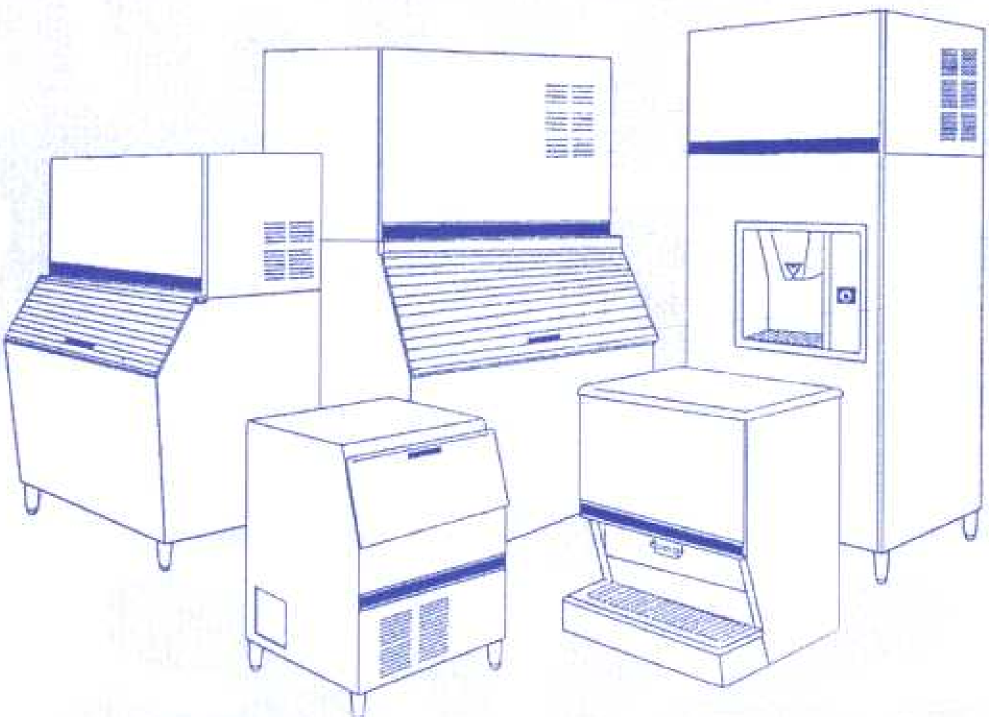
Manitowoc®

ICE MACHINES

B Series
Single Evaporator Service Manual



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

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Part No. 80–1014–3

TABLE OF CONTENTS

SECTION 7 - REFRIGERATION SYSTEM

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SECTION 1 - WARRANTY COVERAGE

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

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

Parts

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

Labor

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

Exclusions from Warranty Coverage

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 the use of nonstandard 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 the ice machine 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 the Installation Manual and this Owner/Operator Use and Care Guide.

Authorized Warranty Service

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

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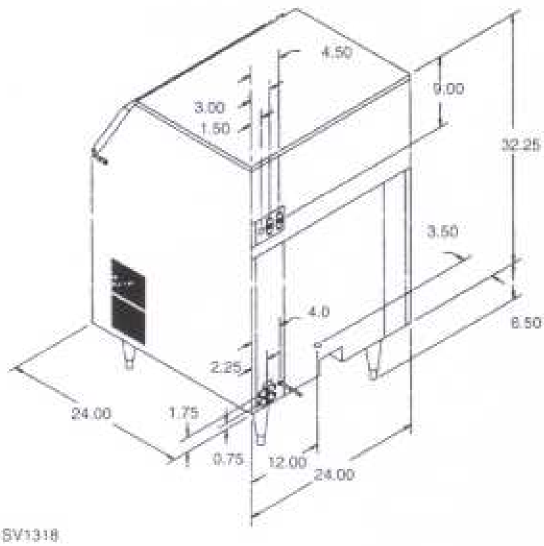
SECTION 2 - INSTALLATION REFERENCES

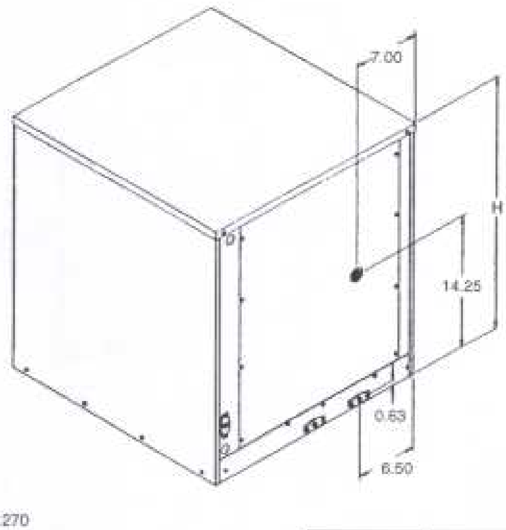
DIMENSIONS

(All dimensions are in inches)

B150 ICE MACHINE

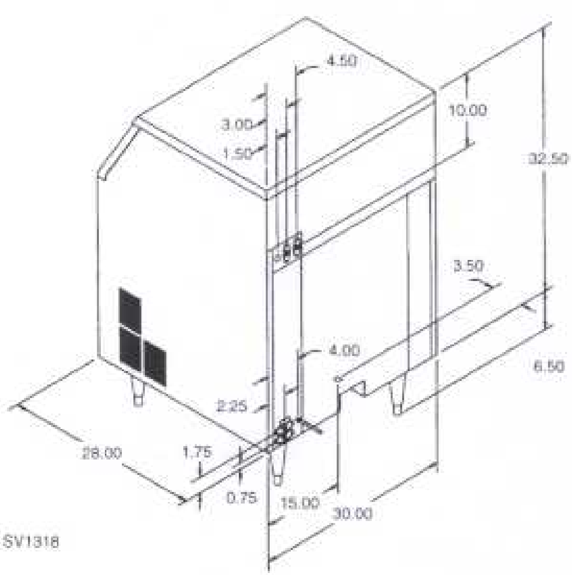


B320/B420 ICE MACHINES



ICE MACHINE	DIMENSION H
B320	20"
B420	25"

B250 ICE MACHINE



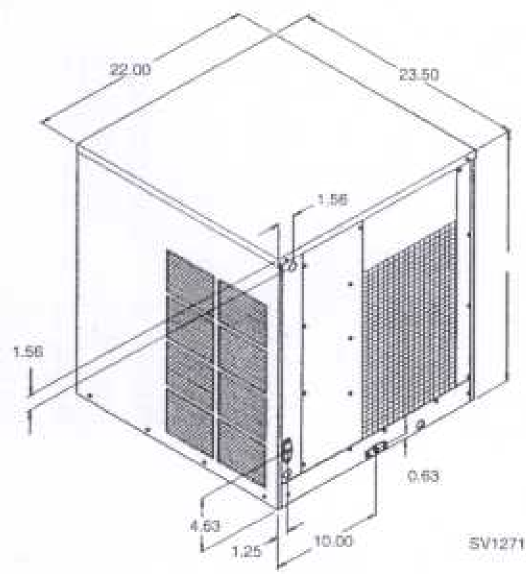
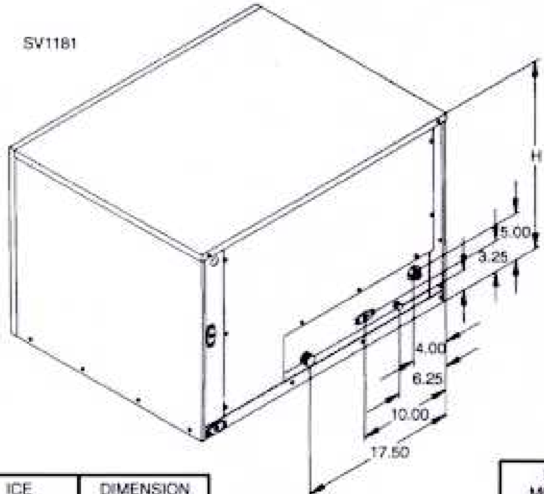


Figure 2-1. DIMENSIONS

DIMENSIONS

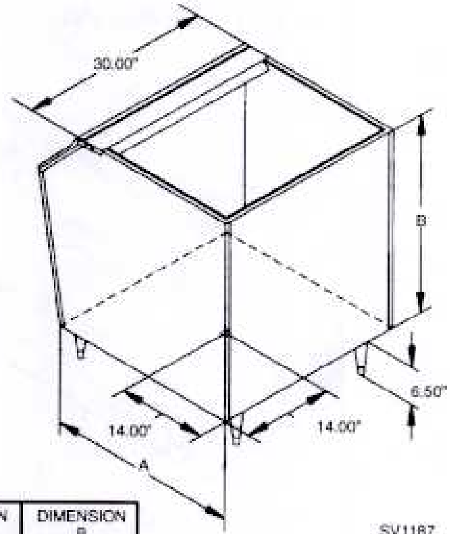
(All dimensions are in inches)

