KOOLAIRE®

E Model Ice Machines

Technician's Handbook

This manual is updated as new information and models are released. Visit our website for the latest manual.
http://www.Welbilt.cn

America's #1 Selling Ice Machine

Part Number 040005957 12/17

Safety Notices

As you work on Manitowoc equipment, 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 equipment.

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 situation in which you could damage the equipment. Be sure to read the Caution statement before proceeding, and work carefully.

Procedural Notices

As you work on Manitowoc equipment, be sure to read the procedural notices in this handbook. These notices supply helpful information which 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 it 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 performance and trouble-free operation of your Manitowoc equipment. If you encounter problems not covered by this handbook, do not proceed, contact Manitowoc Foodservice Group. We will be happy to provide assistance.

Important

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

⚠ 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

POTENTIAL PERSONAL INJURY SITUATION

This ice machine 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 US Government Environmental Protection Agency (EPA) certified in proper refrigerant handling and servicing procedures.

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

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Section 1
General Information

Model Numbers

This manual covers the following models:

Self-Contained Air-Cooled	Self-Contained Water-Cooled
E460A Series	E460W Series
E660A Series	E660W Series
E1060A Series	E1060W Series

E460A Series, Such as ES0462A-251

E660A Series, Such as ES0662A-251

E1060A Series, Such as ES1062A-251

E460W Series, Such as ES0463W-251

E660W Series, Such as ES0663W-251

E1060W Series, Such as ES1063W-251

Accessories

Contact your Manitowoc distributor for these optional accessories:

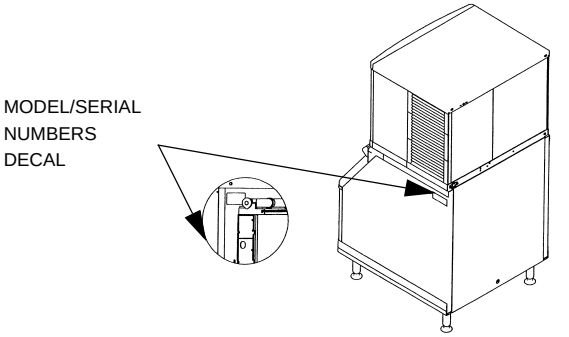
CLEANER AND SANITIZER

Manitowoc Ice Machine Cleaner and Sanitizer are available in convenient 16 oz. (473 ml) and 1 gal (3.78 l) bottles. These are the only cleaner and sanitizer approved for use with Manitowoc products.

Cleaner Part Number		Sanitizer Part Number	
16 0z.	000005162	16 0z.	94-0565-3
1 Gallon	94-0580-3	1 Gallon	94-0581-3

Model/Serial Number Location

Record the model and serial number of your ice machine and bin in the space provided below. These numbers are required when requesting information from your local Manitowoc distributor, or Manitowoc Ice, Inc.



Model/Serial Number Location

	Ice Machine	Bin
Model Number		
Serial Number		

Owner Warranty Registration Card

GENERAL

Warranty coverage begins the day your new ice machine is installed.

Important

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

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

COMMERCIAL WARRANTY COVERAGE

General

The following Warranty outline is provided for your convenience.

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

Parts

Manitowoc warrants the ice machine against defects in materials and workmanship, under normal use and service for one (1) years from the date of original installation.

Labor

Labor required to repair or replace defective components is covered for one (1) years from the date of 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.

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.

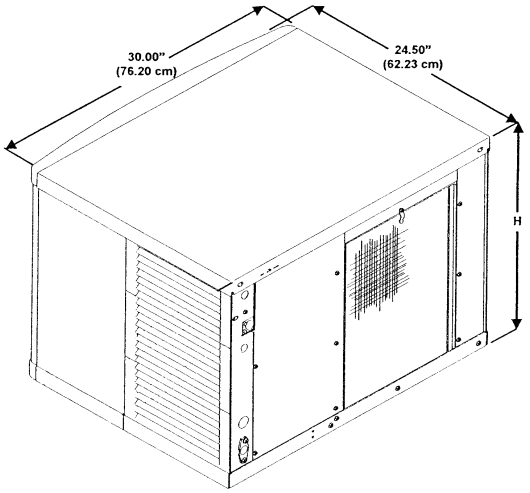
NOTE: If the dealer you purchased the ice machine from is not authorized to perform warranty service, contact your Manitowoc distributor or Manitowoc Ice, Inc. for the name of the nearest authorized service representative.

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 authorized service company.

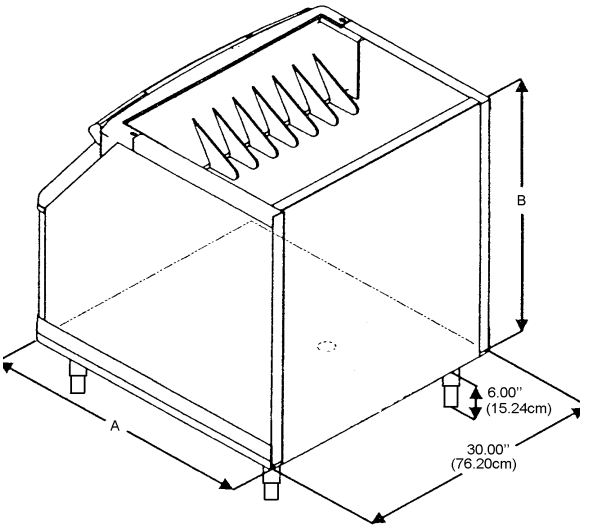
Section 2
Installation Instructions

Ice Machine Dimensions



Ice Machine	Dimension H
E460	54.6cm
E660	54.6cm
E1060	74.9cm

Ice Storage Bin Dimensions



Bin Model	Dimension A	Dimension B
E400C	86.30 cm	81.30 cm
E570C	88.90 cm	111.80 cm

Location of Ice Machine

The location selected for the ice machine 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 Clearance Requirements

	Self-Contained Air-Cooled	Self-Contained Water-Cooled*
Top/Sides	203 mm	203 mm
Back	127 mm	127 mm

*There is no minimum clearance required for water-cooled or remote ice machines. This value is recommended for efficient operation and servicing only.

Ice Machine Heat of Rejection

Series Ice Machine	Heat of Rejection*	
	Air Conditioning**	Peak
E460	7,000	9,600
E660	9,000	13,900
E1060	16,000	24,700

* B.T.U./Hour

** Because the heat of rejection varies during the ice making cycle,
the figure shown is an average.

Ice machines, like other refrigeration equipment, reject heat through the condenser. It is helpful to know the amount of heat rejected by the ice machine when

sizing air conditioning equipment where self-contained air-cooled ice machines are installed.

Leveling the Ice Storage Bin

⚠ Warning

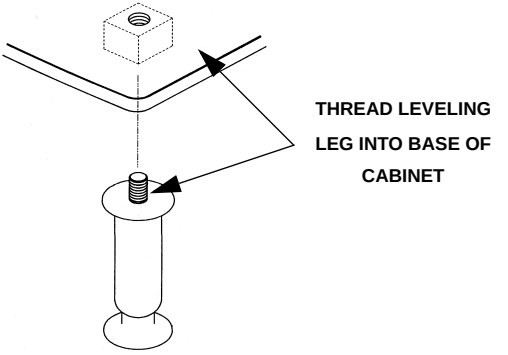
To avoid a hazard due to instability of the appliance, it must be fixed according to the instructions.

