3	4
Ice Production	Air-Temperature Entering Condenser______________ Water Temperature Entering Ice Machine__________ Published 24 hour ice production_________________ Calculated (actual) ice production________________ NOTE: The ice machine is operating properly if the ice fill patterns is normal and ice production is within 10% of charted capacity.			
Installation and Water System	All installation and water related problems must be corrected before proceeding with chart.			
Ice Formation Pattern	Ice formation is extremely thin on outlet of evaporator -or- No ice formation on the entire evaporator	Ice formation is extremely thin on outlet of evaporator -or- No ice formation on entire evaporator	Ice formation normal -or- Ice formation is extremely thin on inlet of evaporator -or- No ice formation on entire evaporator	Ice formation normal -or- No ice formation on entire evaporator
Safety Limits Refer to "Analyzing Safety Limits" to eliminate all non-refrigeration problems.	Stops on safety limit: **1**	Stops on safety limit: **1**	Stops on safety limit: **1 or 2**	Stops on safety limit: **1**

Q, J OR B MODELS SINGLE EXPANSION VALVE

Operational Analysis	1	2	3	4
Freeze Cycle **Discharge Pressure** _____ _____ _____ **1 minute into cycle** **Middle** **End**	If discharge pressure is High or Low refer to freeze cycle high or low discharge pressure problem checklist to eliminate problems and/or components not listed on this table before proceeding.			
Freeze Cycle **Suction Pressure** _____ _____ _____ **1 minute** **Middle** **End**	If suction pressure is High or Low refer to freeze cycle high or low suction pressure problem checklist to eliminate problems and/or components not listed on this table before proceeding.			
	Suction pressure is **High**	Suction pressure is **Low or Normal**	Suction pressure is **High**	Suction pressure is **High**
Wait 5 minutes into the freeze cycle. Compare temperatures of **evaporator inlet** and **evaporator outlet.** **Inlet __________ ° F (°C)** **Outlet __________ ° F (°C)** **Difference_________ ° F (°C)**	Inlet and outlet **within 7°** of each other	Inlet and outlet **not within 7°** of each other -and- Inlet is colder than outlet	Inlet and outlet **within 7°** of each other -or- Inlet and outlet **not within 7°** of each other -and- Inlet is warmer than outlet	Inlet and outlet **within 7°** of each other

Q, J OR B MODELS SINGLE EXPANSION VALVE

Operational Analysis	**1**	**2**	**3**	**4**
Wait 5 minutes into the freeze cycle. Compare temperatures of **compressor discharge line** and **harvest valve inlet.**	The harvest valve inlet is **Hot** -and- approaches the temperature of a **Hot** compressor discharge line.	The harvest valve inlet is **Cool** enough to hold hand on -and- the compressor discharge line is **Hot.**	The harvest valve inlet is **Cool** enough to hold hand on -and- the compressor discharge line is **Cool** enough to hold hand on.	The harvest valve inlet is **Cool** enough to hold hand on -and- the compressor discharge line is **Hot.**
Discharge Line Temperature Record freeze cycle discharge line temperature at the end of the freeze cycle ________**°F (°C)**	Discharge line temperature **160°F (71.1°C) or higher** at the end of the freeze cycle	Discharge line temperature **160°F (71.1°C) or higher** at the end of the freeze cycle	Discharge line Temperature **less than 160°F (71.1°C)** at the end of the freeze cycle	Discharge line temperature **160°F (71.1°C) or higher** at the end of the freeze cycle
Final Analysis Enter total number of boxes checked in each column.	**Harvest Valve Leaking**	**Low On Charge -Or- TXV Starving**	**TXV Flooding**	**Compressor**

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Q OR J MODEL - DUAL EXPANSION VALVE

Operational Analysis	**1**	**2**	**3**	**4**
Ice Production	Air-Temperature Entering Condenser____________ Water Temperature Entering Ice Machine_________ Published 24 hour ice production________________ Calculated (actual) ice production________________ NOTE: The ice machine is operating properly if the ice production and ice formation pattern is normal and ice production is within 10% of charted capacity.			
Ice Formation Pattern **Left Side____________** **Right Side___________**	Ice formation is extremely thin on outlet of one side of evaporator -or- No ice formation on one side of evaporator	Ice formation is extremely thin on outlet of one or both sides of evaporator -or- No ice formation on entire evaporator	Ice formation normal -or- Ice formation is extremely thin on inlet of one side of evaporator -or- No ice formation on entire evaporator	Ice formation normal -or- No ice formation on entire evaporator
Safety Limits Refer to "Analyzing Safety Limits" to eliminate problems and/or components not listed on this table	Stops on safety limit: **1**	Stops on safety limit: **1**	Stops on safety limit: **1 or 2**	Stops on safety limit: **1**

Q OR J MODEL - DUAL EXPANSION VALVE

Operational Analysis	1	2	3	4
Freeze Cycle DISCHARGE pressure ____ ____ ____ **1 minute into cycle Middle End**	If discharge pressure is **High or Low** refer to a freeze cycle high or low discharge pressure problem checklist to eliminate problems and/or components not listed on this table before proceeding.			
Freeze Cycle SUCTION pressure ____ ____ ____ **Beginning Middle End**	If suction pressure is **High or Low** refer to a freeze cycle high or low suction pressure problem checklist to eliminate problems and/or components not listed on this table before proceeding.			
	Suction pressure is **High**	Suction pressure is **Low or Normal**	Suction pressure is **High**	Suction pressure is **High**
Harvest Valve Wait 5 minutes into the freeze cycle. Compare temperatures of **compressor discharge line** and **both harvest valve inlets**.	One harvest valve inlet is **Hot** -and- approaches the temperature of a **Hot** compressor discharge line.	Both harvest valve inlets are **Cool** enough to hold hand on -and- the compressor discharge line is **Hot.**	Both harvest valve inlets are **Cool** enough to hold hand on -and- the compressor discharge line is **Cool** enough to hold hand on.	Both harvest valve inlets are **Cool** enough to hold hand on -and- the compressor discharge line is **Hot**

Q OR J MODEL - DUAL EXPANSION VALVE

Operational Analysis	**1**	**2**	**3**	**4**
Discharge Line Temperature Record freeze cycle discharge line temperature at the end of the freeze cycle **_________°F (°C)**	Discharge line emperature **160°F (71.1°C) or higher** at the end of the freeze cycle	Discharge line temperature **160°F (71.1°C) or higher** at the end of the freeze cycle	Discharge line temperature **less than 160°F (71.1°C)** at the end of the freeze cycle	Discharge line temperature **160°F (71.1°C) or higher** at the end of the freeze cycle
Final Analysis Enter total number of boxes checked in each column	**Harvest Valve Leaking**	**Low On Charge** **-Or-** **TXV Starving**	**TXV Flooding**	**Compressor**

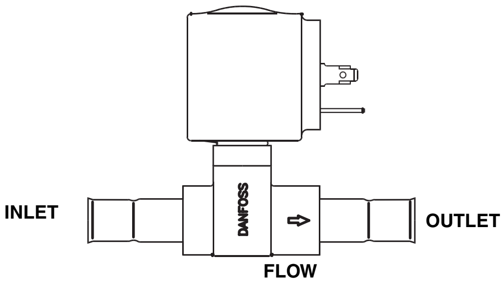
PRESSURE CONTROL SPECIFICATIONS AND DIAGNOSTICS

Harvest Pressure Regulating (HPR) System Remotes Only

GENERAL

The harvest pressure regulating (H.P.R.) system includes:

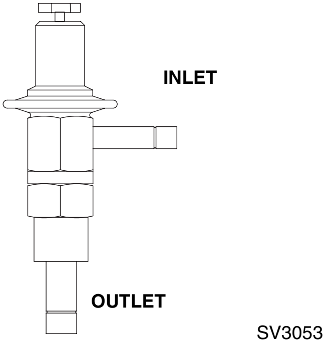
- Harvest pressure regulating solenoid valve (H.P.R. solenoid). This is an electrically operated valve which opens when energized, and closes when de-energized.



HPR SOLENOID

SV3074

- Harvest pressure regulating valve (H.P.R. valve). This is a pressure regulating valve which modulates open and closed, based on the refrigerant pressure at the outlet of the valve. The valve closes completely and stops refrigerant flow when the pressure at the outlet rises above the valve setting.



HPR VALVE

<u>FREEZE CYCLE</u>

The H.P.R. system is not used during the freeze cycle. The H.P.R. solenoid is closed (de-energized), preventing refrigerant flow into the H.P.R. valve.

<u>HARVEST CYCLE</u>

During the harvest cycle, the check valve in the discharge line prevents refrigerant in the remote condenser and receiver from backfeeding into the evaporator and condensing to liquid.

The H.P.R. solenoid is opened (energized) during the harvest cycle, allowing refrigerant gas from the top of the receiver to flow into the H.P.R. valve. The H.P.R. valve modulates open and closed, raising the suction pressure high enough to sustain heat for the harvest cycle, without allowing refrigerant to condense to liquid in the evaporator.