B200-B1000 ICE MACHINE

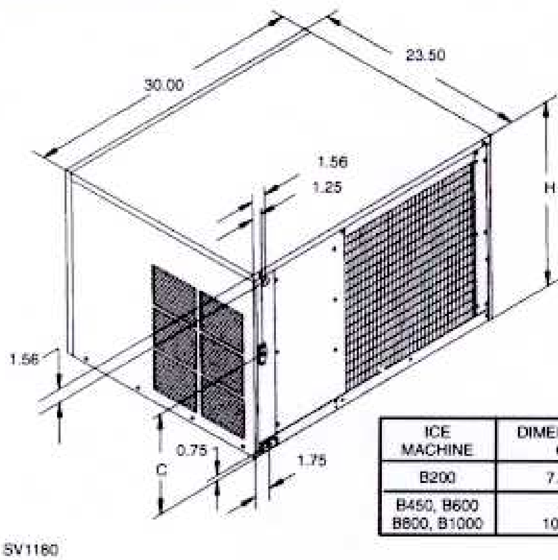


ICE MACHINE	DIMENSION H
B200 B450 B600 B800 B1000	16.50 20.00 20.00 25.00 28.00

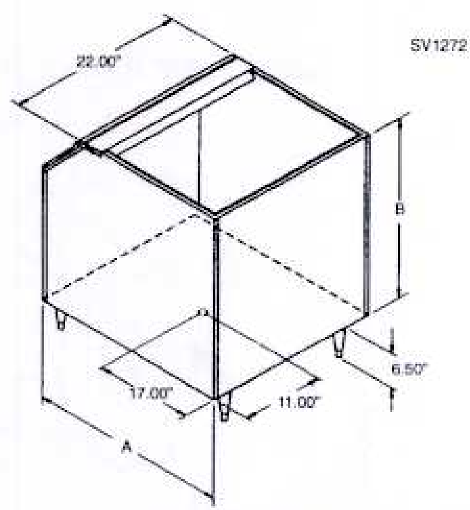
ICE STORAGE BINS



BIN MODEL	DIMENSION A	DIMENSION B
C170 C400 C470 C570	28.25" 34.00" 29.50" 34.00"	19.06" 31.37" 44.00" 44.00"



ICE MACHINE	DIMENSION C
B200	7.25
B450, B600 B800, B1000	10.50



BIN MODEL	DIMENSION A	DIMENSION B
C320 C420	34.00" 34.00"	32.00" 44.00"

Figure 2-2. DIMENSIONS

DIMENSIONS

(All dimensions are in inches)

SINGLE CIRCUIT REMOTE CONDENSER

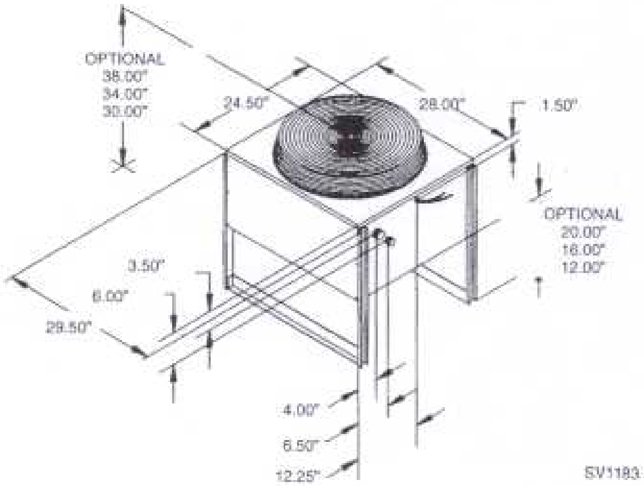


Figure 2-3. DIMENSIONS

LOCATION OF ICE MACHINE

Air Temperature	
Minimum	Maximum
B150 — 50°F (10°C) All Others — 35°F (1.7°C)	All — 110°F (43.3°C)

> **⚠ Caution**
> 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 in the Owner/Operator Use and Care Guide.

Locate your machine away from heat-generating equipment and direct sunlight. Manitowoc ice machines operate most efficiently when:

- **LOCATED IN A CONTAMINANT-FREE AREA**

  Air-cooled models are particularly vulnerable, and should be installed in an area that is free of airborne contaminants.

- **HAVE PROPER CLEARANCE AT TOP, SIDES AND REAR**

  Adequate air flow through and around the ice machine is essential for maximum ice production and long component part life.

  SELF-CONTAINED AIR-COOLED MODELS
  - 8″ minimum clearance on the sides and the top.
  - 5″ minimum clearance in the back.

  WATER-COOLED AND REMOTE AIR-COOLED MODELS
  There is no minimum clearance required, but 5″ on the top, sides and rear is recommended for efficient operation and servicing.

ICE MACHINE HEAT OF REJECTION

Series Ice Machine	Heat of Rejection* Air Conditioning**	Peak
B150	3,200	4,600
B250	4,000	5,200
B320	4,600	6,200
B420	7,000	9,600
B200	3,800	5,000
B450	7,000	9,600
B600	9,000	13,900
B800	12,400	19,500
B1000	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. **This information is also necessary when evaluating the benefits of using water-cooled or remote condensers to reduce air conditioning loads.** The amount of heat added to an air conditioned environment by an ice machine using water-cooled or remote condenser is negligible. Knowing the amount of heat rejected is also important when sizing a cooling tower for a water-cooled condenser unit. The peak figure is used for sizing the cooling tower.

ELECTRICAL FUSE SIZES/CIRCUIT AMPACITY

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

VOLTAGE

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

> **WARNING**
> The ice machine must be grounded in accordance with the National and Local Electrical Code.

FUSE/CIRCUIT BREAKER

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

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., and therefore must be determined by a qualified electrician.

B150/B250

Ice machines with power cord. (The power cord is 6 feet long, with NEMA 5-15P plug configuration.)					
Ice Machine	Voltage Phase Cycle	Air-Cooled		Water-Cooled	
		Maximum Fuse/Circuit Breaker	Total Amps	Maximum Fuse/Circuit Breaker	Total Amps
B150	115/1/60	15	9.8	15	9.8
B250	115/1/60	15	10	15	10

> **Caution**
> Never use an extension cord. If an outlet is not in reach of the ice machine's power cord, have a proper amperage outlet wired closer.

Ice machines requiring direct wiring (no power cord).					
Ice Machine	Voltage Phase Cycle	Air-Cooled		Water-Cooled	
		Maximum Fuse/Circuit Breaker	Minimum Circuit Amps	Maximum Fuse/Circuit Breaker	Minimum Circuit Amps
B150	208-230/1/60	15	5.2	15	4.9
	220-240/1/50	15	4.7	15	4.4
B250	208-230/1/60	15	5.2	15	4.3
	220-240/1/50	15	5.3	15	4.4
NUMBERS LISTED ARE AMPS					

B320/B420

Ice Machine	Voltage Phase Cycle	Air-Cooled		Water-Cooled	
		Maximum Fuse/Circuit Breaker	Minimum Circuit Amps	Maximum Fuse/Circuit Breaker	Minimum Circuit Amps
B320	115/1/60	15	11.2	15	10.3
	208-230/1/60	15	5.6	15	5.2
	*220-240/1/50	*15	5.7	*15	5.3
B420	115/1/60	20	13.1	20	12.3
	208-230/1/60	15	7.8	15	5.3
	*220-240/1/50	15	6.2	15	5.7
NUMBERS LISTED ARE AMPS					
*90°F (32.2°C) Air / 70°F (21.1°C) Water at 254 Volts					

B200/B1000

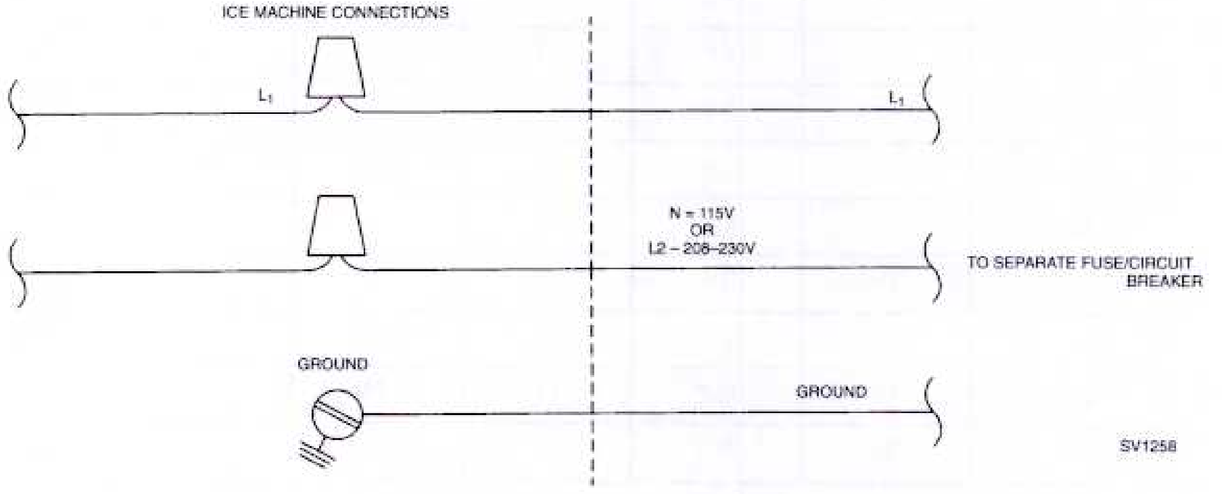
Ice Machine	Voltage Phase Cycle	Air-Cooled		Water-Cooled		Remote	
		Maximum Fuse/Circuit Breaker	Minimum Circuit Amps	Maximum Fuse/Circuit Breaker	Minimum Circuit Amps	Maximum Fuse/Circuit Breaker	Minimum Circuit Amps
B200	115/1/60	15	11.1	15	10.3	N/A	N/A
	208-230/1/60	15	5.6	15	5.3	N/A	N/A
	*220-240/1/50	15	5.9	15	5.6	N/A	N/A
B450	115/1/60	20	12.9	20	12.1	20	13.4
	208-230/1/60	15	7.8	15	5.3	N/A	N/A
	*220-240/1/50	15	6.2	15	5.7	N/A	N/A
B600	208-230/1/60	15	8.9	15	8.5	15	9.1
	*220-240/1/50	15	9.7	15	9.1	15	10.2
B800	115/1/60	20	11.9	20	11.3	20	12.0
	208-230/1/60	15	8.4	15	7.8	15	9.5
	*220-240/1/50	15	11.3	15	9.8	15	10.2
B1000	115/1/60	30	17.2	30	16.6	30	17.9
	208-230/1/60	25	10.7	15	10.1	15	10.6
	*220-240/1/50	20	14.0	20	12.4	25	14.7
NUMBERS LISTED ARE AMPS							
*90°F (32.2°C) Air / 70°F (21.1°C) Water at 254 Volts							