1. Screw the leveling legs onto the bottom of the bin.
2. Screw the foot of each leg in as far as possible.

⚠ Caution

The legs must be screwed in tightly to prevent them from bending.

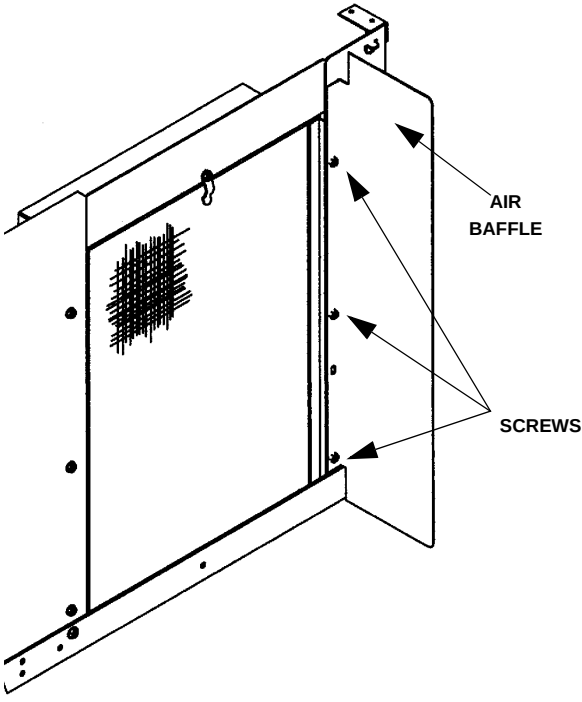
3. Move the bin into its final position.
4. Level the bin to assure that the bin door closes and seals properly. Use a level on top of the bin. Turn each foot as necessary to level the bin.



Air-Cooled Baffle(Air-cooled only)

The air-cooled baffle prevents condenser air from recirculating. To install:

1. Remove the back panel screws next to the condenser.
2. Align the mounting holes in the air baffle with the screw holes and reinstall the screws



Electrical Service

GENERAL

An electrical disconnect switch must be provided if the ice machine is hard wired (wired without a plug).

⚠ Warning

RISK OF ELECTRICAL SHOCK

FOR HARD WIRED(WIRED WITHOUT A PLUG) MACHINE, IT MUST BE PROPERLY GROUNDED AND CONNECTED TO THE FIELD WIRING TERMINAL IN ACCORDANCE WITH ALL APPLICABLE NATIONAL AND LOCAL ELECTRICAL CODES BY A QUALIFIED ELECTRICIAN. BEFORE CONNECTING WIRES, DISCONNECT POWER AT THE ELECTRICAL DISCONNECT AND LOCK OUT TO PREVENT ACCIDENTALLY ENERGIZING.CONNECT ALL ELECTRICAL WIRING BEFORE USE - DO NOT ENERGIZE ICE MACHINE UNTIL INSTALLATION IS COMPLETE.

1. Connect –the three supply lead wires (Blue, Brown, and Yellow/Green) to the field wiring terminal, “L”, “N”, and “G”, the Yellow/Green wire must connect to the “G” (ground).
2. After connecting the wiring to the terminal strip, the supply lead must be secured to the cabinet with a strain relief near the terminal strip.
3. Verify wiring is contained in the electrical wiring box.

Important

If the supply cord is damaged, it must be replaced by the manufacturer or its service agent or a similarly qualified person in order to avoid a hazard.

⚠ Warning

All wiring must conform to local, state and national codes.

VOLTAGE

The maximum allowable voltage variation is ±10% of the rated voltage at ice machine start-up (when the electrical load is highest).

FUSE/CIRCUIT BREAKER

A separate fuse/circuit breaker must be provided for each ice machine. Circuit breakers must be H.A.C.R. rated (does not apply in Canada).

⚠ Warning

The ice machine must be grounded in accordance with national and local electrical codes.

MINIMUM CIRCUIT AMPACITY

The minimum circuit ampacity is used to help select the wire size of the electrical supply. (Minimum circuit ampacity is not the ice machine's running amp load.)

The wire size (or gauge) is also dependent upon location, materials used, length of run, etc., so it must be determined by a qualified electrician.

E460/E660/E1060

Model	Voltage Phase Cycle	Self-Contained Air-cooled	Self-Contained Water-cooled
		Minimum Circuit Amps	Minimum Circuit Amps
E460	220-240/1/50	6.7	6.0
E660	220-240/1/50	9.2	7.0
E1060	220-2401/50	15.6	13.0

Electrical Wiring Connections

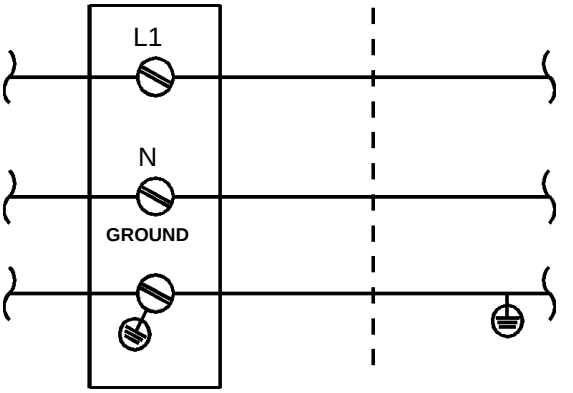
⚠ Warning

These diagrams are not intended to show proper wire routing, wire sizing, disconnects, etc., only the correct wire connections.

All electrical work, including wire routing and grounding, must conform to local, state and national electrical codes.

Though wire nuts are shown in the drawings, the ice machine field wiring connections may use either wire nuts or screw terminals.

SELF CONTAINED ICE MACHINE220/1/50



Water Supply and Drain Requirements

WATER SUPPLY

⚠ Warning

Connect to potable water supply only.

Local water conditions may require treatment of the water to inhibit scale formation, filter sediment, and remove chlorine odor and taste.

Important

If you are installing a Manitowoc water filter system, refer to the Installation Instructions supplied with the filter system for ice making water inlet connections.

WATER INLET LINES

Follow these guidelines to install water inlet lines:

- Do not connect the ice machine to a hot water supply. Be sure all hot water restrictors installed for other equipment are working. (Check valves on sink faucets, dishwashers, etc.)
- If water pressure exceeds the maximum recommended pressure(80 psig-551.5 kPA) , obtain a water pressure regulator from your Manitowoc distributor.
- Contact your distributor if your water pressure is greater than 150 psig (10.34 bar).
- Install a water shut-off valve for both the ice making and condenser water lines.
- Insulate water inlet lines to prevent condensation.

DRAIN CONNECTIONS

Follow these guidelines when installing drain lines to prevent drain water from flowing back into the ice machine and storage bin:

- Drain lines must have a 1.5 inch drop per 5 feet of run (2.5 cm per meter), and must not create traps.
- The floor drain must be large enough to accommodate drainage from all drains.
- Run separate bin and ice machine drain lines. Insulate them to prevent condensation.
- Vent the bin and ice machine drain to the atmosphere. Do not vent the condenser drain on water-cooled models.

⚠ Warning

The new hose-sets supplied with the appliance are to used and that old hose-sets should not be reused.

WATER SUPPLY AND DRAIN LINE SIZING/CONNECTIONS

⚠ Warning

Plumbing must conform to state and local codes.