In general, harvest cycle suction pressure rises, then stabilizes in the range of 75-100 psig (517-758 kPA). Exact pressures vary from model to model. Refer to the “Operational Refrigerant Pressures” charts.

HPR DIAGNOSTICS

Steps 1 through 4 can be quickly verified without attaching a manifold gauge set or thermometer.

All questions must have a yes answer to continue the diagnostic procedure.

1. Liquid line warm?
   (Body temperature is normal)
   If liquid line is warmer or cooler than body temperature, refer to headmaster diagnostics.

2. Ice fill pattern normal?
   Refer to “Ice Formation Pattern” if ice fill is not normal.

3. Freeze time normal?
   (Refer to Cycle Times/Refrigerant Pressures/24 Hour Ice Production Charts)
   Shorter freeze cycles - Refer to headmaster diagnostics.
   Longer freeze cycles - Refer to water system checklist, then refer to Refrigeration Diagnostic Procedures.

4. Harvest time is longer than normal and control board indicates safety limit #2?
   (Refer to Cycle Times/Refrigerant Pressures/24 Hour Ice Production Charts)
   Connect refrigeration manifold gauge set to the access valves on the front of the ice machine, and a thermometer thermocouple on the discharge line within 6" of the compressor (insulate thermocouple).
   Establish baseline by recording suction and discharge pressure, discharge line temperature and freeze & harvest cycle times. (Refer to “**Refrigeration System Operational Analysis Tables**” for data collection detail).

5. Freeze cycle Head Pressure 220 psig (1517 kPa) or higher?
   If the head pressure is lower than 220 psig (1517 kPa) refer to headmaster diagnostics.
6. Freeze cycle Suction Pressure normal?
   Refer to analyzing suction pressure if suction pressure is high or low.
7. Discharge line temperature is 160°F (71.1°C) or higher at end of freeze cycle?
   If less than 160°F (71.1°C) check expansion valve bulb mounting and insulation.
8. Harvest cycle suction and discharge pressures are lower than indicated in the cycle times/refrigerant pressures/24 hour ice production chart?
   Replace Harvest Pressure Regulating system (HPR Valve and HPR solenoid valve).

Headmaster Control Valve

Manitowoc remote systems require headmaster control valves with special settings. Replace defective headmaster control valves only with “original” Manitowoc replacement parts.

OPERATION

The R404A headmaster control valve is non adjustable.

At ambient temperatures of approximately 70°F (21.1°C) or above, refrigerant flows through the valve from the condenser to the receiver inlet. At temperatures below this (or at higher temperatures if it is raining), the head pressure control dome’s nitrogen charge closes the condenser port and opens the bypass port from the compressor discharge line.

In this modulating mode, the valve maintains minimum head pressure by building up liquid in the condenser and bypassing discharge gas directly to the receiver.

DIAGNOSING

1. Determine the air temperature entering the remote condenser.
2. Determine if the head pressure is high or low in relationship to the outside temperature. (Refer to the proper “Operational Pressure Chart”). If the air temperature is below 70°F (21.1°C), the head pressure should be modulating about 225 PSIG (1551 kPa).
3. Determine the temperature of the liquid line entering the receiver by feeling it. This line is normally warm; “body temperature.”

4. Using the information gathered, refer to the chart below.

NOTE: A headmaster that will not bypass, will function properly with condenser air temperatures of approximately 70°F (21.1°C) or above. When the temperature drops below 70°F (21.1°C), the headmaster fails to bypass and the ice machine malfunctions. Lower ambient conditions can be simulated by rinsing the condenser with cool water during the freeze cycle.

Symptom	Probable Cause	Corrective Measure
Valve not maintaining pressures	Non-approved valve	Install a Manitowoc Headmaster control valve with proper setting
Discharge pressure low; Liquid line entering receiver feels warm to hot	Ice machine low on charge	See “Low on Charge Verification”
Discharge pressure extremely high; Liquid line entering receiver feels hot	Valve stuck in bypass	Replace valve
Discharge pressure low; Liquid line entering receiver feels extremely cold	Valve not bypassing	Replace valve

LOW ON CHARGE VERIFICATION

The remote ice machine requires more refrigerant charge at lower ambient temperatures than at higher temperatures. A low on charge ice machine may function properly during the day, and then malfunction at night. Check this possibility.

If you cannot verify that the ice machine is low on charge:

1. Add refrigerant in 2 lb. increments, but do not exceed 6 lbs.
2. If the ice machine was low on charge, the headmaster function and discharge pressure will return to normal after the charge is added. Do not let the ice machine continue to run. To assure operation in all ambient conditions, the refrigerant leak must be found and repaired, the liquid line drier must be changed, and the ice machine must be evacuated and properly recharged.
3. If the ice machine does not start to operate properly after adding charge, replace the headmaster.

FAN CYCLE CONTROL VS. HEADMASTER

A fan cycle control cannot be used in place of a headmaster. The fan cycle control is not capable of bypassing the condenser coil and keeping the liquid line temperature and pressure up.

This is very apparent when it rains or the outside temperature drops. When it rains or the outside temperature drops, the fan begins to cycle on and off. At first, everything appears normal. But, as it continues raining or getting colder, the fan cycle control can only turn the fan off. All the refrigerant must continue to flow through the condenser coil, being cooled by the rain or low outside temperature.

This causes excessive sub-cooling of the refrigerant. As a result, the liquid line temperature and pressure are not maintained for proper operation.

Fan Cycle Control
(Self-Contained Air-Cooled Models Only)

FUNCTION

Cycles the fan motor on and off to maintain proper operating discharge pressure.

The fan cycle control closes on an increase, and opens on a decrease in discharge pressure.

Specifications		
Model	**Cut-In (Close)**	**Cut-Out (Open)**
Q200/Q280 Q320/Q370/ Q420/Q450/ Q600	250 psig ±5 (1724 kPa ±35)	200 psig ±5 (1379 kPa ±35)
Q800/Q1000/ Q1300/Q1800	275 psig ±5 (1896 kPa ±35)	225 psig ±5 (1551 kPa ±35)

CHECK PROCEDURE

1. Verify fan motor windings are not open or grounded, and fan spins freely.
2. Connect manifold gauges to ice machine.
3. Hook voltmeter in parallel across the fan cycle control, leaving wires attached.
4. Refer to chart below.

FCC Setpoint:	Reading Should Be:	Fan Should Be:
Above Cut-In	0 Volts	Running
Below Cut-Out	Line Voltage	Off

High Pressure Cutout (HPCO) Control

FUNCTION

Stops the ice machine if subjected to excessive high-side pressure.

The HPCO control is normally closed, and opens on a rise in discharge pressure.

Specifications	
Cut-Out	**Cut-In**
450 psig ±10 (3103 kPa ±69)	Manual or Automatic Reset
(Must be below 300 psig (2068 kPa) to reset.)	

CHECK PROCEDURE

1. Set ICE/OFF/CLEAN switch to OFF, (Manual reset HPCO reset if tripped).
2. Connect manifold gauges.
3. Hook voltmeter in parallel across the HPCO, leaving wires attached.
4. On water-cooled models, close the water service valve to the water condenser inlet. On self-contained air-cooled and remote models, disconnect the fan motor.
5. Set ICE/OFF/CLEAN switch to ICE.
6. No water or air flowing through the condenser will cause the HPCO control to open because of excessive pressure. Watch the pressure gauge and record the cut-out pressure.

⚠ Warning

If discharge pressure exceeds 460 psig (3172 kPa) and the HPCO control does not cut out, set ICE/OFF/CLEAN switch to OFF to stop ice machine operation.