ELECTRICAL WIRING CONNECTIONS

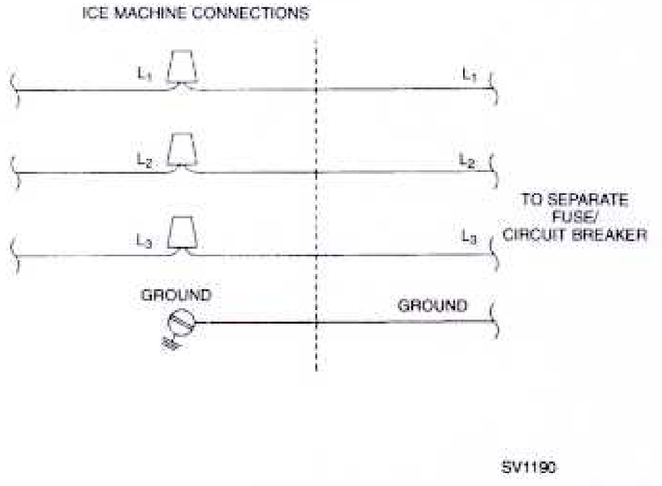
SELF-CONTAINED ELECTRICAL CONNECTIONS

> **Caution**
>
> The diagrams are not intended to show proper wire routing, wire sizing, disconnects, etc., only the correct wire connections. **All electrical connections and routing must conform to local and national codes.**

SELF-CONTAINED ICE MACHINE
115/1/60
- OR -
208-230/1/60



SELF-CONTAINED ICE MACHINE
208-230/3/60



SELF-CONTAINED ICE MACHINE
208-240/1/50

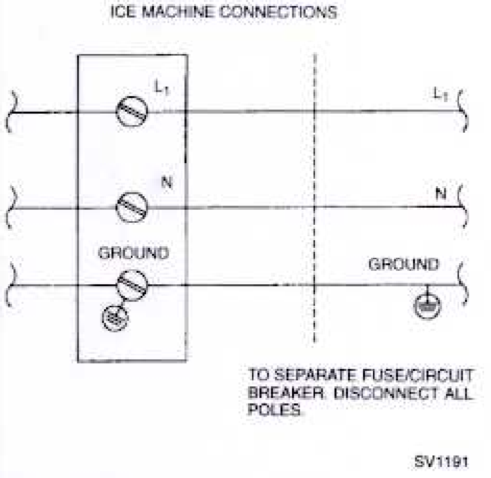


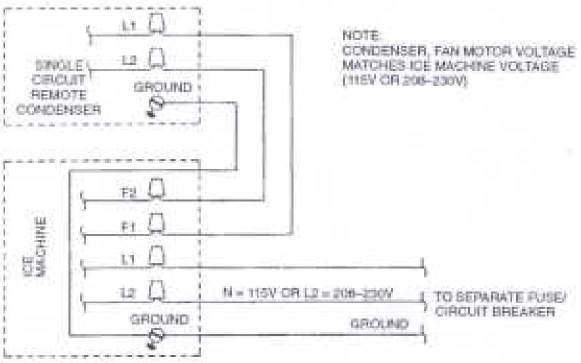
Figure 2-4. SELF-CONTAINED ELECTRICAL WIRING CONNECTIONS

REMOTE ELECTRICAL CONNECTIONS

> ⚠ **Caution**
>
> The diagrams are not intended to show proper wire routing, wire sizing, disconnects, etc., only the correct wire connections. **All electrical connections and routing must conform to local and national codes.**

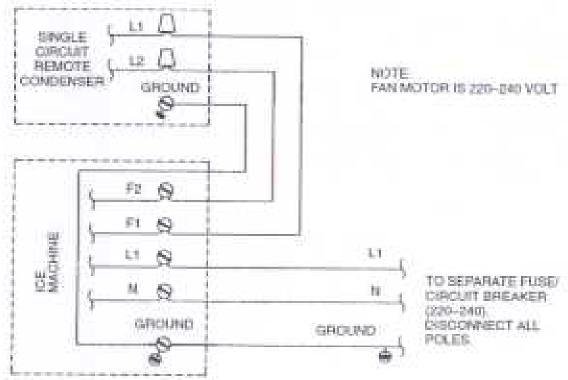
The single circuit condenser should be wired directly to the ice machine's electrical panel. The condenser fan runs only when the ice machine is operating.

SELF-CONTAINED ICE MACHINE
115/1/60
- OR -
208-230/1/60
With single circuit model condenser



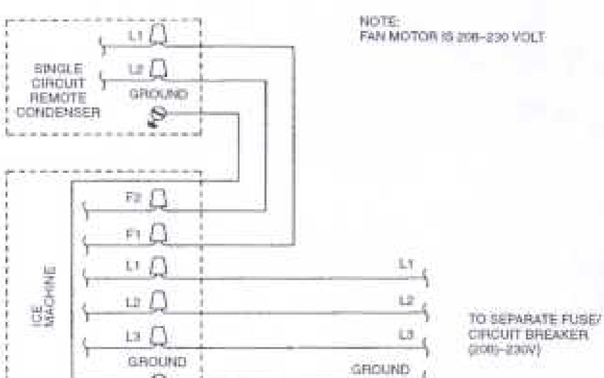
SV1255

SELF-CONTAINED ICE MACHINE
220/240/1/50
With single circuit model condenser



SV1256

SELF-CONTAINED ICE MACHINE
220/240/1/50
With single circuit model condenser



SV1199

Figure 2-5. REMOTE ELECTRICAL WIRING CONNECTIONS

WATER CONNECTIONS AND DRAINS

⚠ Caution
Plumbing must conform to local and state codes.

Location	Water Temperature	Water Pressure	Female Pipe Fitting (F.P.T.) Size	Tubing Size Up to Ice Machine Fitting
Ice Making Water Inlet	33°F (.6°C) min. 90°F (32.2°C) max.	20 psi min. 80 psi max.	3/8″ F.P.T.	3/8″
Ice Making Water Drain	-	-	1/2″ F.P.T.	1/2″
Condenser Water Inlet	33°F (.6°C) min. 90°F (32.2°C) max.	20 psi min. 150 psi max.	B150 - 1/2″ F.P.T. others - 3/8″ F.P.T.	1/2″
Condenser Water Drain	-	-	1/2″ F.P.T.	1/2″
Bin Drain	-	-	3/4″ F.P.T.	3/4″

F.P.T. - Female Pipe Thread

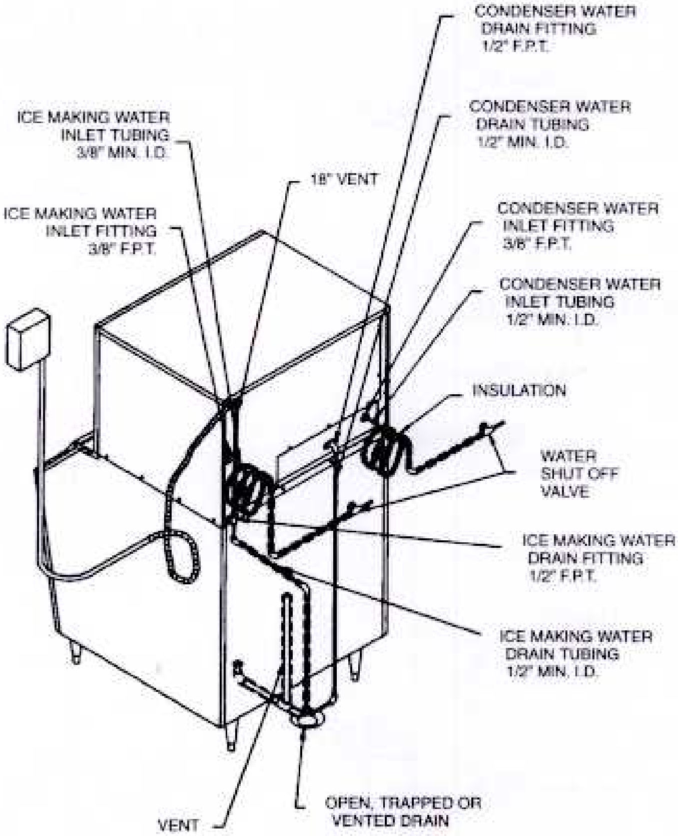


Figure 2-6. TYPICAL WATER SUPPLY DRAIN INSTALLATION (B450 SHOWN)

COOLING TOWER APPLICATIONS (Water-Cooled Models)

A water-cooling tower installation does not require modification of the ice machine. The water regulator valve for the condenser continues to control the refrigeration discharge pressure. It is necessary to know the amount of heat rejection and the pressure drop through the condenser and the water valves (inlet and outlet of the ice machine) when using a cooling tower on an ice machine.

- Water entering the condenser must not exceed 90°F (32.2°C).
- Water flow through the condenser must not exceed 5 gallons per minute.
- Allow for a pressure drop of 7 psi between the condenser water inlet and the outlet of the ice machine.
- Water exiting the condenser must not exceed 110°F (43.3°C).