Location	Water Temperature	Water Pressure	Ice Machine Fitting
Ice Making Water Inlet	33°F (0.6°C) Min. 90°F (32.2°C) Max.	20 psi (137.9 kPA) Min. 80 psi (551.5 kPA) Max.	3/8" Female Pipe Thread
Ice Making Water Drain	---	---	1/2" Female Pipe Thread
Condenser Water Inlet	90°F (32.2°C) Max.	20 psi (137.9 kPA) Min. 150 psi (1034.2 kPA) Max.	3/8" Female Pipe Thread
Condenser Water Drain	---	---	1/2" Female Pipe Thread
Bin Drain	---	---	3/4" Female Pipe Thread

Installation Check List

- [ ] Is the Ice Machine level?
- [ ] Has all of the internal packing been removed?
- [ ] Have all of the electrical and water connections been made?
- [ ] Has the supply voltage been tested and checked against the rating on the nameplate?
- [ ] Is there proper clearance around the ice machine for air circulation?
- [ ] Are the ice machine and bin drains vented?
- [ ] Has the ice machine been installed where ambient temperatures will remain in the range of 5° - 43°C?
- [ ] Has the ice machine been installed where the incoming water temperature will remain in the range of 33° - 90°F (0.6° - 32.2°C)?
- [ ] Are all electrical leads free from contact with refrigeration lines and moving equipment?

☐ Has the owner/operator been instructed regarding maintenance and the use of Manitowoc Cleaner and Sanitizer?

☐ Has the owner/operator completed the warranty registration card?

☐ Is the toggle switch set to ice?

Before Starting the Ice Machine

All Manitowoc ice machines are factory-operated and adjusted before shipment. Normally, new installations do not require any adjustment.

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

⚠ Warning

PERSONAL INJURY POTENTIAL

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

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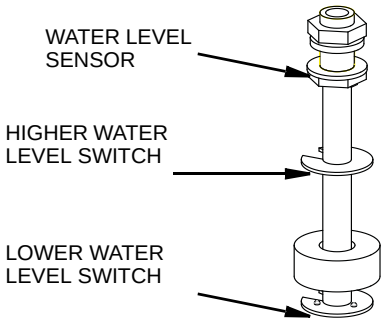
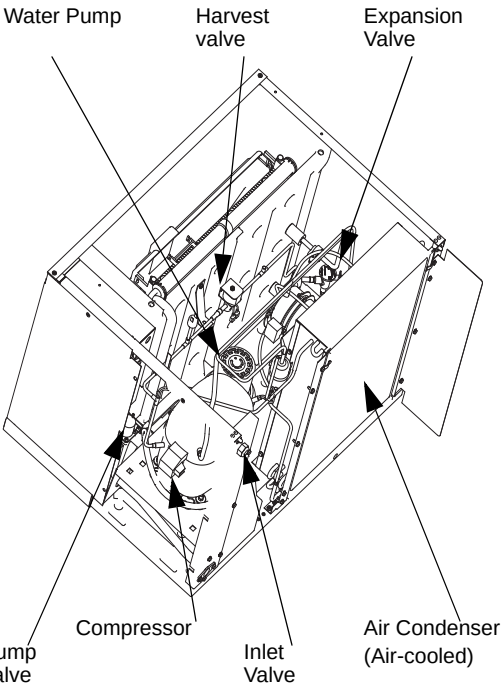
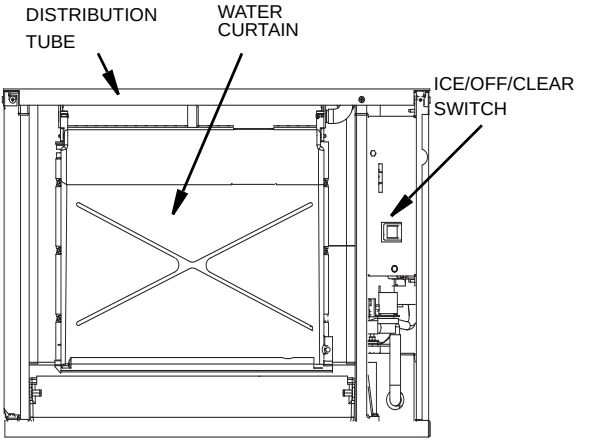
Section 3
Ice Machine Operation

Component identification







Operation Procedure

INITIAL START-UP OR START-UP AFTER AUTOMATIC SHUT-OFF

1. Initial Water Inlet and Purge

Put the toggle switch to “ICE” position, the water inlet valve is energized until the higher water level switch closes.Then water pump and dump valve are energized until lower water level switch closes.

2. Water Inlet Before Ice Making

After the initial water inlet and purge, water inlet valve is energized until the higher water level switch closes.

The hot gas valve is also energized during water inlet to balance the system pressure.

3. Refrigeration System Start-up

At 45 seconds after water inlet valve and hot gas valve energize, compressor and condenser fan motor are supplied with power.

4. Pre-chill

5 seconds later, hot gas valve is de-energized, and ice machine goes into pre-chill process for 30 seconds,

then water pump is energized and ice machine starts ice making.

5. Freeze

An even flow of water is directed across the evaporator and into each cube cell, where it freezes. When sufficient ice has formed, the lower water level switch closes, 2 minutes later, the harvest sequence is initiated.

6. Harvest Sequence

The water pump continues to run, and the water dump valve energizes to purge the water in the sump trough. After 15 seconds, water pump and dump valve de-energizes, then water inlet valve energizes until the higher water level switch closes.

The harvest valve also opens at the beginning of the water purge to divert hot refrigerant gas into the evaporator. 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 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

Sequence	Step	1 Water Pump	2 Water Inlet	3 Hot Gas	4 Dump Valve	5 Fan Motor	6 Compr es-sor	7 Length
INITIAL START-UP OR START-UP AFTER AUTOMATIC SHUT-OFF	Initial Water Inlet	OFF	ON	OFF	OFF	OFF	OFF	until higher water level switch closes
	Initial Water Purge	ON	OFF	OFF	ON	OFF	OFF	until lower water level switch closes
	Water Inlet Before Ice	OFF	ON	ON	OFF	OFF	OFF	until higher water level switch closes
	Refrigeration System Start-up	OFF	ON	ON	OFF	ON	ON	5 seconds
FREEZING SEQUENCE	Pre-chill	OFF	ON	OFF	OFF	ON	ON	30 seconds
	Freeze	ON	OFF	OFF	OFF	ON	ON	until lower water level switch closes
HARVEST SEQUENCE	Water Purge	ON	OFF	ON	ON	ON/OFF	ON	15 seconds
	Harvest	OFF	ON	ON	OFF	ON/OFF	ON	bin switch activation
AUTOMATIC SHUT-OFF		OFF	OFF	OFF	OFF	OFF	OFF	until bin switch re-close and 3 minutes delay completed

Condenser Fan Motor(Air-cooled only): The fan motor is wired through a fan cycle pressure control, therefore, it may cycle on and off.

Operational Checks

GERNERAL

Your ice machine was factory-operated and adjusted before shipment. Normally, a newly installed ice machine does not require any adjustment.

To ensure proper operation, always follow these Operational Checks when starting the ice machine:

- for the first time
- after a prolonged out of service period
- after cleaning and sanitizing

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

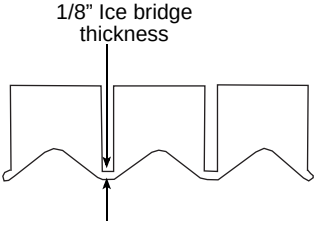
Important

It is recommended that adjustments made to this ice machine be made by a qualified technician. Improper adjustment, may seriously affect the life of this ice machine.