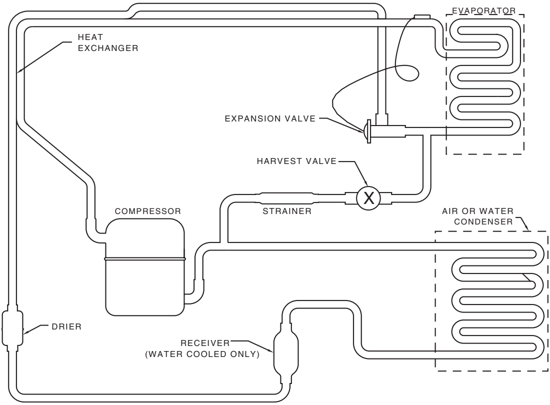
Replace the HPCO control if it:

1. Will not reset [below 300 psig (2068 kPa)].
2. Does not open at the specified cut-out point.

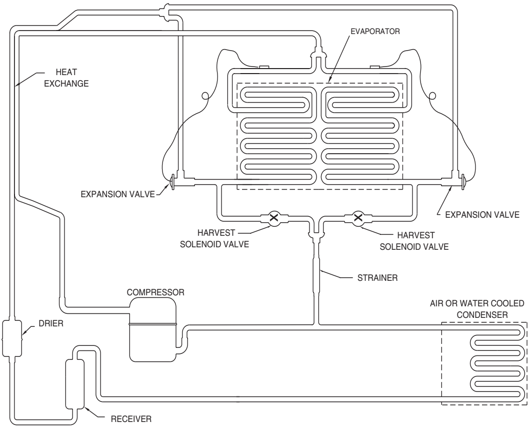
REFRIGERATION TUBING SCHEMATICS

Self-Contained Air- or Water -Cooled Models

Q200/Q280/Q320/Q370/Q420/Q450/Q600/Q800/Q1000

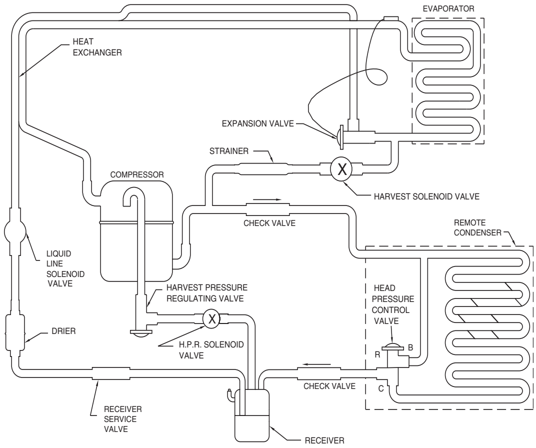


Q1300/Q1600/Q1800

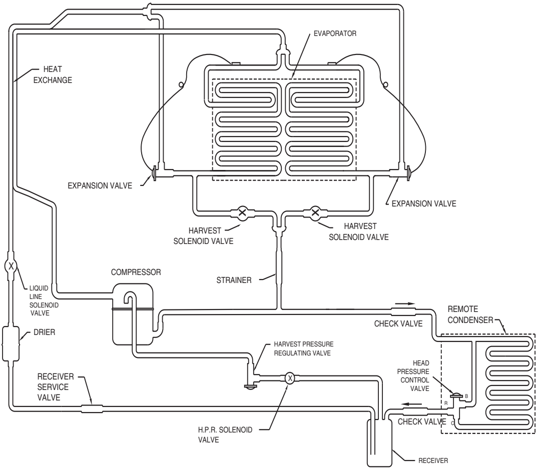


Remote Models

Q200/Q280/Q320/Q370/Q420/Q450/Q600/Q800/Q1000



Q1300/Q1600/Q1800



CYCLE TIMES/24-HOUR ICE PRODUCTION/ REFRIGERANT PRESSURE CHARTS

These charts are used as guidelines to verify correct ice machine operation.

Accurate collection of data is essential to obtain the correct diagnosis.

- Refer to “OPERATIONAL ANALYSIS TABLE” for the list of data that must be collected for refrigeration diagnostics. This list includes: before beginning service, ice production check, installation/visual inspection, water system checklist, ice formation pattern, safety limits, comparing evaporator inlet/ outlet temperatures, discharge and suction pressure analysis.
- Ice production checks that are within 10% of the chart are considered normal. This is due to variances in water and air temperature. Actual temperatures will seldom match the chart exactly.
- Zero out manifold gauge set before obtaining pressure readings to avoid misdiagnosis.
- Discharge and suction pressure are highest at the beginning of the cycle. Suction pressure will drop throughout the cycle. Verify the pressures are within the range indicated.

Q200 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	11.5-13.5	13.8-16.1	15.2-17.8	1.0-2.5
80/26.7	13.8-16.1	15.6-18.2	17.0-19.8	
90/32.2	16.1-18.7	18.6-21.6	20.5-23.8	
100/37.8	19.8-23.0	23.6-27.4	25.5-29.6	

Times in Minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	270	230	210
80/26.7	230	205	190
90/32.2	200	175	160
100/37.8	165	140	130

Based on average ice slab weight of 2.44 - 2.81 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG [1]
50/10.0	195-260	60-28	120-190	85-110
70/21.1	195-260	60-28	120-190	85-110
80/26.7	210-270	65-28	160-190	90-110
90/32.2	240-290	70-30	190-210	100-120
100/37.8	270-330	70-35	220-240	120-140
110/43.3	310-390	85-40	250-270	120-150

Q200 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	11.5-13.5	12.8-15.0	14.5-16.9	1-2.5
80/26.7	12.0-14.1	13.5-15.7	15.2-17.8	
90/32.2	12.6-14.7	14.1-16.5	16.1-18.7	
100/37.8	13.1-15.4	14.8-17.3	17.0-19.8	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	270	245	220
80/26.7	260	235	210
90/32.2	250	225	200
100/37.8	240	215	190

Based on average ice slab weight of 2.44 - 2.81 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	240	480	2100

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	60-28	170-200	90-110
70/21.1	225-235	60-28	170-200	90-110
80/26.7	225-240	60-28	175-205	90-110
90/32.2	225-245	65-30	175-205	90-115
100/37.8	225-250	70-32	180-210	90-115
110/43.3	225-260	75-34	185-215	90-120

Suction pressure drops gradually throughout the freeze cycle

Q280 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	10.6-12.5	11.8-13.8	12.6-14.7	1.0-2.5
80/26.7	11.5-13.5	12.8-15.0	13.8-16.1	
90/32.2	12.6-14.7	14.1-16.5	15.2-17.8	
100/37.8	14.5-16.9	16.5-19.3	18.0-21.0	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	290	265	250
80/26.7	270	245	230
90/32.2	250	225	210
100/37.8	220	195	180

Based on average ice slab weight of 2.44 - 2.81 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	195-250	60-20	150-190	70-90
70/21.1	195-250	60-20	150-190	70-90
80/26.7	220-280	60-26	180-220	70-90
90/32.2	250-310	66-30	190-220	80-100
100/37.8	280-350	70-32	220-250	80-110
110/43.3	310-390	85-40	250-270	80-120

Suction pressure drops gradually throughout the freeze cycle

Q280 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	10.6-12.5	12.0-14.1	12.3-14.4	1-2.5
80/26.7	10.8-12.7	12.3-14.4	13.8-16.1	
90/32.2	11.0-13.0	12.6-14.7	14.1-16.5	
100/37.8	11.3-13.2	12.8-15.0	14.5-16.9	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	290	260	255
80/26.7	285	255	230
90/32.2	280	250	225
100/37.8	275	245	220

Based on average ice slab weight of 2.44 - 2.81 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	250	490	3400

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	60-28	190-200	75-90
70/21.1	225-235	60-28	190-200	80-90
80/26.7	225-240	60-28	190-200	80-90
90/32.2	225-245	62-28	190-200	80-90
100/37.8	225-250	62-30	190-200	80-90
110/43.3	225-260	64-32	195-205	80-95

Suction pressure drops gradually throughout the freeze cycle

Q320 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	12.2-13.9	13.1-14.9	14.2-16.2	1-2.5
80/26.7	13.6-15.5	14.8-16.8-	16.1-18.4	
90/32.2	16.1-18.4	17.7-20.2	19.7-22.3	
100/37.8	19.7-22.3	22.0-25.0	25.0-28.3	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	310	290	270
80/26.7	280	260	240
90/32.2	240	220	200
100/37.8	200	180	160

Based on average ice slab weight of 2.94 - 3.31 lb.

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	200-250	50-36	150-180	75-90
70/21.1	200-250	50-36	160-190	80-100
80/26.7	220-280	50-36	170-200	90-110
90/32.2	230-320	54-38	180-220	90-120
100/37.8	270-360	56-40	200-250	95-140
110/43.3	280-380	58-42	210-260	95-150

Suction pressure drops gradually throughout the freeze cycle

Q320 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	12.6-14.4	13.6-15.5	15.4-17.6	1-2.5
80/26.7	13.1-14.9	14.2-16.2	16.1-18.4	
90/32.2	13.6-15.5	14.8-16.8	16.9-19.2	
100/37.8	14.2-16.2	15.4-17.6	17.7-20.2	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	300	280	250
80/26.7	290	270	240
90/32.2	280	260	230
100/37.8	270	250	220

Based on average ice slab weight of 2.94 - 3.31 lb.

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	270	560	3200

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	50-36	160-180	80-110
70/21.1	225-235	50-36	170-190	85-115
80/26.7	225-240	50-36	170-200	85-115
90/32.2	225-250	50-36	170-210	90-120
100/37.8	225-260	52-36	170-210	90-120
110/43.3	225-265	54-36	175-215	95-125

Suction pressure drops gradually throughout the freeze cycle

Q370 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	10.3-11.7	11.7-13.4	12.6-14.4	1-2.5
80/26.7	11.3-12.9	12.6-14.4	13.9-15.8	
90/32.2	12.9-14.7	13.9-15.8	15.4-17.6	
100/37.8	14.5-16.5	16.1-18.4	17.3-19.7	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	360	320	300
80/26.7	330	300	275
90/32.2	295	275	250
100/37.8	265	240	225

Based on average ice slab weight of 2.94 - 3.31 lb.