REMOTE CONDENSER/ LINE SET INSTALLATION

Ice Machine	Remote Single Circuit Condenser	Line* Set
B450	BC0495	RT-20-HP81 RT-35-HP81 RT-50-HP81
B600	BC0895	
B800	BC0895	
B1000	BC1095	

* Line set size: Discharge 1/2″
Liquid 5/16″

Air temperature around the condenser	
Minimum	Maximum
-20°F (-28.9°C)	130°F (54.4°C)

Condensers must be mounted horizontally with the fan motor on top.

GENERAL

Remote condenser installations consist of vertical and horizontal line set distances between the machine and condenser. When combined, they must fit within approved guidelines. These guidelines, drawings, and calculation methods must be followed to verify a proper remote condenser installation.

WARRANTY NOTE

The sixty (60) month compressor warranty, including the thirty-six (36) month labor replacement warranty, will not apply when the remote ice machine is not installed according to specifications, or the refrigeration system is modified with a condenser, heat reclaim device, or parts and assemblies other than those manufactured by Manitowoc Ice, Inc., unless Manitowoc Ice, Inc. approves these modifications for specific locations in writing.

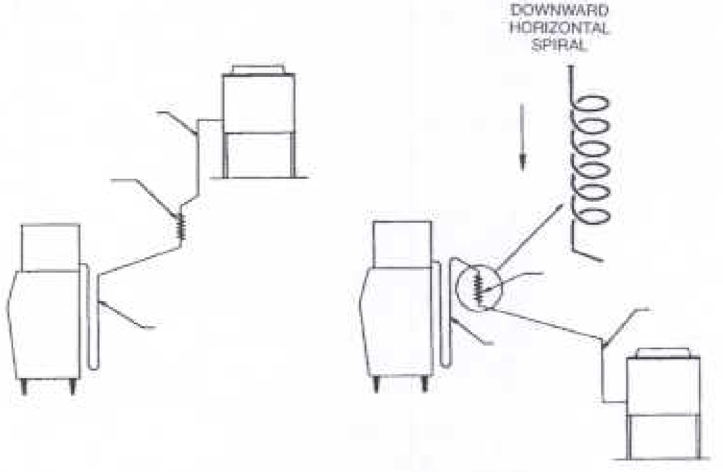


Figure 2-7. ROUTING OF LINE SETS

ROUTING OF LINE SETS

Follow these guidelines when routing refrigerant lines. This will insure the proper performance and service accessibility to the ice machine. A 2-1/2" (6.35 cm) round hole in the wall or roof is needed for tubing routing.

> **Note**
> The line set end with the 90° bend connects to ice machine. The straight end connects to the remote condenser.

1. Make the service loop in the line sets as shown. This permits easy access to the ice machine for cleaning and service. Hard ridged copper should not be used at this location.
2. Never form a trap in refrigeration lines. Refrigerant oil must always be free to drain toward the ice maker or the condenser. The trap formed by the service loop is part of the ice machine's design.

   Excess tubing must be routed in a downward horizontal spiral and supported to assure it does not collapse. Do not coil tubing vertically.
3. Refrigerant lines located outdoors should be kept as short as possible, and must be run to prevent traps.

REMOTE CONDENSER MAXIMUM LOCATION DISTANCES

PHYSICAL LINE SET LENGTH: 100 FT. (30 M) MAXIMUM

The ice machine compressor must have the proper oil return. The receiver capacity is only designed to hold the nameplate charge. This is sufficient to operate the ice machine in ambient temperatures of -20°F (-28°C) to +130°F (54.4°C) with line set lengths up to 100 ft.

LINE SET RISE: 35 FT. (10 M) MAXIMUM
LINE SET DROP: 15 FT. (4 M) MAXIMUM

Line set rises, drops, or horizontal runs greater than the maximum distance allowed will exceed the compressor start-up and pumping design limits and will result in poor oil return to the compressor.

CALCULATED LINE SET DISTANCE: 150 FT. (45 M) MAXIMUM

To eliminate the combination of rises, drops, and horizontal runs exceeding the compressor start-up and pumping design limits, one of the following calculations must be made:

Step 1. Insert measured rise (R) into formula and multiply it by 1.7 to get a calculated rise.
Example: A condenser located above the ice machine 10 ft. has a 17 ft. calculated total (10 ft. x 1.7 = 17 ft.)

Step 2. Insert measured drop (D) into formula and multiply by 6.6 to get a calculated drop.
Example: A condenser located below the ice machine 10 ft. has a 66 ft. calculated total (10 ft. x 6.6 = 66 ft.)

Step 3. Insert measured horizontal distance into formula. No calculation is necessary.

Step 4. Add the calculated rise, calculated drop, and horizontal distance together to get the total calculated distance. If 150 ft. total calculated distance is exceeded, the condenser must be moved to a new location which permits proper equipment operation.

> **Important**
> If a line set rise if followed by a line set drop, a second line set rise cannot be made.
> -OR-
> If a line set drop is followed by a line set rise, a second line set drop cannot be made.

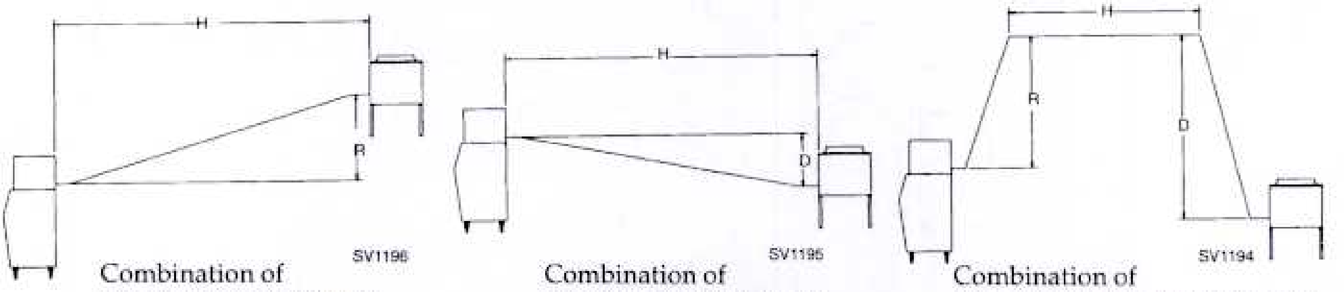
MAXIMUM LINE SET DISTANCE FORMULA

Step 1. Measured Rise (35 ft. (10 m) Maximum) ________ x 1.7 = ____________ Calculated Rise

Step 2 Measured Drop (15 ft. (4 m) Maximum) ________ x 6.6 = ____________ Calculated Drop

Step 3. Measured Horizontal Distance (100 ft. (30 m) Maximum) = ____________ Horizontal Distance

Step 4. Total Calculated Distance (150 ft. (45 m) Maximum) = ____________ Total Calculated Distance



Combination of Rise(s) with Horizontal

Combination of Drop(s) with Horizontal

Combination of Rise and Drop with Horizontal

Figure 2-8. LINE SET MEASUREMENTS

SECTION 3 - MAINTENANCE

WATER LEVEL/ICE THICKNESS CHECK

Routine adjustments and maintenance procedures are not covered by the warranty.

WATER LEVEL CHECK

Check the water level while the machine is in the freeze mode and the water pump is running.

The correct water level is approximately even with the offset in the water trough.

The float valve is factory set for the proper water level. Make the following adjustments if necessary:

1. Loosen the two screws on the float valve bracket.
2. Raise or lower the float valve assembly as needed, then re-tighten the screws.
3. If further adjustment is necessary, carefully bend the float arm to achieve the correct water level.

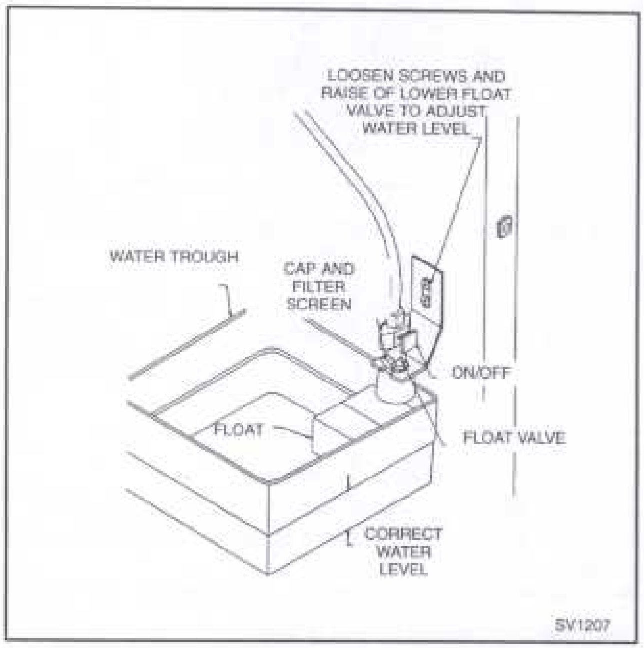


Figure 3-1. WATER LEVEL CHECK (B450 SHOWN)

ICE THICKNESS CHECK

The ice thickness probe is factory set to maintain the ice bridge thickness at 1/8" (3.18 mm).

Make sure the water curtain is in place when performing the Ice Thickness Check. The water curtain prevents water from splashing out of the water trough.

Inspect the bridge connecting the cubes. The bridge should be approximately 1/8" (3.18 mm) thick. Follow the steps below if any adjustment is needed.

1. Turn the ice thickness probe adjustment screw clockwise to increase the bridge thickness or counterclockwise to decrease the bridge thickness.