ICE CUBE THICKNESS CHECK

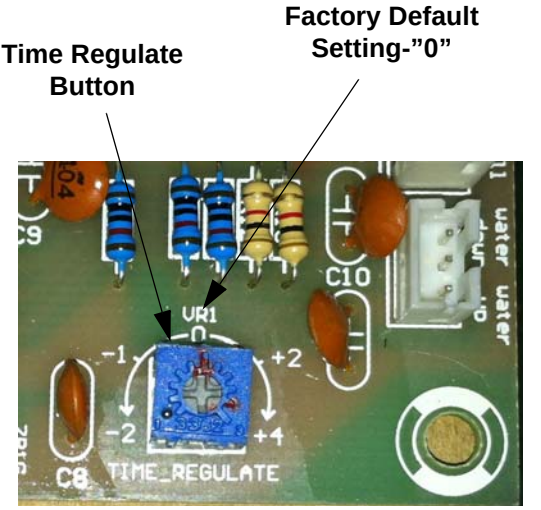
The TIME REGULATE is factory-set to maintain the ice bridge thickness at 1/8 in. (3.2 mm).

1. Inspect the bridge connecting the cubes. It should be about 1/8 in. (3.2 mm) thick.



2. If adjustment is necessary,remove the front panel and the contral box cover, find the TIME REGULATE button on the contral board.Turn the TIME REGULATE button clockwise to increase

bridge thickness or counterclockwise to decrease bridge thickness.



3. After completing the procedure above, if you are unable to obtain a right ice thickness contact the Manitowoc Service Department for further assistance.

Section 4
Maintenance

Interior Cleaning and Sanitizing

GENERAL

Clean and sanitize the ice machine every six months for efficient operation. If the ice machine requires more frequent cleaning and sanitizing, consult a qualified service company to test the water quality and recommend appropriate water treatment. The ice machine must be taken apart for cleaning and sanitizing.

⚠ Caution

Use only Manitowoc approved Ice Machine Cleaner and Sanitizer for this application (Manitowoc Cleaner part number 94-0546-3 and Manitowoc Sanitizer part number 94-0565-3). It is a violation of Federal law to use these solutions in a manner inconsistent with their labeling. Read and understand all labels printed on bottles before use.

CLEANING PROCEDURE

⚠ Caution

Do not mix Cleaner and Sanitizer solutions together. It is a violation of Federal law to use these solutions in a manner inconsistent with their labeling.

⚠ Warning

Wear rubber gloves and safety goggles (and/or face shield) when handling ice machine Cleaner or Sanitizer.

Ice machine cleaner is used to remove lime scale and mineral deposits.

Ice machine sanitizer disinfects and removes algae and slime.

Step 1 Set the toggle switch to the OFF position after ice falls from the evaporator at the end of a Harvest cycle. Or, set the switch to the OFF position and allow the ice to melt off the evaporator.

> **⚠ Caution**
>
> Never use anything to force ice from the evaporator. Damage may result.

Step 2 Remove all ice from the bin.

Step 3 Place the toggle switch in the CLEAN position. Wait until the water flows over the evaporator, then add the proper amount of ice machine cleaner.

Model	Amount of Cleaner
E460/E660	150 ml
E1060	265 ml

Step 4 Wait until the clean cycle is complete (approximately 25 minutes) then place the toggle switch in the OFF position and disconnect power to the ice machine.

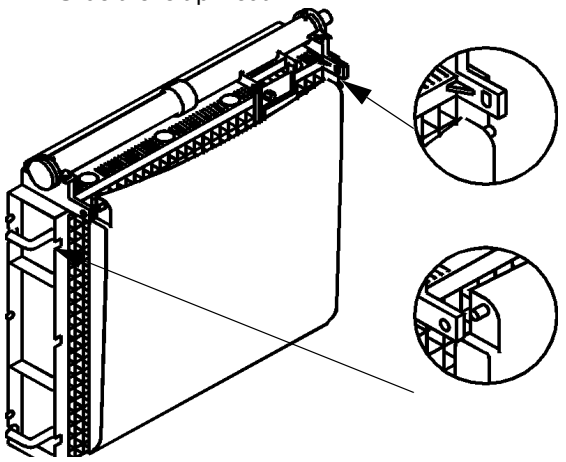
> **⚠ Warning**
>
> Disconnect the electric power to the ice machine at the electric service switch box.

Step 5 Remove parts for cleaning and hand sanitizing.

A. Remove the water curtain

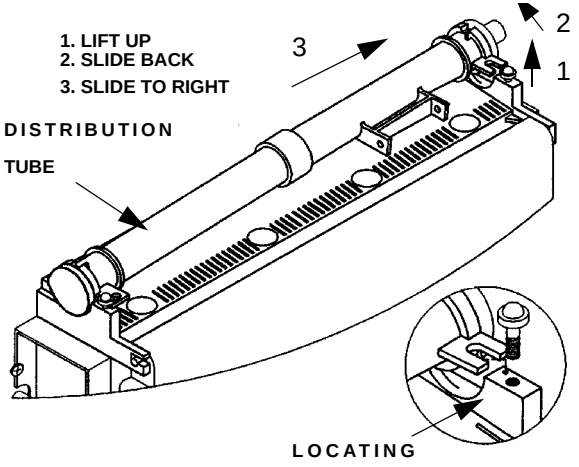
- Gently flex the curtain in the center and remove it from the right side.

- Slide the left pin out.



B. Remove the water distribution tube

- Disconnect the water hose from the distribution tube.



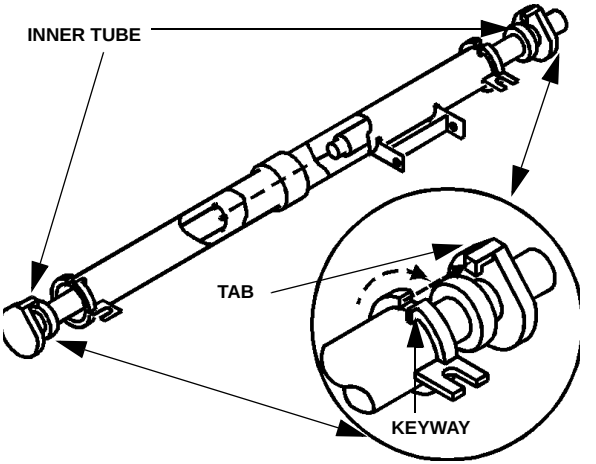
- Loosen the two thumbscrews which secure the distribution tube.

- Lift the right side of the distribution tube up off the locating pin, then slide it back and to the right.

> **⚠ Caution**
>
> Do not force this removal. Be sure the locating pin is clear of the hole before sliding the distribution tube out.

Disassemble for cleaning.

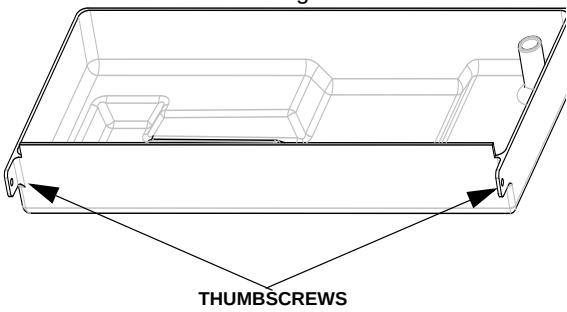
- Twist both of the inner tube ends until the tabs line up with the key ways.
- Pull the inner tube ends outward.