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	200-250	60-34	145-165	75-95
70/21.1	215-250	60-36	150-170	85-100
80/26.7	250-290	65-38	165-185	90-110
90/32.2	260-330	70-40	175-195	100-120
100/37.8	300-380	80-41	195-220	130-150
110/43.3	310-390	80-42	200-225	135-155

Suction pressure drops gradually throughout the freeze cycle

Q370 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	10.3-11.7	11.0-12.5	12.2-13.9	1-2.5
80/26.7	10.6-12.1	11.3-12.9	12.6-14.4	
90/32.2	11.0-12.5	11.7-13.4	13.1-14.4	
100/37.8	11.3-12.9	12.2-13.9	13.6-15.5	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	360	340	310
80/26.7	350	330	300
90/32.2	340	320	290
100/37.8	330	310	280

Based on average ice slab weight of 2.94 - 3.31 lb.

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	220	490	3700

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	60-32	150-170	85-100
70/21.1	225-235	60-33	150-170	85-105
80/26.7	225-240	65-36	155-175	90-110
90/32.2	225-240	68-38	155-175	90-110
100/37.8	235-260	75-40	175-200	100-120
110/43.3	240-265	85-40	185-205	105-125

Suction pressure drops gradually throughout the freeze cycle

Q420/450 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	9.7-11.4	10.9-12.8	12.0-14.0	1-2.5
80/26.7	10.9-12.8	12.3-14.4	13.3-15.6	
90/32.2	12.3-14.4	14.1-16.5	15.5-18.0	
100/37.8	14.5-17.0	16.5-19.2	18.3-21.3	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	530	480	440
80/26.7	480	430	400
90/32.2	430	380	350
100/37.8	370	330	300

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	195-260	45-30	150-170	75-90
70/21.1	200-260	47-33	165-180	80-100
80/26.7	230-265	50-35	165-185	80-100
90/32.2	260-290	55-36	190-210	90-110
100/37.8	290-340	60-38	215-235	105-125
110/43.3	195-260	45-30	235-255	125-140

Suction pressure drops gradually throughout the freeze cycle

Q420/450 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	9.9-11.7	11.4-13.4	12.6-14.8	1-2.5
80/26.7	10.1-11.9	11.7-13.7	13.0-15.2	
90/32.2	10.4-12.2	12.0-14.0	13.3-15.6	
100/37.8	10.6-12.5	12.3-14.4	13.7-16.0	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	520	460	420
80/26.7	510	450	410
90/32.2	500	440	400
100/37.8	490	430	390

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
Gal/24 hours	400	740	2400

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	235-245	50-35	165-180	85-100
70/21.1	235-245	50-35	165-180	85-100
80/26.7	235-245	50-35	165-180	85-100
90/32.2	235-245	52-35	165-180	85-100
100/37.8	235-245	52-35	165-185	85-100
110/43.3	240-250	55-36	165-185	85-100

Suction pressure drops gradually throughout the freeze cycle

Q450 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
-20/-28.9 to 70/21.1	10.6-12.5	12.0-14.0	13.3-15.6	1-2.5
80/26.7	10.9-12.8	12.3-14.4	13.7-16.0	
90/32.2	11.1-13.1	12.6-14.8	14.1-16.5	
100/37.8	12.0-14.0	13.7-16.0	15.5-18.0	
110/43.3	13.3-15.6	15.5-18.0	17.6-20.6	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
-20/-28.9 to 70/21.1	490	440	400
80/26.7	480	430	390
90/32.2	470	420	380
100/37.8	440	390	350
110/43.3	400	350	310

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%
Ratings with JC0495 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
-20/-28.9 to 50/10.0	225-245	50-32	175-190	85-100
70/21.1	230-250	50-32	175-190	85-100
80/26.7	240-260	52-32	180-195	85-100
90/32.2	245-270	54-35	185-200	85-100
100/37.8	280-310	57-37	190-205	90-105
110/43.3	290-325	64-39	190-205	95-110

Suction pressure drops gradually throughout the freeze cycle

Q600 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time Water Temperature °F/°C			Harvest Time
	50/10.0	70/21.1	90/32.2	
70/21.1	7.1-8.4	7.8-9.2	8.6-10.1	1-2.5
80/26.7	7.8-9.2	8.6-10.1	9.5-11.2	
90/32.2	8.6-10.1	9.5-11.2	10.4-12.2	
100/37.8	9.5-11.2	10.6-12.5	12.0-14.0	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	690	640	590
80/26.7	640	590	540
90/32.2	590	540	500
100/37.8	540	490	440

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	195-260	42-22	155-180	75-95
70/21.1	220-290	44-22	160-185	85-100
80/26.7	220-305	52-22	160-190	90-110
90/32.2	250-325	52-23	175-195	95-115
100/37.8	280-355	54-30	195-210	95-125
110/43.3	300-385	56-32	200-225	100-135

Suction pressure drops gradually throughout the freeze cycle

Q600 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	7.4-8.7	8.2-9.7	9.5-11.2	1-2.5
80/26.7	7.5-8.9	8.4-9.9	9.7-11.4	
90/32.2	7.8-9.2	8.7-10.3	9.9-11.7	
100/37.8	7.9-9.4	8.9-10.5	10.1-11.9	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	670	610	540
80/26.7	660	600	530
90/32.2	640	580	520
100/37.8	630	570	510

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	600	1250	6800

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	46-25	140-184	80-102
70/21.1	225-235	46-26	148-184	82-104
80/26.7	225-235	48-26	154-186	86-108
90/32.2	225-240	48-26	154-190	86-108
100/37.8	225-245	50-28	162-194	86-112
110/43.3	225-250	52-28	165-200	86-115

Suction pressure drops gradually throughout the freeze cycle

Q600 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
-20/-28.9 to 70/21.1	7.9-9.4	8.9-10.5	9.5-11.2	1-2.5
80/26.7	8.0-9.4	9.0-10.6	9.6-11.3	
90/32.2	8.1-9.5	9.1-10.7	9.7-11.4	
100/37.8	8.4-9.9	9.5-11.2	10.1-11.9	
110/43.3	8.9-10.5	10.1-11.9	10.9-12.8	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
-20/-28.9 to 70/21.1	630	570	540
80/26.7	625	565	535
90/32.2	620	560	530
100/37.8	600	540	510
110/43.3	570	510	480

Based on average ice slab weight of 4.12 - 4.75 lb.
Regular cube derate is 7%
Ratings with JC0895 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
-20/-28.9 to 50/10.0	220-250	42-26	152-170	75-100
70/21.1	225-260	44-26	155-172	82-100
80/26.7	245-265	46-26	156-174	82-100
90/32.2	250-265	48-26	157-174	84-100
100/37.8	265-295	52-26	158-176	84-100
110/43.3	300-335	52-28	158-176	84-105

Suction pressure drops gradually throughout the freeze cycle

Q800 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	8.9-10.2	9.7-11.1	10.3-11.9	1-2.5
80/26.7	9.3-10.7	10.2-11.7	10.9-12.5	
90/32.2	10.3-11.9	11.4-13.1	12.3-14.1	
100/37.8	12.1-13.8	13.3-15.2	14.4-16.5	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	800	740	700
80/26.7	770	710	670
90/32.2	700	640	600
100/37.8	610	560	520

Based on average ice slab weight of 5.75 - 6.50 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	220-280	31-18	135-180	65-90
70/21.1	220-280	32-18	140-180	70-90
80/26.7	225-280	36-20	140-180	70-95
90/32.2	260-295	38-22	150-200	80-100
100/37.8	300-330	40-24	210-225	80-100
110/43.3	320-360	44-26	210-240	85-120

Suction pressure drops gradually throughout the freeze cycle

Q800 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	8.7-10.1	9.5-11.0	10.9-12.5	1-2.5
80/26.7	8.9-10.2	9.7-11.1	11.0-12.7	
90/32.2	9.0-10.3	9.8-11.3	11.2-12.9	
100/37.8	9.1-10.5	10.0-11.5	11.4-13.1	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	810	750	670
80/26.7	800	740	660
90/32.2	790	730	650
100/37.8	780	720	640

Based on average ice slab weight of 5.75 - 6.50 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	640	1420	6000

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	33-20	160-185	65-85
70/21.1	225-235	34-20	165-185	70-85
80/26.7	225-235	34-20	165-185	70-85
90/32.2	225-235	36-22	165-185	70-85
100/37.8	225-235	36-22	165-185	70-85
110/43.3	225-240	38-24	170-190	75-90

Suction pressure drops gradually throughout the freeze cycle

Q800 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
-20/-28.9 to 70/ 21.1	9.5-11.0	10.6-12.2	11.6-13.4	1-2.5
80/26.7	9.7-11.1	10.8-12.4	11.9-13.6	
90/32.2	9.8-11.3	11.0-12.6	12.1-13.8	
100/37.8	10.6-12.2	11.9-13.6	13.2-15.1	
110/43.3	11.9-13.6	13.4-15.4	14.7-16.9	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
-20/-28.9 to 70/21.1	750	685	630
80/26.7	740	675	620
90/32.2	730	665	610
100/37.8	685	620	565
110/43.3	620	555	510