> **Note**
> A 1/3 turn of the adjustment screw changes the ice thickness approximately 1/16" (1.59 mm).

2. Make sure that the ice thickness probe wires and bracket do not restrict movement of the probe.

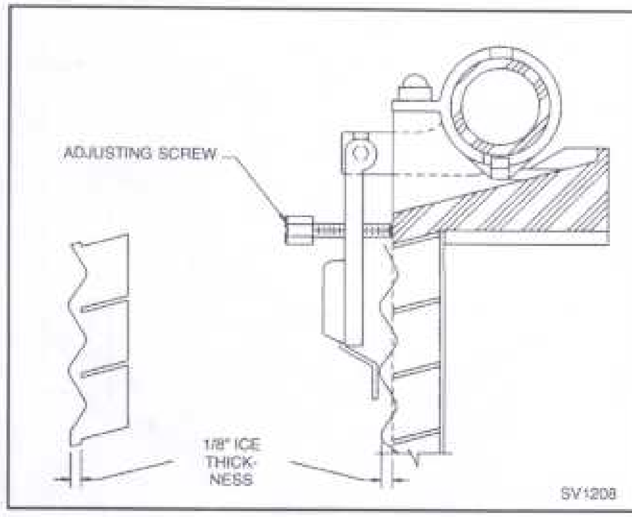


Figure 3-2. ICE THICKNESS CHECK

CLEANING CONDENSERS

⚠ WARNING

Disconnect the electric power to the machine and the remote condenser at the electric service switch box before cleaning the condenser..

AIR-COOLED CONDENSER (SELF-CONTAINED AND REMOTE MODELS)

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.

⚠ Caution

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

1. The washable aluminum filter is designed to catch dust, dirt, lint, and grease. This helps keep the condenser clean. Clean the filter with a mild soap and water solution.

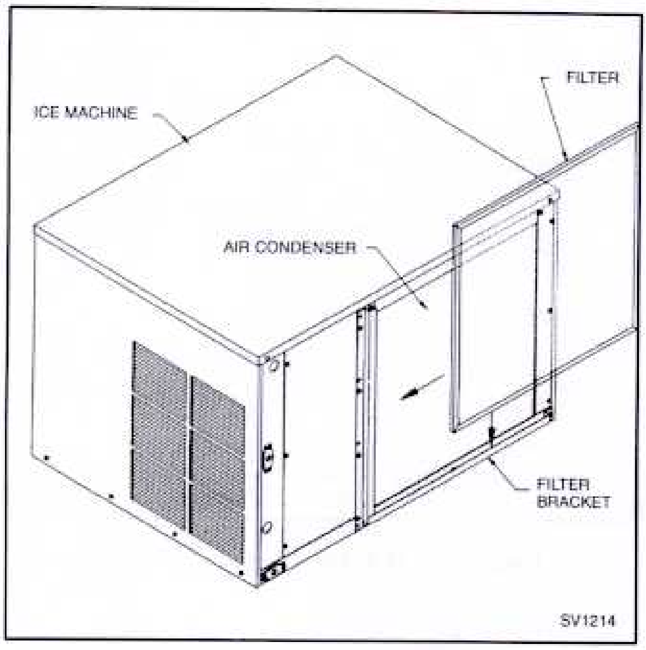


Figure 3-3. SELF-CONTAINED AIR-COOLED FILTER (B450 SHOWN)

2. Clean the outside of the condenser (the bottom side of the remote condenser) with a soft brush or a vacuum with a brush attachment. Brush or wash the condenser from top to bottom - not from side to side. Be careful not to bend the fins. Shine a flashlight through the condenser to check for dirt between the fins.

If further cleaning is required, use one or both of the following procedures:

a. Blow compressed air through the condenser from the inside. Take care not to bend the fan blades. Shine a flashlight through the condenser to check that all the dirt is removed.
b. Clean with a commercial condenser coil cleaner, according to the directions and cautions supplied with the cleaner.

3. Straighten any bent condenser fins with a fin comb, Figure 3-4.

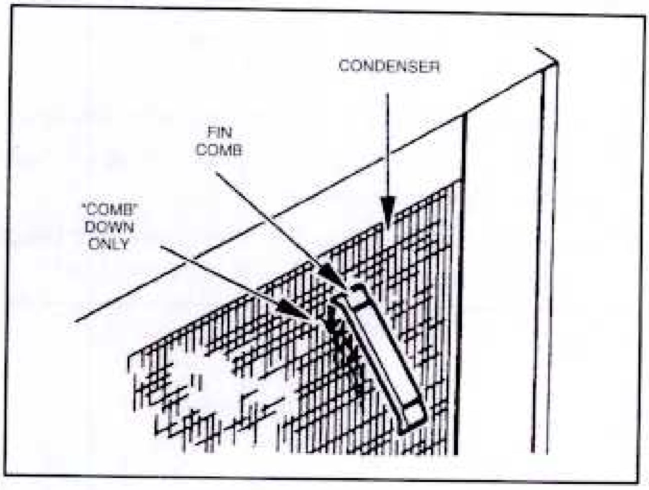


Figure 3-4. STRAIGHTEN BENT CONDENSER FINS

4. Carefully wipe off the fan blades and motor with a soft cloth, taking care not to bend the fan blades. Wash excessively dirty fan blades with warm soapy water, then rinse thoroughly.

⚠ Caution

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

WATER-COOLED CONDENSER (AND WATER REGULATING VALVE)

The water-cooled condenser and the water regulating valve may require cleaning due to scale build-up.

Low ice production, high water consumption and high operating temperatures and pressures all may be symptoms of restrictions in the condenser water circuit.

1. Disconnect the water-cooled condenser from water supply and drain lines.
2. Circulate commercial condenser cleaner through condenser according to condenser cleaner instructions.

INTERIOR CLEANING/SANITIZING

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 or installation of AuCS™ accessory (Automatic Cleaning System).

> **⚠ WARNING**
>
> Use only Manitowoc approved Ice Machine Cleaner (part number 94-0546-3) and 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.

SELF-CLEANING PROCEDURES

Ice machine cleaner is used to remove lime scale or other mineral deposits. It is not used to remove algae or slime. Refer to the section on Self-Sanitizing for removing algae and slime.

> **⚠ Caution**
>
> Do not mix Cleaner and Sanitizer solutions together. It is a violation of Federal law to use these products 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.

> **Note**
>
> If required, extremely dirty ice machines may be taken apart for cleaning or sanitizing.

1. Set the toggle switch to the OFF position after the 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 of the evaporator.

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

2. To start self-cleaning, place the toggle switch in the CLEAN position. The water will flow through the water dump valve and down the drain.
3. Wait about one minute or until water starts to flow over the evaporator.
4. Add 2 ounces (59 ml) of Manitowoc Ice Machine Cleaner to the water trough.
5. The ice machine Self Cleaning System (SeCS™) will automatically time out a ten minute cleaning cycle, followed by six rinse cycles, and then stop. (This process runs approximately 25 minutes.)
6. When the self-cleaning stops, move the switch to the OFF position and proceed to the Self-Sanitizing section.

SELF-SANITIZING PROCEDURES

Use Sanitizer to remove algae or slime. Do not use it to remove lime scale or other mineral deposits.

> **⚠ WARNING**
> Wear rubber gloves and safety goggles (and/or face shield) when handling ice machine cleaner or sanitizer.

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

> **Note**
> If required, extremely dirty ice machines may be taken apart for cleaning or sanitizing.

The Self Cleaning System (SeCS™) is also used for sanitizing:

1. Set the toggle switch to the OFF position after the ice falls from the evaporator at end of a Harves cycle. Or, set the switch to the OFF psoition and allow the ice to melt off of the evaporator.
2. Place the toggle switch in the CLEAN position. The water will flow through the water dump valve and down the drain.
3. Wait about one minute or until water starts to flow over the evaporator.
4. Add 3 ounces (88 ml) of Manitowoc Ice Machine Sanitizer to the water trough.
5. The ice machine Self Cleaning System (SeCS™) will automatically time out a ten minute sanitizing cycle, followed by six rinse cycles, and then stop. (This lasts approximately 25 minutes.)

> **Note**
> If the bin requires sanitizing, remove all the ice and sanitize it with a solution of one ounce (30 ml) of sanitizer to up to four gallons (15 l) of water.
>
> Rinse all sanitized surfaces with clean water.

6. When the self-cleaning (sanitizing) cycle stops, move the toggle switch to the ICE position.

> **⚠ WARNING**
> Wear rubber gloves and safety goggles (and/or face shield) when handling ice machine cleaner or sanitizer.

AuCS™ ACCESSORY

This accessory monitors icemaking cycles and initiates self-cleaning procedures automatically. The AuCS™ Accessory can be set to automatically clean or sanitize the ice machine every 2, 4 or 12 weeks.

> **⚠ DANGER ⚠**
> Refer to the AuCS™ Accessory Installation Instructions and the AuCS™ Accessory Owner/Operator Use and Care Guide for complete details on the installation, operation, maintenance and cautionary statements of this accessory.

1. Automatic Operation

The following occurs when the ice machine switch is in the ICE position:

1. The ice machine unitized ice sensor board counts the number of ice harvest cycles.
2. The AuCS™ Accessory automatically interrupts the ice making mode and starts the automatic cleaning mode when the harvest count equals the "frequency of cleaning" setting of the AuCS™ Accessory.
3. When the automatic cleaning mode is complete (approximately 25 minutes), ice making mode resumes automatically.

> **Note**
> The harvest count is reset to zero only after the AuCS™ cycle is completed. It cannot be reset by unplugging the modular wire, changing the switch position, power loss, etc.