C. Remove the water trough

- Remove the two thumbscrews.

- Remove the water trough from the bin area.



Step 6 Mix a solution of cleaner and warm water. Depending upon the amount of mineral buildup, a larger quantity of solution may be required. Use the ratio in the table below to mix enough solution to thoroughly clean all parts.

Solution Type	Water	Mixed With
Cleaner	4 l	500 ml cleaner

Step 7 Use 1/2 of the cleaner/water mixture to clean all components. The cleaner solution will foam when it contacts lime scale and mineral deposits; once the foaming stops use a soft-bristle nylon brush, sponge or cloth (NOT a wire brush) to carefully clean the parts. Soak parts for 5 minutes (15 - 20 minutes for heavily scaled parts). Rinse all components with clean water.

Step 8 While components are soaking, use 1/2 of the cleaner/water solution to clean all foodzone surfaces of the ice machine and bin (or dispenser). Use a nylon brush or cloth to thoroughly clean the following ice machine areas:

- Side walls
- Base (bottom of the water trough)
- bottom of the water bump. water level switch.
- Evaporator cells and evaporator plastic parts - including top, bottom, and sides

- Bin
- Ice machine top cover

Rinse all areas thoroughly with clean water.

SANITIZING PROCEDURE

Sanitizing procedure is the same as cleaning procedure, but it needs to change the cleaner with sanitizer.

Wait until the water flows over the evaporator, then add the proper amount of ice machine sanitizer:

Model	Amount of Sanitizer
E460/E660	90 ml
E1060	210 ml

Mix a solution of sanitizer and warm water. Depending upon the amount of mineral buildup, a larger quantity of solution may be required:

Solution Type	Water	Mixed With
sanitizer	23 l	120 ml

Step 9 Install the removed parts, restore power and place the toggle switch in the ICE position.

Ice Machine Inspection

Check all water fittings and lines for leaks. Also, make sure the refrigeration tubing is not rubbing or vibrating against other tubing, panels, etc.

Do not put anything (boxes, etc.) on the sides or back of the ice machine. There must be adequate airflow through and around the ice machine to maximize ice production and ensure long component life.

Exterior Cleaning

Clean the area around the ice machine as often as necessary to maintain cleanliness and efficient operation.

Sponge any dust and dirt off the outside of the ice machine with mild soap and water. Wipe dry with a clean, soft cloth.

Cleaning the Condenser

GENERAL

⚠ Warning

Disconnect electric power to the ice machine at the electric service switches before cleaning the condenser.

A dirty condenser restricts airflow, resulting in excessively high operating temperatures. This reduces ice production and shortens component life. Clean the condenser at least every six months. Follow the steps below.

⚠ Warning

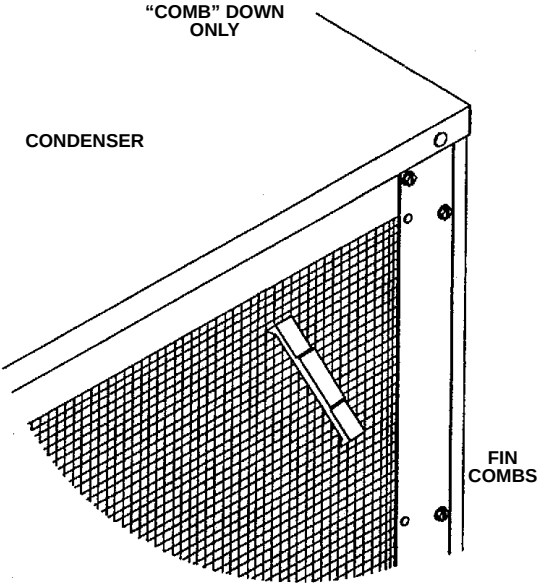
The condenser fins are sharp. Use care when cleaning them.

1. The washable aluminum filter on self-contained ice machines is designed to catch dust dirt lint and grease. Clean the filter with a mild soap and water.
2. Clean the outside of the condenser with a soft brush or a vacuum with a brush attachment. Be careful not to bend the condenser fins.
3. Shine a flashlight through the condenser to check for dirt between the fins. If dirt remains:

A. Blow compressed air through the condenser fins from the inside. Be careful not to bend the fan blades.

B. Use a commercial condenser coil cleaner. Follow the directions and cautions supplied with the cleaner.

4. Straighten any bent condenser fins with a fin comb.



5. Carefully wipe off the fan blades and motor with a soft cloth. Do not bend the fan blades. If the fan blades are excessively dirty, wash with warm, soapy water and rinse thoroughly.

⚠ Caution

If you are cleaning the condenser fan blades with water, cover the fan motor to prevent water damage and disconnect electrical power.

Water-Cooled Condenser and Water Regulating Valve

Symptoms of restrictions in the condenser water circuit include:

- Low ice production
- High water consumption
- High operating temperatures
- High operating pressures

If the ice machine is experiencing any of these symptoms, the water-cooled condenser and water regulating valve may require cleaning due to scale build-up.

Because the cleaning procedures require special pumps and cleaning solutions, qualified maintenance or service personnel must perform them.

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.

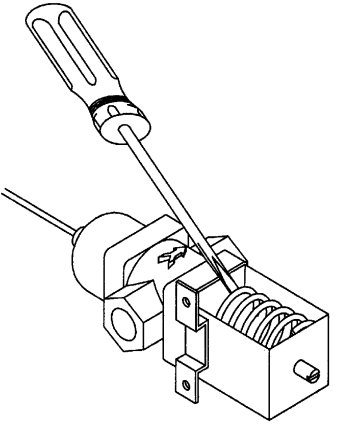
Self-Contained Air-Cooled Ice Machines

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.



Pry Open the Water Regulating Valve

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

Section 5
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:

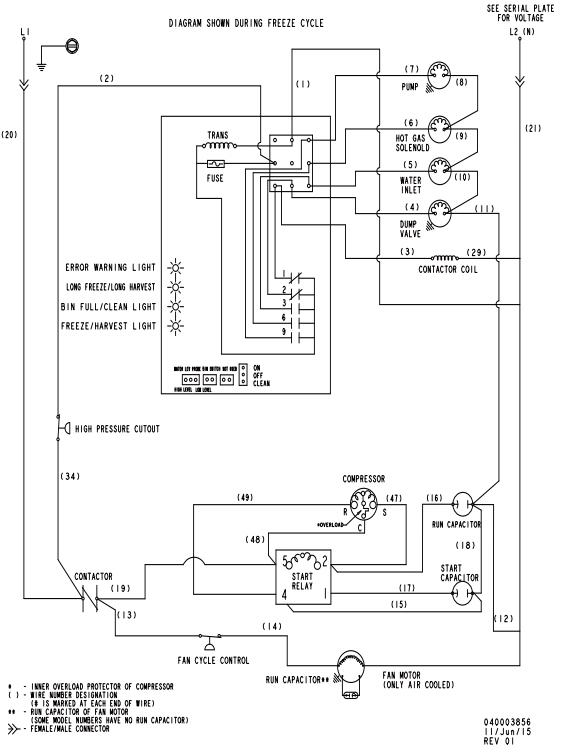
*	Internal Compressor Overload (Some models have external compressor overloads)
**	Fan Motor Run Capacitor (Some models do not incorporate fan motor run capacitor)
TB	Terminal Board Connection (Terminal board numbers are printed on the actual terminal board)
( )	Wire Number Designation (The number is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