Based on average ice slab weight of 5.75 - 6.50 lb.
Regular cube derate is 7%
Ratings with JC0895 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
-20/-28.9 to 50/10.0	220-250	30-22	180-200	65-90
70/21.1	225-250	32-22	190-200	70-90
80/26.7	240-260	33-22	190-205	70-90
90/32.2	255-265	34-22	195-205	70-90
100/37.8	275-295	38-24	200-210	70-90
110/43.3	280-320	40-26	200-225	75-100

Suction pressure drops gradually throughout the freeze cycle

Q1000 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	9.9-10.6	10.6-11.4	11.3-12.2	1-2.5
80/26.7	10.2-11.0	11.2-12.0	11.9-12.8	
90/32.2	10.9-11.7	11.9-12.8	12.8-13.7	
100/37.8	12.1-13.0	13.2-14.1	14.2-15.2	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	980	920	870
80/26.7	950	880	830
90/32.2	900	830	780
100/37.8	820	760	710

Based on average ice slab weight of 7.75 - 8.25 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	220-280	38-18	135-180	65-90
70/21.1	220-280	40-18	140-180	70-90
80/26.7	225-280	42-20	140-180	70-95
90/32.2	260-295	42-22	150-200	80-100
100/37.8	300-330	42-24	210-225	80-100
110/43.3	320-360	44-24	210-240	85-120

Suction pressure drops gradually throughout the freeze cycle

Q1000 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	10.0-10.7	10.6-11.4	12.1-13.0	1-2.5
80/26.7	10.1-10.9	10.8-11.6	12.3-13.2	
90/32.2	10.2-11.0	10.9-11.7	12.5-14.3	
100/37.8	10.4-11.1	11.0-11.8	12.6-14.4	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	970	920	820
80/26.7	960	910	810
90/32.2	950	900	800
100/37.8	940	890	790

Based on average ice slab weight of 7.75 - 8.25 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	750	1500	6200

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	225-235	36-18	160-185	65-85
70/21.1	225-235	38-18	165-185	70-85
80/26.7	225-235	40-18	165-185	70-85
90/32.2	225-235	40-20	165-185	70-85
100/37.8	225-235	40-20	165-185	70-85
110/43.3	225-240	42-20	170-190	75-90

Suction pressure drops gradually throughout the freeze cycle

Q1000 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
-20/-28.9 to 70/21.1	10.5-11.3	11.3-12.2	12.1-13.0	1-2.5
80/26.7	10.7-11.5	11.5-12.3	12.3-13.2	
90/32.2	10.8-11.6	11.6-12.5	12.5-13.4	
100/37.8	11.5-12.3	12.5-13.4	13.4-14.3	
110/43.3	12.3-13.2	13.4-14.3	14.4-15.5	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
-20/-28.9 to 70/21.1	930	870	820
80/26.7	915	860	810
90/32.2	906	850	800
100/37.8	860	800	750
110/43.3	810	750	700

Based on average ice slab weight of 7.75 - 8.25 lb.
Regular cube derate is 7%
Ratings with JC1095 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
-20/-28.9 to 50/10.0	220-250	40-22	180-200	65-90
70/21.1	225-250	40-22	190-200	70-90
80/26.7	240-260	42-22	190-205	70-90
90/32.2	255-265	44-22	195-205	70-90
100/37.8	275-295	44-24	200-210	70-90
110/43.3	280-320	46-26	200-225	75-100

Suction pressure drops gradually throughout the freeze cycle

Q1300 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	9.4-10.5	9.9-11.1	10.9-12.2	1-2.5
80/26.7	9.9-11.1	10.6-11.8	11.6-12.9	
90/32.2	11.0-12.3	11.5-12.8	12.8-14.2	
100/37.8	12.3-13.7	13.2-14.7	14.7-16.3	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	1320	1260	1160
80/26.7	1260	1190	1100
90/32.2	1150	1110	1010
100/37.8	1040	980	890

Based on average ice slab weight of 10.0 - 11.0 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	220-280	40-20	140-170	65-80
70/21.1	220-280	40-20	145-170	70-80
80/26.7	220-280	42-22	150-185	70-80
90/32.2	245-300	48-26	160-190	70-85
100/37.8	275-330	50-26	160-210	70-90
110/43.3	280-360	52-28	165-225	75-100

Suction pressure drops gradually throughout the freeze cycle

Q1300 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	9.0-10.1	9.8-10.9	11.4-12.6	1-2.5
80/26.7	9.1-10.1	9.8-11.0	11.6-12.9	
90/32.2	9.2-10.3	10.0-11.2	12.0-13.3	
100/37.8	9.4-10.5	10.1-11.3	12.2-13.6	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	1370	1280	1120
80/26.7	1360	1270	1100
90/32.2	1340	1250	1070
100/37.8	1320	1240	1050

Based on average ice slab weight of 10.0 - 11.0 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	1150	2220	7400

Water regulating valve set to maintain 230 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	235-245	40-18	150-180	70-80
70/21.1	235-245	40-18	150-180	70-80
80/26.7	235-245	40-20	150-180	70-80
90/32.2	235-250	42-20	150-180	70-80
100/37.8	235-255	44-20	150-180	70-80
110/43.3	240-265	46-20	150-180	70-80

Suction pressure drops gradually throughout the freeze cycle

Q1300 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
-20/-28.9 to 70/ 21.1	9.9-11.1	10.9-12.2	11.7-13.0	1-2.5
80/26.7	10.0-11.2	11.0-12.3	11.1-12.4	
90/32.2	10.1-11.3	11.1-12.4	10.7-11.9	
100/37.8	10.8-12.0	11.8-13.2	12.8-14.2	
110/43.3	11.7-13.0	12.9-14.3	13.8-15.4	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
-20/-28.9 to 70/21.1	1260	1160	1090
80/26.7	1250	1150	1140
90/32.2	1240	1140	1180
100/37.8	1170	1080	1010
110/43.3	1090	1000	940

Based on average ice slab weight of 10.0 - 11.0 lb.
Regular cube derate is 7%
Ratings with JC1395 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
-20/-28.9 to 50/10.0	220-250	40-22	135-170	75-95
70/21.1	240-260	40-22	140-180	80-95
80/26.7	240-270	41-22	140-190	80-95
90/32.2	250-290	42-22	140-200	80-95
100/37.8	280-320	46-22	140-210	80-95
110/43.3	310-360	48-24	140-220	85-100

Suction pressure drops gradually throughout the freeze cycle

Q1600 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	7.2-8.1	8.0-9.0	8.9-9.9	1-2.5
80/26.7	7.3-8.2	8.1-9.1	9.2-10.2	
90/32.2	7.4-8.2	8.2-9.1	9.6-10.7	
100/37.8	7.4-8.3	8.4-9.4	9.7-10.8	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	1650	1510	1390
80/26.7	1635	1500	1350
90/32.2	1625	1490	1300
100/37.8	1620	1450	1290
70/21.1	1650	1510	1390

Based on average ice slab weight of 10.0 - 11.0 lb.
Ratings with JC1395 condenser, dice or half-dice cubes

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	1400	2235	6500

Water regulating valve set to maintain 240 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
-20/-28.9 to 50/10.0	235-245	48-24	145-170	70-90
70/21.1	235-265	52-26	150-175	70-90
80/26.7	235-270	52-26	150-175	75-95
90/32.2	235-280	52-28	155-180	75-95
100/37.8	240-285	52-28	155-180	80-100
110/43.3	240-290	54-28	155-185	80-100

Suction pressure drops gradually throughout the freeze cycle

Q1600 Series - Remote

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
-20 to 70 -29 to 21.1	7.5-8.4	8.2-9.2	9.0-10.1	1 - 2.5
90/32.2	8.0-8.9	8.6-9.6	9.2-10.3	
100/37.8	8.4-9.3	9.2-10.2	9.7-10.8	
110/43.3	9.2-10.3	10.0-11.2	10.4-11.6	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
-20 to 70 -29 to 21.1	1600	1478	1370
90/32.2	1523	1425	1340
100/37.8	1460	1350	1290
110/43.3	1343	1250	1213

Based on average ice slab weight of 13.0 - 14.12 lb.
Ratings with JC1895 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
-20 to 50/-29 to 10.0	220-255	52-26	100-120	70-85
70/21.1	250-270	56-28	110-120	75-90
80/26.7	250-275	56-28	110-120	75-90
90/32.2	255-285	56-28	110-120	80-90
100/37.8	270-310	56-30	115-130	80-95
110/43.3	305-350	58-32	120-135	80-100