2. Manual Start Operation

Verify that no ice is on the evaporator surface. (Set the ICE/OFF/CLEAN switch to the OFF position after the ice falls from the evaporator at end of a harvest cycle, or set the switch to the OFF position and allow the ice to melt off of the evaporator.)

The following occurs when the switch is moved to the CLEAN position:

1. The ice machine runs through one rinse cycle and then into the automatic cleaning mode.
2. The ice machine stops all functions when the automatic cleaning mode is completed. Set the switch to the ICE position to restart.

> **Note**
> The harvest counter for automatic operation is reset to zero after the automatic cleaning mode cycle is complete.

SEQUENCE OF OPERATION

The ice machine automatically times out a ten minute clean (or sanitizing) cycle, followed by six rinse cycles. The Automatic Cleaning mode lasts approximately 25 minutes.

> **Note**
> Opening or removing the water curtain stops the automatic cleaning mode. Upon reclosing, the automatic cleaning mode resumes from the point at which it stopped.

1. Clean (or Sanitize) Cycle
(10 minutes, 45 seconds)

1. The water pump circulates water over the evaporator for 10 minutes. The cleaner or sanitizer is dispensed from the AuCS™ Accessory for 10-20 seconds at the beginning of the cycle.

> **Important**
> Once the cleaner or sanitizer solution is dispensed during the clean cycle, you cannot stop the ice machine from running through <u>all six</u> rinse cycles before starting another ice making cycle.

2. The water dump valve energizes for 45 seconds to dump the wash water down the drain.

2. Rince Cycles (Step 1 and 2 repeated 6 times)
(13 minutes, 30 seconds)

1. The water pump circulates water over the evaporator for 90 seconds.
2. The water dump valve energizes to dump the rinse water down the drain for 45 seconds.

3. Changing Switch Position Prior to Completion of Automatic Cleaning Mode

1. If the switch is turned OFF <u>prior</u> to dispensing the cleaner or sanitizer, then switched to:
   a. ICE position, normal ice making begins.
   b. CLEAN position, a manual start of automatic cleaning mode begins.
2. If the switch is turned OFF <u>after</u> the cleaner or sanitizer is dispensed, then switched to:
   a. ICE position, the rinse cycles portion of the automatic cleaning mode begins. The ice machine reusmes normal ice making operation when rinsing is complete.

> **Note**
> Each time you turn the switch OFF and back to ICE, the six rinse cycles begin again.

   b. CLEAN position, a manual start of automatic cleaning mode begins.

REMOVAL OF PARTS FOR CLEANING/SANITIZING

1. Turn off the water supply to the ice machine at the water service valve.

> **WARNING**
> Disconnect electric power to the ice machine at the electric switch box before proceeding.

2. Remove the water trough, water curtain, water pump, water distribution tube and ice thickness probe. (Refer to the appropriate sections to remove each part.)

> **WARNING**
> Wear rubber gloves and safety goggles (and/or face shield) when handling ice machine cleaner or sanitizer.

3. Soak the removed parts in a properly mixed solution:

   Manitowoc Cleaner - mix 16 (500 ml) ounces of cleaner with one gallon (4 l) of water.

   Manitowoc Sanitizer - mix one ounce (30 ml) of sanitizer with four gallons (15 l) of water.

   Use a soft-bristle brush (DO NOT USE A WIRE BRUSH) or a sponge to clean the parts. Take care not to damage them.

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

> **Caution**
> Do not immerse the water pump motor in the cleaning or sanitizing solution.

4. Use the cleaning or sanitizing solution and a brush or sponge to clean the top, sides, and bottom evaporator extrusions, the inside of the ice machine panels, and the entire inside of the bin.

5. Thoroughly rinse all of the parts and surfaces with clean water and reinstall the parts.

> **Note**
> Incomplete rinsing of the ice thickness probe may leave a residue. This could cause the ice machine to go into the harvest cycle prematurely. For best results, brush or wipe the probe off while rinsing. Thoroughly dry it before replacing it.

6. Turn the water and electrical supply back on.

WATER DUMP VALVE REMOVAL

The water dump valve normally does not require removal for cleaning. Follow the instructions listed below to determine if removal is necessary.

1. Remove the top and right side panels.
2. Set the ICE/OFF/CLEAN switch to ICE.
3. Check the dump valve's clear plastic outlet drain hose (Figure 3-6), for leakage while the ice machine is in the freeze mode.
4. If the dump valve is leaking, remove, disassemble and clean it.
5. Do not remove the dump valve it is is not leaking. Following the Self Cleaning (SeCS™) procedures is adequate.

Removal Procedure

> **WARNING**
> Disconnect electric power to the ice machine at the electric switch box before proceeding.

1. Remove the water dump valve shield from its mounting bracket (if applicable).
2. Lift and slide the coil retainer cap from the top of the coil.
3. Leaving the wires attached, lift the coil assembly off of the valve body (enclosing tube). Note the position of the coil assembly on the valve before removing it. Make sure the coil is in the same position when reassembling the valve.
4. Press the enclosing tube's plastic nut down and rotate it 1/4 turn. Remove the enclosing tube, plunger and plastic gasket from the valve body.

   The water dump valve can easily be cleaned at this point, without removing the entire valve body.

   You do not need to remove the spring from the plunger when cleaning. If the spring is removed, insert the spring's **flared** end into the slotted opening in the top of the plunger, until it comes in contact with the plunger spring stop. Do not stretch or damage the spring when cleaning.

> Important
> The plunger and the inside of the enclosing tube must be thoroughly dry before reassembling.

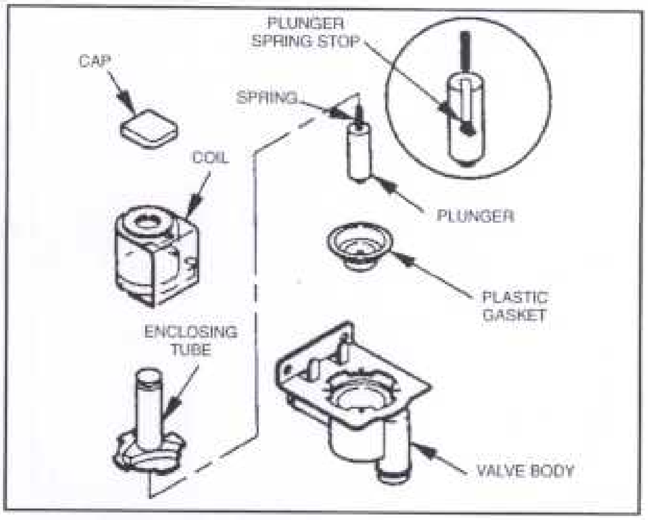


Figure 3-5. DUMP VALVE DISASSEMBLY

5. Remove the valve body.
   a. Remove the tubing from the dump valve by twisting the clamps off.
   b. Remove the two screws securing the dump valve and the mounting bracket.

> **WARNING**
> Disconnect the electrical power to the ice machine at the electrical switch box and turn off the water supply before proceeding.

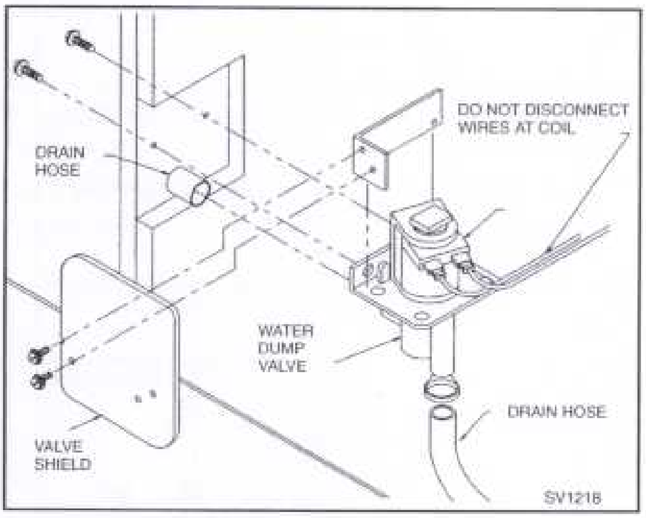


Figure 3-6. DUMP VALVE REMOVAL (B450 SHOWN)

Water Pump

1. Disconnect the water pump power cord.

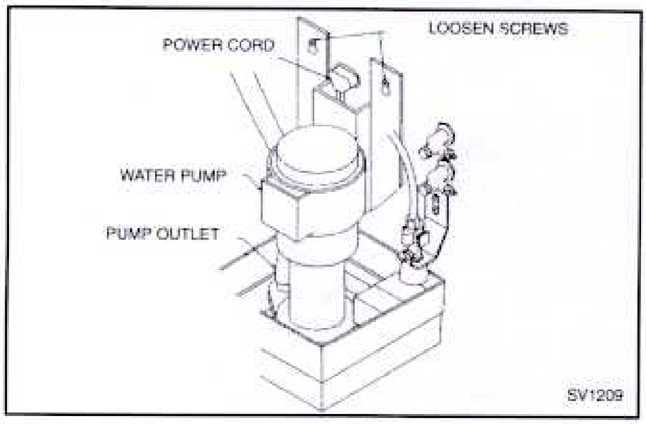


Figure 3-7. WATER PUMP REMOVAL (B450 SHOWN)

2. Disconnect the hose from the pump outlet.
3. Loosen the two screws which hold the pump mounting bracket to the bulkhead.
4. Lift the pump and bracket assembly off the screws.

Ice Thickness Probe

1. Remove the ice thickness probe by compressing the side of the probe near the top hinge pin and removing it from the bracket. NOTE: The ice thickness probe can easily be cleaned at this point without proceeding to Step 2.