—>>—Multi-Pin Connection

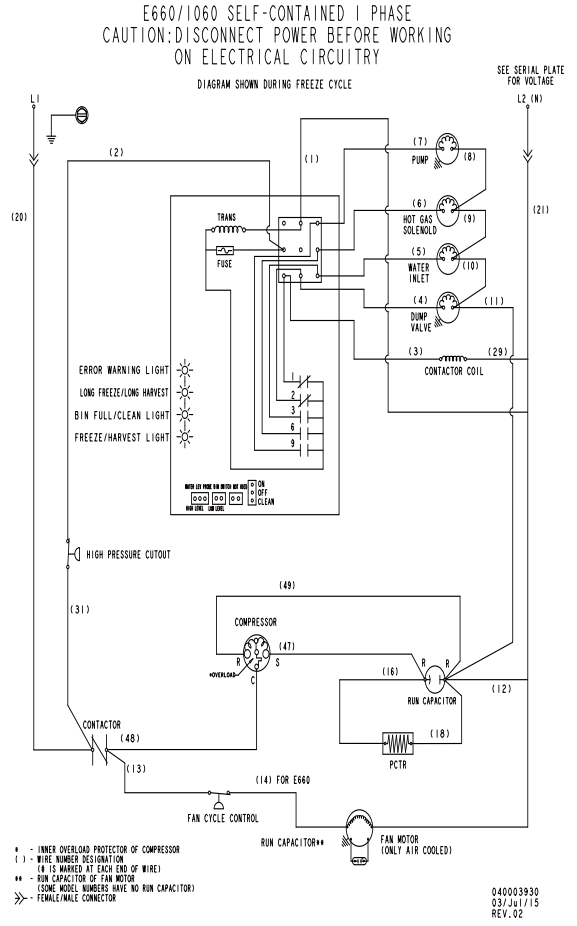
(Electrical Box Side) —>>—

(Compressor Compartment Side)

ES460-SELF CONTAINED



ES660/1060 SELF CONTAINED



Component Specifications and Diagnostics

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 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 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.

symptoms

1. Bin Switch fails open:

The ice machine will not start an ice making cycle, but the ice machine will run in the clean cycle.

2. Bin Switch fails closed:

The Safety #2 has been recorded in control board.The harvest cycle continues after ice opens and closes the water curtain.(harvest cycle is 3.5 min.)

Notice in diagnose

1. Always use the water curtain magnet to cycle the switch. Larger or smaller magnets will affect switch operation.

2. Open the water curtain 3 seconds, then close it 3 seconds. This operation can make the Ohmmeter stable.
3. When water curtain close, the bin switch close, and the resistance value displaying on Ohmmeter is 0(It can be accepted from 0 to 10). When water curtain open, the value displaying on Ohmmeter must be infinite.
4. Watch for consistent readings when the bin switch is open and closed. Bin switch failure could be erratic

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.

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 pre-chill.

FAN CYCLE CONTROL

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)
ES460 ES660	250psig±5	200psig±5
ES1060	275psig±5	225psig±5

Check Procedure

1. Disconnect electrical power to the ice machine at the electrical service disconnect.
2. Verify fan motor windings are not open or grounded, and fan spins freely.
3. Connect manifold gauge to ice machine.
4. Hook voltmeter in parallel across the fan cycle control, leaving wires attached.
5. Reconnect electrical power to the ice machine and set the ON/OFF/WASH toggle switch to ON.
6. Wait until water flows over the evaporator then refer to chart below.

System Pressure	Reading Should Be:	Fan Should Be:
Above cut-in	0 volts	running
Below cut-in	line voltage	off

HIGH PRESSURE CUT-OUT (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:450psig±10(3103kPa±69,31Bar±0.69)

Cut-In: Manual or automatic reset. (Must be below 300 psig to reset.)

Check Procedure

1. Set ON/OFF/WASH switch to OFF.
2. Connect manifold gauge.
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 models, disconnect the fan motor.
5. Set ON/OFF/WASH switch to ON.
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 460psig and the HPCO control does not cut out, set ON/OFF/WASH switch to OFF to stop ice machine operation.

Replace the HPCO control if it:

- Will not reset (below 300 psig)
- Does not open at the specified cut-out point.

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.
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	1-6	Open
	1-2	Closed
	2-6	Open
CLEAN	1-6	Closed
	1-2	Open
	2-6	Closed
OFF	1-6	Open
	1-2	Open
	2-6	Open

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

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.

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.

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.

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 START COMPONENTS

If the compressor attempts to start, or hums and trips the overload protector, check the start components before replacing the compressor.

Capacitor

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.

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.

Relay

The relay has a set of contacts that connect and disconnect the start capacitor from the compressor start winding. The contacts on the relay are normally

closed (start capacitor in series with the start winding).The relay senses the voltage generated by the start winding and opens the contacts as the compressor motor starts.The contacts remain open until the compressor is de-energized.

RELAY OPERATION CHECK

1. Disconnect wires from relay terminals.
2. Verify the contacts are closed.Measure the resistance between terminals 1 and 2.No continuity indicates open contacts.Replace the relay.
3. Check the relay coil: Measure the resisitance between terminals 2 and 5. No resistance indicates an open coil.Replace the relay.

DIAGNOSING THE PTCR

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.

Compressor Start-up procedure

The PTCR allows current to flow through the start winding at compressor startup. PTCR is in parallel operation with run capacitor.(and in cascade operation with start winding.)

1. Beofre compressor startup,the discharge pressure and the suction pressure must be equal.To make sure the pressures equal,the hot gas valve will open 45 seconds before the compressor statup.The hot gas valve keep opening 5 seconds after the compressor startup.
2. When compressor startup, the contactor connect, and the PTCR allows the large current to flow through the start windings.
3. Current flow heats the ceramic discs in the PTCR.The electrical resistance increases with temperature and stops all except a trickle of current flow through the start winding.
4. Now the motor of compressor begin to run. The current flow to start capacitor form the start winding.
5. The small flow of current keeps the PTCR hot(210°F/100°C)and the start winding out of the circuit.
6. The PTCR must be cooled before attempting to start the compressor, otherwise the PTCR will heat up too quickly and stop current flow through the start winding before the compressor motor reaches full speed.

NOTE: If a PTCR is dropped internal damage can occur to the ceramic PTCR discs.The ceramic disc can chip and cause arcing which leads to PTCR failure.Since there is no way to open the PTCR in order to determine if the ceramic disc is chipped or not,it must be discarded when dropped.

Ice machine automatic shut-off and restart

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. To make sure the PTCR is cooled enough, 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, provided the 3 minute delay period is complete.

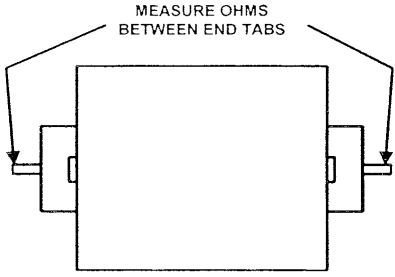
Checking the PTCR

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	Room Temperature Resistance
E660/E1060	8504993	18-40 Ohms



Manitowoc PTCR's 8504993

CONTROL BOARD

General

E-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.

WATER LEVEL SWITCH

Function

E-Model water level switch has two function. It can control the water level and trigger the harvest cycle.

ICE MAKING CIRCUITRY

1. Initial Water Inlet and Purge

If the higher water level switch closes, the water pump and dump valve are energized until lower water level switch closes.