Suction pressure drops gradually throughout the freeze cycle

Q1800 Series - Self-Contained Air-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	8.5-9.3	9.4-10.3	9.9-10.9	1-2.5
80/26.7	9.0-9.9	9.8-10.8	10.5-11.5	
90/32.2	9.6-10.5	10.4-11.5	11.1-12.2	
100/37.8	10.6-11.6	11.5-12.6	12.4-13.6	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	1880	1720	1640
80/26.7	1780	1650	1560
90/32.2	1690	1570	1480
100/37.8	1550	1440	1350

Based on average ice slab weight of 13.0 - 14.12 lb.
Regular cube derate is 7%

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
50/10.0	220-280	40-20	155-190	60-80
70/21.1	220-280	40-20	160-190	65-80
80/26.7	230-290	42-20	160-190	65-80
90/32.2	260-320	44-22	185-205	70-90
100/37.8	300-360	46-24	210-225	75-100
110/43.3	320-400	48-26	215-240	80-100

Suction pressure drops gradually throughout the freeze cycle

Q1800 Series - Self-Contained Water-Cooled

Characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Around Ice Machine °F/°C	Freeze Time			Harvest Time
	Water Temperature °F/°C			
	50/10.0	**70/21.1**	**90/32.2**	
70/21.1	8.7-9.6	9.6-10.5	10.8-11.9	1-2.5
80/26.7	9.0-9.9	9.6-10.6	10.8-11.9	
90/32.2	9.1-10.1	9.7-10.7	10.9-12.0	
100/37.8	9.2-10.1	9.8-10.7	11.1-12.1	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Around Ice Machine °F/°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
70/21.1	1840	1690	1520
80/26.7	1780	1680	1520
90/32.2	1760	1670	1510
100/37.8	1750	1660	1490

Based on average ice slab weight of 13.0 - 14.12 lb.
Regular cube derate is 7%

CONDENSER WATER CONSUMPTION

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C		
	50/10.0	**70/21.1**	**90/32.2**
Gal/24 hours	2000	2670	7750

Water regulating valve set to maintain 240 PSIG discharge pressure

OPERATING PRESSURES

Air Temp. Around Ice Machine °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	**Suction Pressure PSIG**	**Discharge Pressure PSIG**	**Suction Pressure PSIG**
50/10.0	235-245	36-20	170-190	65-80
70/21.1	235-245	38-20	170-190	65-80
80/26.7	235-245	40-20	170-190	65-80
90/32.2	235-250	42-22	175-190	65-80
100/37.8	235-255	44-22	175-190	65-80
110/43.3	235-260	46-22	175-190	65-80

Suction pressure drops gradually throughout the freeze cycle

Q1800 Series - Remote

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

Air Temp. Entering Condenser °F/°C	Freeze Time Water Temperature °F/°C			Harvest Time
	50/10.0	70/21.1	90/32.2	
-20/-28.9 to 70/21.1	9.1-10.0	9.8-10.8	10.7-11.7	1-2.5
80/26.7	9.3-10.2	10.1-11.1	10.9-12.0	
90/32.2	9.5-10.5	10.3-11.4	11.1-12.2	
100/37.8	10.1-11.1	11.1-12.2	11.9-13.0	
110/43.3	11.0-12.1	12.1-13.2	12.7-13.9	

Times in minutes

24 HOUR ICE PRODUCTION

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C		
	50/10.0	70/21.1	90/32.2
-20/-28.9 to 70/21.1	1770	1650	1540
80/26.7	1735	1615	1510
90/32.2	1700	1580	1480
100/37.8	1620	1480	1400
110/43.3	1500	1380	1320

Based on average ice slab weight of 13.0 - 14.12 lb.
Regular cube derate is 7%
Ratings with JC1895 condenser, dice or half-dice cubes

OPERATING PRESSURES

Air Temp. Entering Condenser °F/°C	Freeze Cycle		Harvest Cycle	
	Discharge Pressure PSIG	Suction Pressure PSIG	Discharge Pressure PSIG	Suction Pressure PSIG
-20/-28.9 to 50/10.0	220-250	38-24	160-180	60-80
70/21.1	220-260	40-24	170-180	60-80
80/26.7	250-270	48-24	175-190	70-90
90/32.2	250-280	50-24	180-200	80-90
100/37.8	270-300	52-28	205-215	80-95
110/43.3	300-350	54-28	205-230	80-100

Suction pressure drops gradually throughout the freeze cycle

REFRIGERANT RECOVERY/EVACUATION

Normal Self-Contained Model Procedures

Do not purge refrigerant to the atmosphere. Capture refrigerant using recovery equipment. Follow the manufacturer's recommendations.

Important

Manitowoc Ice, Inc. assumes no responsibility for the use of contaminated refrigerant. Damage resulting from the use of contaminated refrigerant is the sole responsibility of the servicing company.

Important

Replace the liquid line drier before evacuating and recharging. Use only a Manitowoc (OEM) liquid line filter-drier to prevent voiding the warranty.

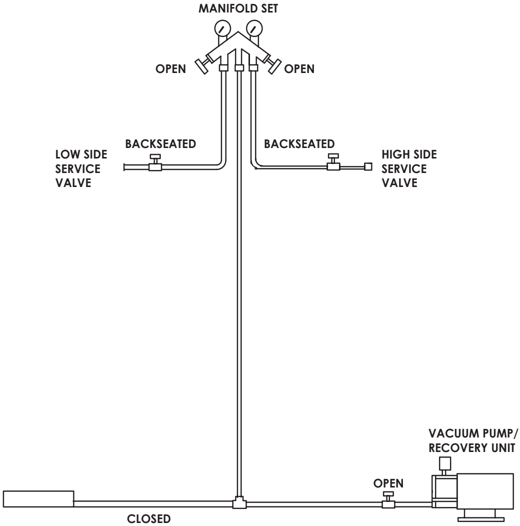
CONNECTIONS

Manifold gauge sets must utilize low loss fittings to comply with U.S. Government rules and regulations.
Make these connections:

- Suction side of the compressor through the suction service valve.
- Discharge side of the compressor through the discharge service valve.

SELF-CONTAINED RECOVERY/EVACUATION

1. Place the toggle switch in the OFF position.
2. Install manifold gauges, charging cylinder/scale, and recovery unit or two-stage vacuum pump.



RECOVERY/EVACUATION CONNECTIONS

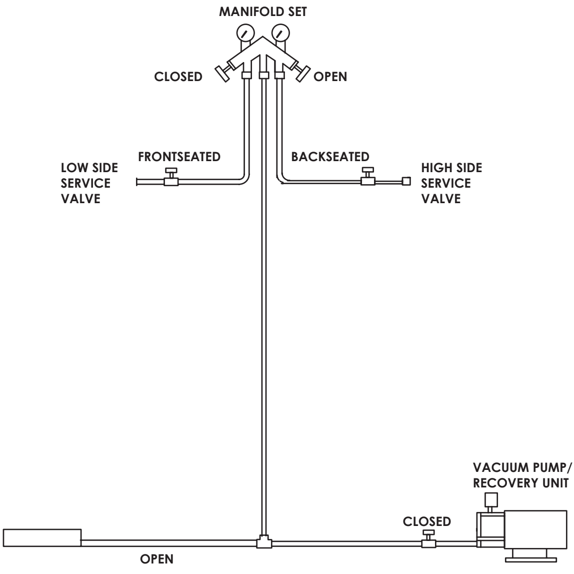
3. Open (backseat) the high and low side ice machine service valves if required, and open high and low side on manifold gauges.
4. Perform recovery or evacuation:
   A. Recovery: Operate the recovery unit as directed by the manufacturer’s instructions.
   B. Evacuation prior to recharging: Pull the system down to 250 microns. Then, allow the pump to run for an additional half hour. Turn off the pump and perform a standing vacuum leak check.
5. Follow the Charging Procedures.

SELF-CONTAINED CHARGING PROCEDURES

Important

The charge is critical on all Manitowoc ice machines. Use a scale or a charging cylinder to ensure the proper charge is installed.

1. Be sure the toggle switch is in the OFF position.



CHARGING CONNECTIONS

2. Close the vacuum pump valve, the low side service valve, and the low side manifold gauge valve.
3. Open the high side manifold gauge valve, and backseat the high side service valve.
4. Open the charging cylinder and add the proper refrigerant charge (shown on nameplate) through the discharge service valve.
5. Let the system "settle" for 2 to 3 minutes.
6. Place the toggle switch in the ICE position.
7. Close the high side on the manifold gauge set. Add any remaining vapor charge through the suction service valve (if necessary).

NOTE: Manifold gauges must be removed properly to ensure that no refrigerant contamination or loss occurs.

8. Make sure that all of the vapor in the charging hoses is drawn into the ice machine before disconnecting the charging hoses.
   A. Run the ice machine in freeze cycle.
   B. Close the high side service valve at the ice machine.
   C. Open the low side service valve at the ice machine.
   D. Open the high and low side valves on the manifold gauge set. Any refrigerant in the lines will be pulled into the low side of the system.
   E. Allow the pressures to equalize while the ice machine is in the freeze cycle.
   F. Close the low side service valve at the ice machine.
   G. Remove the hoses from the ice machine and install the caps.