> **⚠ WARNING**
> Disconnect electric power to the ice machine at the electric service switch box before proceeding.

2. If complete removal is required, disconnect the wire leads from the unitized sensor board inside the electrical control box.

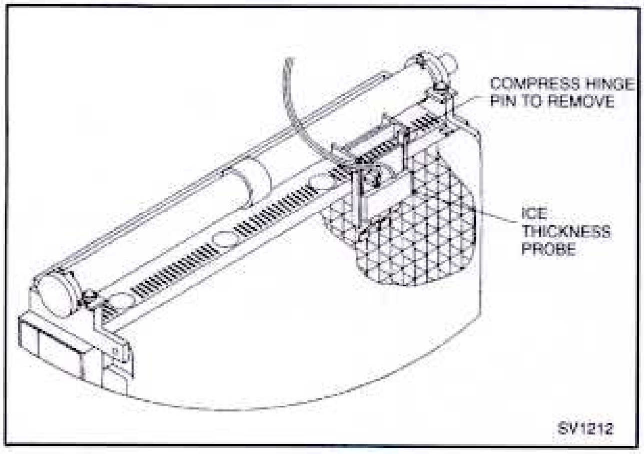


Figure 3-8. ICE THICKNESS PROBE REMOVAL

Water Trough

1. Remove the screws holding the sump trough in place.
2. Lower the right side of the trough into the bin.
3. Disengage the left side of the trough from its holding pegs and remove the trough from the ice machine.

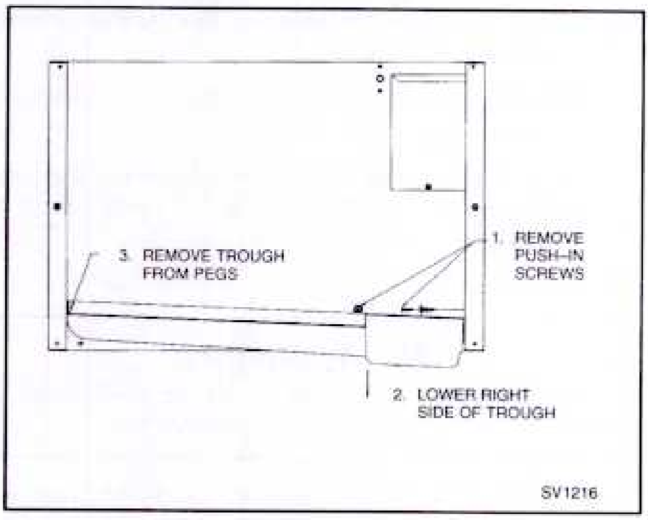


Figure 3-9. WATER TROUGH REMOVAL (B450 SHOWN)

Float Valve

1. Turn the valve splash shield counter-clockwise one or two turns. Pull the valve forward, off the mounting bracket.
2. Disconnect the water inlet tube from the float valve at the compression fitting.
3. Remove the filter screen and cap for cleaning.

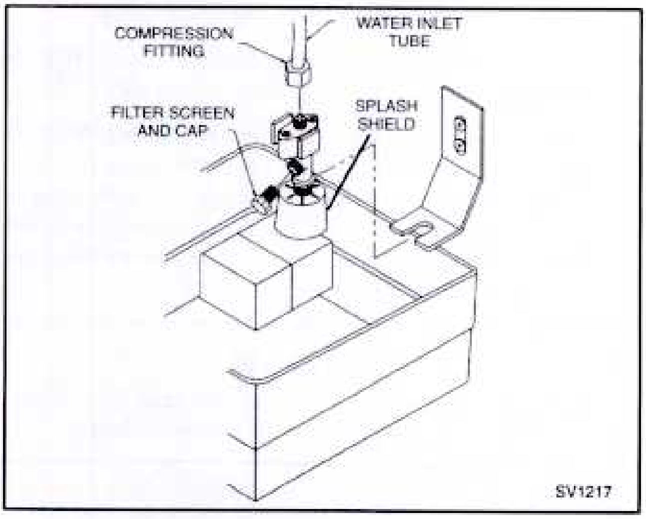


Figure 3-10. FLOAT VALVE REMOVAL (B450 SHOWN)

Water Distribution Tube

1. Disconnect the water hose from the distribution tube.
2. Loosen the two thumbscrews which hold the distribution tube in place.
3. Lift the right side up to clear the locating pin, then slide it back and to the right.

> **Important**
> Do not force this removal. Be sure the locating pin clears the hole before sliding it out.

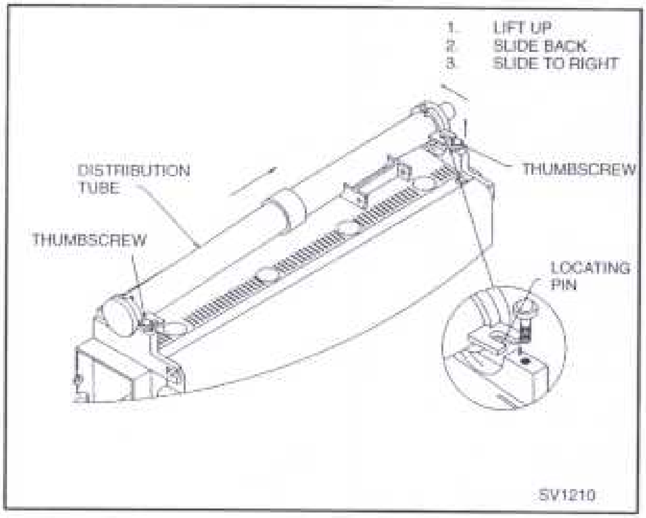


Figure 3-11. WATER PUMP REMOVAL (B450 SHOWN)

4. Disassemble for cleaning.
   a. Twist both of the inner tube ends until the tabs line up with the keyways.
   b. Pull the inner tube ends outward.

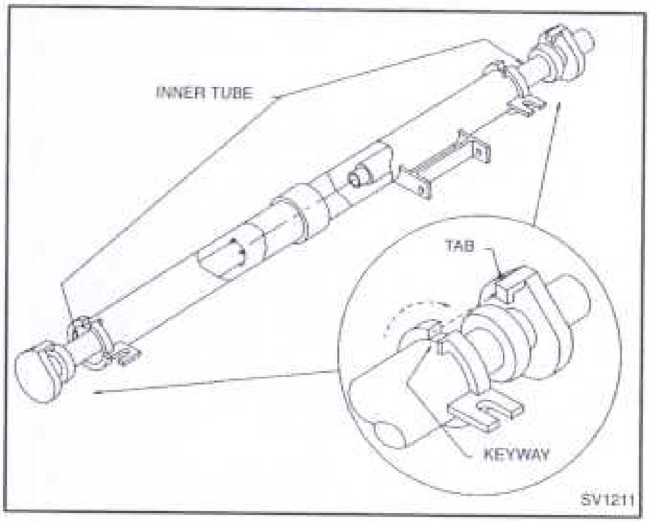


Figure 3-12. WATER DISTRIBUTION TUBE DISASSEMBLY

Water Curtain

1. Gently flex the curtain in the center and remove it from the right side.
2. Slide the left pin out.

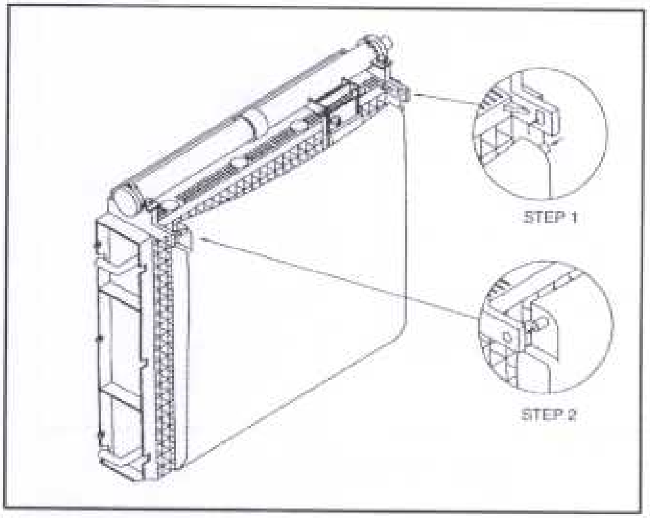


Figure 3-13. WATER CURTAIN REMOVAL

WATER TREATMENT/FILTRATION

Local water conditions may require the installation of a water treatment system to inhibit scale formation, filter sediment, and remove chlorine taste and odor. Consult your local dealer or distributor for information on Manitowoc's full line of Tri-Liminator filtration systems.

Replace the primary filter cartridge every six months to ensure maximum filtration efficiency. The filter gauge indicates if earlier replacement is necessary (a reading below 20 psig).

Tri-Liminator systems include a prefilter, and should not require primary filter replacement prior to six months of usage. If replacement is needed, replace the prefilter first.

REPLACEMENT PROCEDURE

1. Turn off the water supply at the inlet shut-off valve.
2. Press the pressure release button to relieve the pressure.
3. Unscrew the housing from the cap (see illustration).
4. Remove the used cartridge from the housing and discard it.