If the higher water level switch opens, water inlet valve is energized until the higher water level switch closes.Then the pump and the dump valve are energized until lower water level switch closes.

2. Water Inlet Before Ice Making

After the initial water inlet and purge, water inlet valve is energized until the higher water level switch closes.

3. Ice making (until trigger the harvest cycle)

When sufficient ice has formed, the lower water level switch closes. The control read the data in the ice making time adapter, and calculate the harvest time(2 minutes delay has been set initial).

4. Harvest cycle

The water pump runs continue when the harvest cycle beginning. The dump valve is engine to purge the water.Water pump and the dump valve are de-engined after 15 minutes.Then the inlet valve is energized until the higher water level switch closes.

FAILURE WARNING

Water inlet time: The maximum water inlet time is 6 minutes. When longer than 6 minutes, the red light on control board will flash slowly(1 time every second), then ice machine automatic shut-off.

Water purge time: The maximum purge time is 6 minutes.When longer than 6 minutes, the red light on control board will flash quickly(4 time every second), then ice machine automatic shut-off.

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 water level switch during these six minutes, the harvest light will

come on (to indicate that water is in contact with the switch), 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

DIAGNOSING THE 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 switch 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 switch 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.

Step 2. Jumper Wire Connected from switch to Ground			
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 switch 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 switch is causing the problem. Clean or replace the water level switch.
Yes	Off	Energized	The control board is causing the problem.

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**
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 switch 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 switch. If you restart the test, you must reconnect the water level switch, restart the ice machine (step 1), and then disconnect the water level switch after the compressor starts.

Step 3. Disconnect switch 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 switch is causing the problem. Clean or replace the water level switch.
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 ICE THICKNESS CONTROL CIRCUITRY

Ice Machine Does Not Cycle into Harvest When the lower water level switch is closed

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. If the water starts to flow over the evaporator, indicate that the water level switch is functioning properly, and the control board is causing the malfunction.

Ice Machine Cycles into Harvest Before the lower water level switch closed

Step 1. Disconnect the water level switch from the control board at terminal.

Step 2. Wait until the water starts to flow over the evaporator, then monitor the green light.

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

The water level switch is causing the malfunction. Verify that the water level switch 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.

DIAGNOSING AN ICE MACHINE THAT WILL NOT RUN

⚠ Warning

High (line) voltage is applied to the control board 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 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 the terminals on the control board.
3. Verify control board fuse is okay. If the bin switch or water level switch 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.

Section 6
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 water level switch 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.

SAFETY LIMITS

General

In addition to standard safety controls, such as high pressure cut-out, the control board has four built in safety limit controls which protect the ice machine from major component failures.

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

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

Safety Limit #2: If the harvest time reaches 4.5 minutes, the control board automatically returns the ice machine to the freeze cycle.

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

Safety Limit #3: If the water inlet time reaches 6 minutes, the ice machine stops.

Safety Limit #4: If the water purge time reaches 6 minutes, the ice machine stops.

Safety Limit Indication

When a safety limit condition is exceeded for:

1. 3 consecutive safety limit #1 occur, the ice machine stops--the orange light flash slowly(1time every second).
2. 3 consecutive safety limit #2 occur, the ice machine stops--the orange light flash quickly(4 times every second).
3. safety limit #3 occur, the ice machine stops--the red light flash slowly(1time every second).
4. safety limit #4 occur, the red light flash quickly(4 times every second).

After ice machine stopping cause the safety limit, moving the ICE/OFF/CLEAN switch to OFF and back to ICE, the light will stop flash.

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

Freeze Time exceeds 60 minutes for 3 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

- Dirty/defective water level switch.
- Harvest cycle not initiated electrically
- Contactor not energizing
- Compressor electrically non-operational
- Defective fan cycling control
- Defective fan motor

Others

- Restricted condenser airflow
- High inlet air temperature (110°F/43.3°C max.)

- Condenser discharge air recirculation
- Dirty condenser fins
- Dirty condenser filter
- 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 adjustme

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

Harvest time exceeds 3.5 minutes for 3 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

- Defective water level switch.
- water level switch 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

SAFETY LIMIT #3

Water inlet time exceeds 6 minutes .

Possible Cause Checklist

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Water System

- Low water pressure (20 psig min.)
- Loss of water from sump area
- Dirty/defective water fill valve
- Clogged water inter tube

Electrical System

- Defective water level switch.
- water level switch dirty
- Control board defective

Safety Limit #4

Water purge time exceeds 6 minutes.

Possible Cause Checklist

Improper Installation

- Refer to “Installation/Visual Inspection Checklist”

Water System

- Leakage/defective water fill valve.
- Defective water pump.
- Dirty/defective water dump valve
- Clogged water purge tube

Electrical System

- Defective water level switch.
- water level switch dirty
- Control board defective

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/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

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 ES1060A 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.	11-12.4 minutes Published Freeze cycle time: 70-25 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 11 70 61 52 43 34 25 Published Freeze Cycle Suction Pressure (psig)
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: 85 (at 1 min.) Middle of Freeze cycle: 65 (at 5 min.) End of Freeze cycle: 35 (at 10 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 54psig (at 1 minute) – not 85 Approximately 46psig (at 5 minutes) – not 65 Approximately 34psig (at 11 minutes) – not 35

Suction Pressure High Checklist

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
- Harvest valve leaking
- TXV flooding (check bulb mounting)
- Defective compressor

Suction Pressure Low Checklist

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

SINGLE EXPANSION VALVE ICE MACHINES - COMPARING EVAPORATOR INLET AND OUTLET TEMPERATURES

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° F(3.9°C)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.

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.

Final Analysis

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

COLUMN 1 - HARVEST VALVE LEAKING

Replace the valve as required.

COLUMN 2 - LOW CHARGE/TXV STARVING

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

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**

SINGLE EXPANSION VALVE

Operational Analysis	**1**	**2**	**3**	**4**
Freeze Cycle **Discharge Pressure** _____ _____ _____ **1 minute Middle End** **into cycle**	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

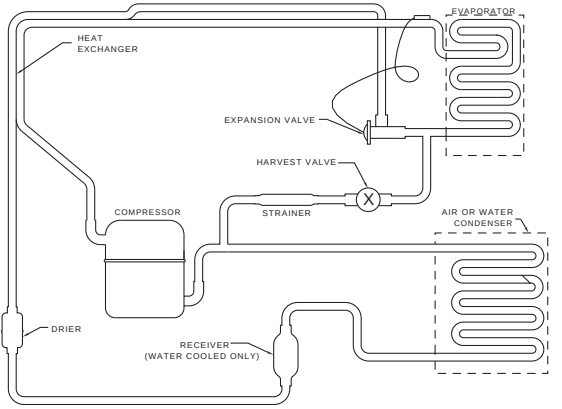
SINGLE EXPANSION VALVE

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.**
Final Analysis Enter total number of boxes checked in each column.	**Harvest Valve Leaking**	**Low On Charge -Or- TXV Starving**	**TXV Flooding**	**Compressor**

Refrigeration Tubing Schematics

SELF-CONTAINED AIR- OR WATER -COOLED MODELS

ES460/ES660/ES1060



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 mis‑diagnosis.
- 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.