Normal Remote Model Procedures

REFRIGERANT RECOVERY/EVACUATION

Do not purge refrigerant to the atmosphere. Capture refrigerant using recovery equipment. Follow the manufacturer's recommendations.

Important

Manitowoc Ice, Inc. assumes no responsibility for the use of contaminated refrigerant. Damage resulting from the use of contaminated refrigerant is the sole responsibility of the servicing company.

Important

Replace the liquid line drier before evacuating and recharging. Use only a Manitowoc (O.E.M.) liquid line filter drier to prevent voiding the warranty.

CONNECTIONS

Important

Recovery/evacuation of a remote system requires connections at four points for complete system evacuation.

Make these connections:

- Suction side of the compressor through the suction service valve.
- Discharge side of the compressor through the discharge service valve.
- Receiver outlet service valve, which evacuates the area between the check valve in the liquid line and the pump down solenoid.
- Access (Schraeder) valve on the discharge line quick-connect fitting, located on the outside of the compressor/evaporator compartment. This connection evacuates the condenser. Without it, the magnetic check valves would close when the

pressure drops during evacuation, preventing complete evacuation of the condenser.

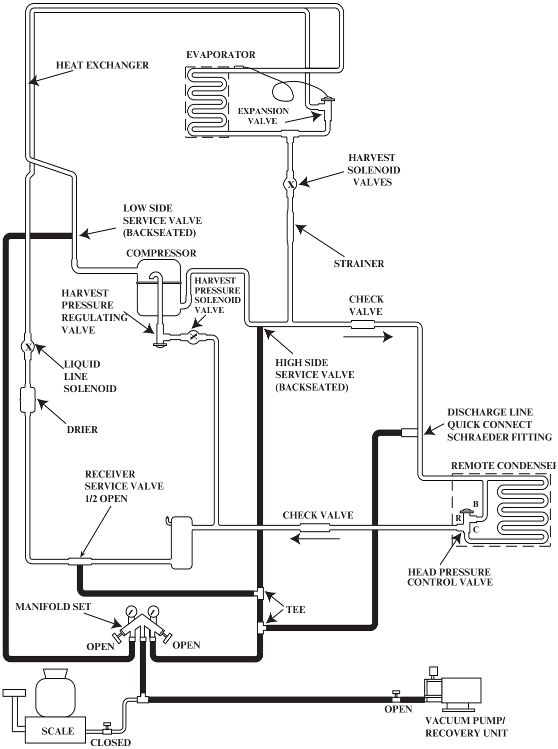
NOTE: Manitowoc recommends using an access valve core removal and installation tool on the discharge line quick-connect fitting. This permits access valve core removal. This allows for faster evacuation and charging, without removing the manifold gauge hose.

REMOTE RECOVERY/EVACUATION

1. Place the toggle switch in the OFF position.
2. Install manifold gauges, charging cylinder/scale, and recovery unit or two-stage vacuum pump.
3. Open (backseat) the high and low side ice machine service valves.
4. Open the receiver service valve halfway.
5. Open high and low side on the manifold gauge set.
6. Perform recovery or evacuation:
   A. Recovery: Operate the recovery unit as directed by the manufacturer’s instructions.
   B. Evacuation prior to recharging: Pull the system down to 250 microns. Then, allow the pump to run for an additional hour. Turn off the pump and perform a standing vacuum leak check.

NOTE: Check for leaks using a halide or electronic leak detector after charging the ice machine.

7. Follow the Charging Procedures.



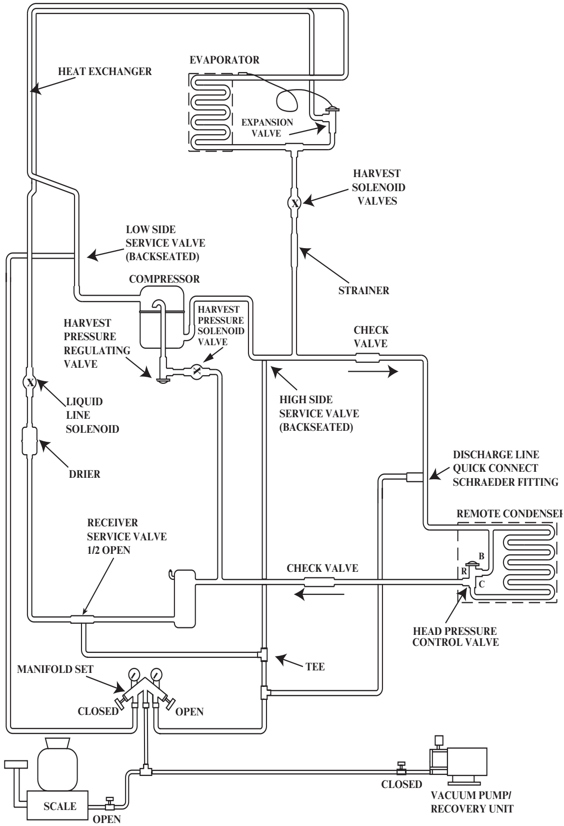
REMOTE RECOVERY/EVACUATION CONNECTIONS

REMOTE CHARGING PROCEDURES

1. Be sure the toggle switch is in the OFF position.
2. Close the vacuum pump valve, the low and high side service valves (frontseat), and the low side manifold gauge valve.
3. Open the charging cylinder and add the proper refrigerant charge (shown on nameplate) into the system high side (receiver outlet valve and discharge lines quick-connect fitting).
4. If the high side does not take the entire charge, close the high side on the manifold gauge set, and backseat (open) the low side service valve and receiver outlet service valve. Start the ice machine and add the remaining charge through the low side (in vapor form) until the machine is fully charged.
5. Ensure all vapor in charging hoses is drawn into the machine, then disconnect the manifold gauges.

NOTE: Backseat the receiver outlet service valve after charging is complete and before operating the ice machine. If the access valve core removal and installation tool is used on the discharge quick-connect fitting, reinstall the Schraeder valve core before disconnecting the access tool and hose.

6. Run the ice machine in freeze cycle.
7. Close the high side service valve at the ice machine.
8. Open the low side service valve at the ice machine.
9. Open the high and low side valves on the manifold gauge set. Any refrigerant in the lines will be pulled into the low side of the system.
10. Allow the pressures to equalize while the ice machine is in the freeze cycle.
11. Close the low side service valve at the ice machine.
12. Remove the hoses from the ice machine and install the caps.



REMOTE CHARGING CONNECTIONS

SYSTEM CONTAMINATION CLEAN-UP

General

This section describes the basic requirements for restoring contaminated systems to reliable service.

> **Important**
>
> Manitowoc Ice, Inc. assumes no responsibility for the use of contaminated refrigerant. Damage resulting from the use of contaminated refrigerant is the sole responsibility of the servicing company.

Determining Severity Of Contamination

System contamination is generally caused by either moisture or residue from compressor burnout entering the refrigeration system.

Inspection of the refrigerant usually provides the first indication of system contamination. Obvious moisture or an acrid odor in the refrigerant indicates contamination.

If either condition is found, or if contamination is suspected, use a Total Test Kit from Totaline or a similar diagnostic tool. These devices sample refrigerant, eliminating the need to take an oil sample. Follow the manufacturer's directions.

If a refrigerant test kit indicates harmful levels of contamination, or if a test kit is not available, inspect the compressor oil.

1. Remove the refrigerant charge from the ice machine.
2. Remove the compressor from the system.
3. Check the odor and appearance of the oil.
4. Inspect open suction and discharge lines at the compressor for burnout deposits.
5. If no signs of contamination are present, perform an acid oil test.

Check the chart on the next page to determine the type of cleanup required.

Contamination Cleanup Chart	
Symptoms/Findings	**Required Cleanup Procedure**
No symptoms or suspicion of contamination	Normal evacuation/recharging procedure
Moisture/Air Contamination symptoms • Refrigeration system open to atmosphere for longer than 15 minutes • Refrigeration test kit and/or acid oil test shows contamination • Leak in water cooled condenser • No burnout deposits in open compressor lines	Mild contamination cleanup procedure
Mild Compressor Burnout symptoms • Oil appears clean but smells acrid • Refrigeration test kit or acid oil test shows harmful acid content • No burnout deposits in open compressor lines	Mild contamination cleanup procedure
Severe Compressor Burnout symptoms • Oil is discolored, acidic, and smells acrid • Burnout deposits found in the compressor, lines, and other components	Severe contamination cleanup procedure

Cleanup Procedure

MILD SYSTEM CONTAMINATION

1. Replace any failed components.
2. If the compressor is good, change the oil.
3. Replace the liquid line drier.

NOTE: If the contamination is from moisture, use heat lamps during evacuation. Position them at the compressor, condenser and evaporator prior to evacuation. Do not position heat lamps too close to plastic components, or they may melt or warp.