ES460 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	12.5-14.3	13.9-16.1	14.7-17	1.0-2.5
90/32.2	15.4-19.5	16.8-19.5	17.7-21.7	
110/43.3			23-27.5	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a b]		
	50/10.0	70/21.1	90/32.2
70/21.1	454		
80/26.7	395		
90/32.2	326	328	298
105/40.5			111

a Based on average ice slab weight of 2.44 - 2.81 lb.
b Regular cube de−rate 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	190-250	55-25	140-150	55-85
70/21.1	195-252	55-28	150-165	65-85
90/32.2	260-285	65-32	185-195	85-110
110/43.3	340-380	100-30	230-245	100-145

ES460 SERIES - SELF-CONTAINED WATER-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	14.1-15.4			1.0-2.5
90/32.2		16-17.5		
110/43.3			19-20.6	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a] [b]		
	50/10.0	70/21.1	90/32.2
70/21.1			
80/26.7			
90/32.2			
105/40.5			

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

Condenser Water Consumption

Air Temp. Around Ice Machine 90°F/32.2°C	Water Temperature °F/°C[a]		
	50/10.0	70/21.1	90/32.2
Gal/24 hours		770	

a Water regulating valve set to maintain 230 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 [1]
50/10.0	230-235	52-26	142-150	76-82
70/21.1	230-235	52-28	142-150	78-82
90/32.2	230-235	52-28	142-150	78-82
110/43.3	242-265	65-30	155-162	85-95

ES660 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	9.4-10.5		10.4-11.3	1-2.5
90/32.2	10.7-11.8	11-12.4		
110/43.3			13.7-15.8	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a b]		
	50/10.0	70/21.1	90/32.2
70/21.1	620		
80/26.7	575		
90/32.2	520	472	461
105/40.5			370

a Based on average ice slab weight of 2.44 - 2.81 lb.
b Regular cube de−rate 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	190-250	50-25	140-150	42-85
70/21.1	190-250	60-25	175-188	45-105
90/32.2	245-290	65-25	175-210	70-110
110/43.3	310-370	70-30	235-265	70-155

ES660 SERIES - SELF-CONTAINED WATER-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	9.9-10.6	10.7-11.2	11.4-12	1.0-2.5
90/32.2		12.3-13.6		
110/43.3			15.2-17.8	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a] [b]		
	50/10.0	70/21.1	90/32.2
70/21.1			
80/26.7			
90/32.2			
105/40.5			

a Based on average ice slab weight of 2.44 - 2.81 lb.
b 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	190-250	55-25	145-155	50-85
70/21.1	195-250	55-25	175-185	50-105
90/32.2	245-290	60-28	175-195	80-110
110/43.3	315-365	70-30	235-265	125-155

ES1060 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	9.4-10.5		10.4-11.3	1.0-2.5
90/32.2	10.7-11.8	11-12.4		
110/43.3			13.7-15.8	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a b]		
	50/10.0	70/21.1	90/32.2
70/21.1	1060		
90/32.2	809	798	
105/40.5			564

a Based on average ice slab weight of 2.44 - 2.81 lb.
b Regular cube de−rate 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	210-280	55-25	135-148	40-80
70/21.1	210-280	70-25	135-150	40-80
90/32.2	250-305	80-25	160-180	45-95
110/43.3	335-390	110-30	205-225	60-125

ES1060 SERIES - SELF-CONTAINED WATER-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	9.6-10.7	10.7-11.2	11.4--12	1.0-2.5
90/32.2		12.3-13.7		
110/43.3			16.2-18	

Times in Minutes

24 Hour Ice Production

Air Temp. Entering Condenser °F/°C	Water Temperature °F/°C[a] [b]		
	50/10.0	70/21.1	90/32.2
70/21.1			
90/32.2			
105/40.5			

a Based on average ice slab weight of 2.44 - 2.81 lb.
b Regular cube de−rate 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	225-235	45-25	140-145	55-75
70/21.1	225-235	45-25	145-150	60-80
90/32.2	225-240	45-25	150-155	65-85
110/43.3	245-280	55-25	155-165	65-90

Refrigerant Recovery/Evacuation

GENERAL

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.

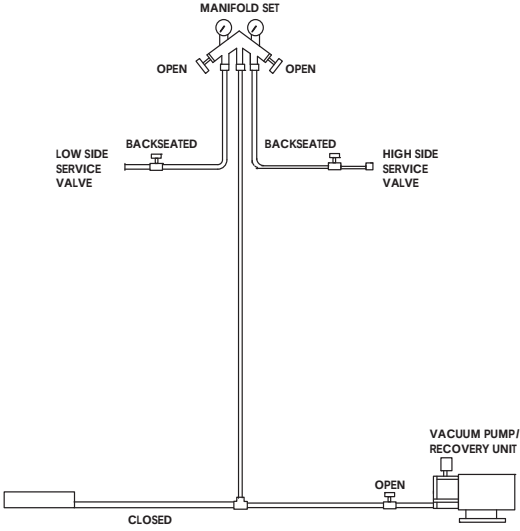
CONNECTIONS

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.

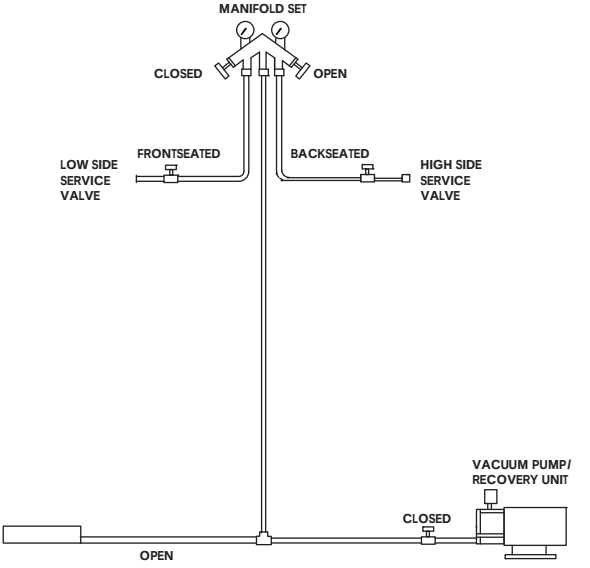
5. Follow the Charging Procedures.

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.

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.

⚠ Warning

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%.

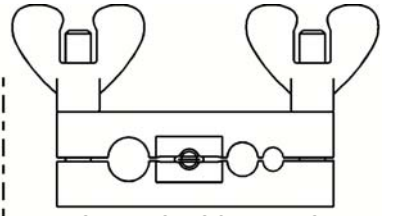


FIG. A - “PINCHING OFF” TUBING

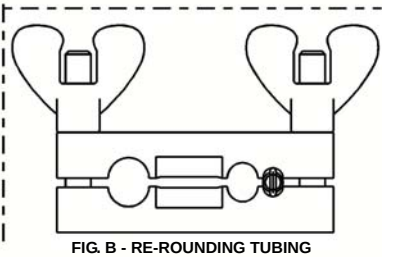


FIG. B - RE-ROUNDING TUBING

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	UK-032S	1/4 in.	89-3025-9
*Suction Filter[a]	UK-165S	5/8 in.	89-3028-3

a *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 reference only. Refer to the ice machine serial number tag to verify the system charge. Serial plate information overrides information listed on this page.

Series	Version	Charge
ES460	Air-Cooled	27.5 oz.
	Water-Cooled	14 oz.
ES660	Air-Cooled	26.6 oz
	Water-Cooled	22.9 oz
ES1060	Air-Cooled	38 oz.
	Water-Cooled	28 oz.

NOTE: The refrigeration is R404A.

Part Number 040005957 12/17

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