> **Important**
>
> Dry nitrogen is recommended for this procedure. This will prevent CFC release.

4. Follow the normal evacuation procedure, except replace the evacuation step with the following:
   A. Pull vacuum to 1000 microns. Break the vacuum with dry nitrogen and sweep the system. Pressurize to a minimum of 5 psig (35 kPa).
   B. Pull vacuum to 500 microns. Break the vacuum with dry nitrogen and sweep the system. Pressurize to a minimum of 5 psig (35 kPa).
   C. Change the vacuum pump oil.
   D. Pull vacuum to 250 microns. Run the vacuum pump for 1/2 hour on self-contained models, 1 hour on remotes.

NOTE: You may perform a standing vacuum test to make a preliminary leak check. You should use an electronic leak detector after system charging to be sure there are no leaks.

5. Charge the system with the proper refrigerant to the nameplate charge.
6. Operate the ice machine.

SEVERE SYSTEM CONTAMINATION

1. Remove the refrigerant charge.
2. Remove the compressor.
3. Disassemble the harvest solenoid valve. If burnout deposits are found inside the valve, install a rebuild kit, and replace the manifold strainer, TXV and harvest pressure regulating valve.
4. Wipe away any burnout deposits from suction and discharge lines at compressor.
5. Sweep through the open system with dry nitrogen.

Important

Refrigerant sweeps are not recommended, as they release CFCs into the atmosphere.

6. Install a new compressor and new start components.
7. Install a suction line filter-drier with acid and moisture removal capability (P/N 89-3028-3). Place the filter drier as close to the compressor as possible.
8. Install an access valve at the inlet of the suction line drier.
9. Install a new liquid line drier.

Important

Dry nitrogen is recommended for this procedure. This will prevent CFC release.

10. Follow the normal evacuation procedure, except replace the evacuation step with the following:
    A. Pull vacuum to 1000 microns. Break the vacuum with dry nitrogen and sweep the system. Pressurize to a minimum of 5 psig (35 kPa).
    B. Change the vacuum pump oil.
    C. Pull vacuum to 500 microns. Break the vacuum with dry nitrogen and sweep the system. Pressurize to a minimum of 5 psig (35 kPa).
    D. Change the vacuum pump oil.
    E. Pull vacuum to 250 microns. Run the vacuum pump for 1/2 hour on self-contained models, 1 hour on remotes.

NOTE: You may perform a standing vacuum test to make a preliminary leak check. You should use an electronic leak detector after system charging to be sure there are no leaks.

11. Charge the system with the proper refrigerant to the nameplate charge.
12. Operate the ice machine for one hour. Then, check the pressure drop across the suction line filter-drier.
    A. If the pressure drop is less than 1 psig, the filter-drier should be adequate for complete cleanup.
    B. If the pressure drop exceeds 1 psig (7 kPa), change the suction line filter-drier and the liquid line drier. Repeat until the pressure drop is acceptable.
13. Operate the ice machine for 48-72 hours. Then remove the suction line drier and change the liquid line drier.
14. Follow normal evacuation procedures.

Replacing Pressure Controls Without Removing Refrigerant Charge

This procedure reduces repair time and cost. Use it when any of the following components require replacement, and the refrigeration system is operational and leak-free.

- Fan cycle control (air cooled only)
- Water regulating valve (water cooled only)
- High pressure cut-out control
- High side service valve
- Low side service valve

> **Important**
>
> This is a required in-warranty repair procedure.

1. Disconnect power to the ice machine.
2. Follow all manufacturer's instructions supplied with the pinch-off tool. Position the pinch-off tool around the tubing as far from the pressure control as feasible. (See the figure on next page.) Clamp down on the tubing until the pinch-off is complete.

> **⚠ Warning**
>
> Do not unsolder a defective component. Cut it out of the system. Do not remove the pinch-off tool until the new component is securely in place.

3. Cut the tubing of the defective component with a small tubing cutter.
4. Solder the replacement component in place. Allow the solder joint to cool.
5. Remove the pinch-off tool.
6. Re-round the tubing. Position the flattened tubing in the proper hole in the pinch-off tool. Tighten the wing nuts until the block is tight and the tubing is rounded.

NOTE: The pressure controls will operate normally once the tubing is re-rounded. Tubing may not re-round 100%.

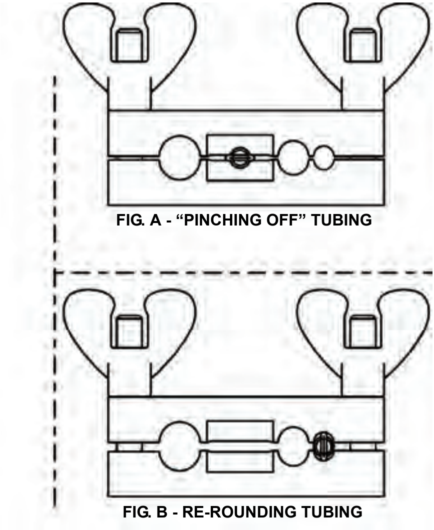


FIG. A - "PINCHING OFF" TUBING

FIG. B - RE-ROUNDING TUBING

SV1406

USING PINCH-OFF TOOL

Filter-Driers

The filter-driers used on Manitowoc ice machines are manufactured to Manitowoc specifications.

The difference between a Manitowoc drier and an off-the-shelf drier is in filtration. A Manitowoc drier has dirt-retaining filtration, with fiberglass filters on both the inlet and outlet ends. This is very important because ice machines have a back-flushing action that takes place during every harvest cycle.

A Manitowoc filter-drier has a very high moisture removal capability and a good acid removal capacity.

The size of the filter-drier is important. The refrigerant charge is critical. Using an improperly sized filter-drier will cause the ice machine to be improperly charged with refrigerant.

Listed below is the recommended OEM field replacement drier:

Liquid Line Driers			
Model	**Drier Size**	**End Connection Size**	**Part Number**
Self-Contained Air and Water Cooled Q200 /Q280/Q320 Q370/Q420/Q450 Q600/Q800/Q1000	UK-032S	1/4 in.	89-3025-3
Remote Air Cooled Q450/Q600 Q800/Q1000	UK-083S	3/8 in.	89-3027-3
All Condenser Type Q1300/Q1600 Q1800	UK-083S	3/8 in.	82-3027-3
*Suction Filter	UK-165S	5/8 in.	89-3028-3

*Used when cleaning up severely contaminated systems

Important

Driers are covered as a warranty part. The drier must be replaced any time the system is opened for repairs.

Total System Refrigerant Charge

Important

This information is for referance only. Refer to the ice machine serial number tage to verify the system charge. Serial plate information overrides information listed on this page.

Series	Version	Charge
Q200	Air-Cooled	18 oz.
	Water-Cooled	15 oz.
Q280	Air-Cooled	18 oz
	Water-Cooled	15 oz
Q320	Air-Cooled	20 oz.
	Water-Cooled	16 oz.
Q370	Air-Cooled	20 oz.
	Water-Cooled	17 oz.
Q420/Q450	Air-Cooled	24 oz.
	Water-Cooled	22 oz.
	Remote	6 lb.
Q600	Air-Cooled	28 oz.
	Water-Cooled	22 oz.
	Remote	8 lb.
Q800	Air-Cooled	36 oz.
	Water-Cooled	25 oz.
	Remote	8 lb.
Q1000	Air-Cooled	38 oz.
	Water-Cooled	32 oz.
	Remote	9.5 lb.
Q1300	Air-Cooled	48 oz.
	Water-Cooled	44 oz.
	Remote	12.5 lb.
Q1600	Water-Cooled	46 oz.
	Remote	15 lb.
Q1800	Air-Cooled	56 oz.
	Water-Cooled	46 oz.
	Remote	15 lb.

**The ice machine serial number plate overrides any amounts listed on this chart.

ADDITIONAL REFRIGERANT CHARGES

For Line Sets Between 50’ - 100’.

Ice Machine	**Nameplate Charge**	**Refrigerant to be Added for 50'-100' Line Sets**	**Maximum System Charge** Never Exceed
Q490	6 lb. (96 oz.)	None	6 lb. (96 oz.)
Q690	8 lb. (128 oz.)	None	8 lb. (128 oz.)
Q890	8 lb. (128 oz.)	None	8 lb. (128 oz.)
Q1090	9.5 lb. (152 oz.)	None	9.5 lb. (152 oz.)
Q1390	12.5 lb. (200 oz.)	1.5 lb. (24 oz.)	14 lb. (224 oz.)
Q1690	15 lb. (240 oz.)	2.0 lb. (32 oz.)	17 lb. (272 oz.)
Q1890	15 lb. (240 oz.)	2.0 lb. (32 oz.)	17 lb. (272 oz.)

Factory School

- Improve Your Service Techniques.
- 4 1/2 Days of Intensive Training on Manitowoc Ice Machines.
- Contact Your Distributor for Dates and Further Information.

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