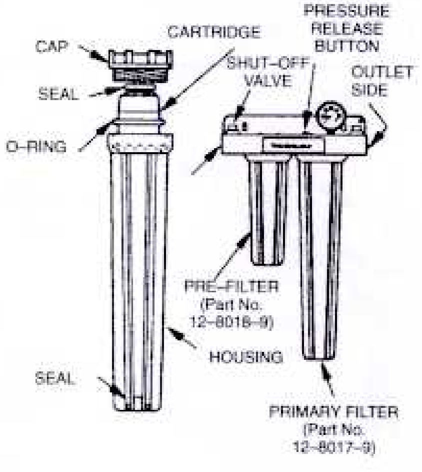


Figure 3-14. WATER FILTRATION

5. Remove the O-ring from the groove in the housing. Wipe the groove and O-ring clean. Relubricate the O-ring with a coating of clean petroleum jelly (Vaseline). Replace the O-ring, and press it down into the groove with two fingers.
6. Insert a new cartridge into the housing. Make sure it slips down over the housing standpipe.
7. Screw the housing onto the cap and **hand tighten. Do not over-tighten or use a spanner wrench.**
8. Repeat steps 3 through 7 for each filter housing.
9. Turn on the water supply to allow the housing (and filter) to slowly fill with water.
10. Press the pressure release button to release trapped air from the housing. Check for leaks.

REMOVAL FROM SERVICE/WINTERIZATION

You must take special precautions if the ice machine is to be removed from service for extended periods, 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.

Self-Contained Air-Cooled Machines

1. Disconnect the electric power at the circuit breaker or the electric service switch.
2. Turn off the water going to the ice machine.
3. Remove the water from the sump trough.
4. Disconnect the incoming ice making water line, and drain the line at the rear of ice machine.
5. Blow compressed air in both the incoming water and drain openings (in the rear of the machine) until no more water comes out of the float valve and drain.
6. Be sure no water is trapped in any of the machine's water lines, drain lines, distribution tubes, etc.

Water-Cooled Machines

1. Perform all the procedures listed under "Self-Contained Air-Cooled Machines" above.
2. Disconnect the incoming water and drain lines from the water-cooled condenser.
3. Pry open the water regulating valve by inserting a large standard screwdriver between the bottom spring coils of the valve. Pry the spring upward to open the valve.
4. Hold the valve open and blow compressed air through the condenser until no water remains.

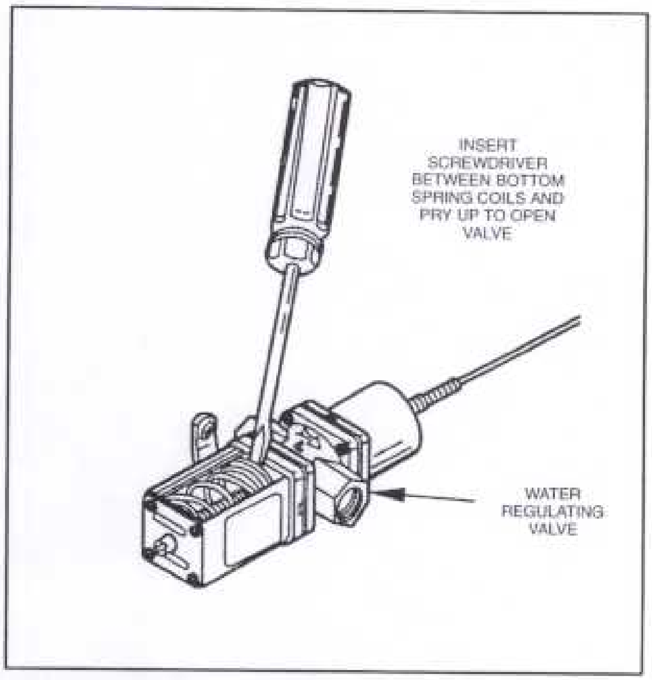


Figure 3-15. MANUALLY OPEN WATER REGULATING VALVE

Remote Machines

1. Turn the ICE/OFF/CLEAN switch to OFF to allow the ice machine to "pump down" the refrigeration system.
2. Frontseat (shut off) the receiver service valves. Hang a tag on the switch as a reminder to open the receiver service valves before restarting.
3. Perform all the procedures listed under "Self-Contained Air-Cooled Machines."

Automatic Cleaning System (AuCS™) Accessory

Refer to the AuCS™ Accessory Installation Owner/Operator Use and Care Guide for winterization of AuCS™ Accessory.

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SECTION 4 - BASIC ICE MACHINE SEQUENCE OF OPERATION

SELF-CONTAINED AIR & WATER-COOLED (B450 Shown)

Initial Start-Up Or Start-Up After Automatic Shut-off

1. Prior to the ice machine starting, the water pump and water dump solenoid are energized for 45 seconds to completely purge the water in the sump trough.
2. After the water pump and water dump valve de-energize, the contactor energizes to start the compressor and the fan motor. (The fan motor on air-cooled models may cycle on/off through fan cycle control.)

Freeze Sequence

3. The water pump restarts after a 30 second delay period. With the water pump running, an even flow of water is directed across the evaporator and into each cube cell, where it freezes.
4. When sufficient ice has formed, the water flow contacts the ice thickness probe. After approximately seven seconds, the harvest sequence is initiated. The ice machine must be in the freeze cycle for 6 minutes prior to harvest initiation.

Harvest Sequence

5. a. The hot gas valve opens, diverting hot refrigerant gas into the evaporator.
   b. The water dump solenoid is energized for 45 seconds to purge the water in the sump trough. After the 45 second purge, the water pump and water dump valve de-energize.
6. The hot refrigerant gas warms the evaporator, causing the cubes to slide, as a unit, off the evaporator and into the storage bin. The sliding sheet of cubes swings the water curtain out, activating a bin switch. The momentary opening of the bin switch terminates the harvest sequence and returns the ice machine to the freeze sequence (Steps 3 and 4).

Automatic Shut-Off

7. At the end of a harvest sequence, if the water curtain is held open for more than 7 seconds, the ice machine will shut off. When the storage bin is full, the last sheet of cubes holds the water curtain open.
8. The ice machine remains off until sufficient ice is removed from the bin, allowing the water curtain to close. As the water curtain swings back to operating position, the ice machine restarts (Steps 1 and 2).

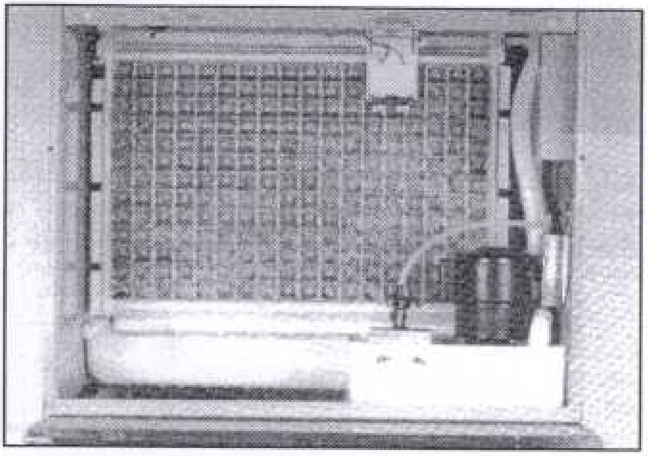

Figure 4-1. FREEZE SEQUENCE

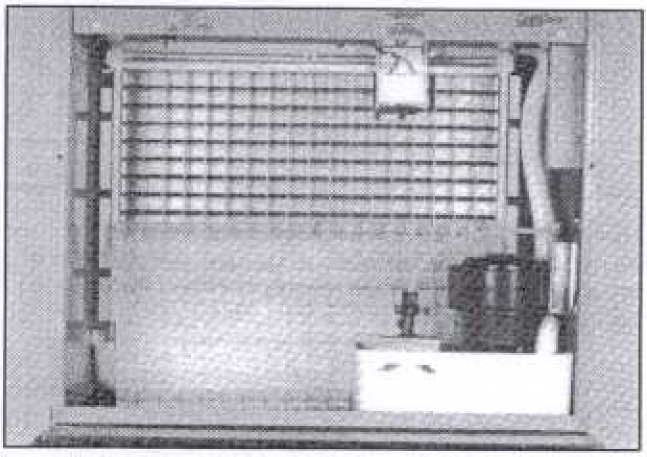

Figure 4-2. HARVEST SEQUENCE

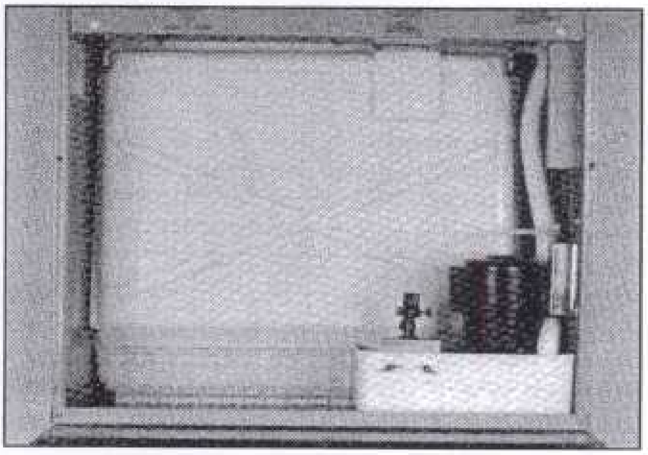

Figure 4-3. AUTOMATIC SHUTOFF

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SECTION 5 - WATER SYSTEM SEQUENCE OF OPERATION

SELF-CONTAINED OR REMOTE MODELS

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

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

Freeze Sequence

2. To prechill the evaporator, there is no water flow over the evaporator for the first 30 seconds of the freeze sequence.
3. After 30 seconds, water flows over the evaporator.

Harvest Sequence

4. The water pump and water dump solenoid are energized for 45 seconds to purge the water in the sump trough.
5. After the 45 second purge, the water pump and water dump valve de-energize.

Automatic Shut-Off

There is no water flow during automatic shut-off.

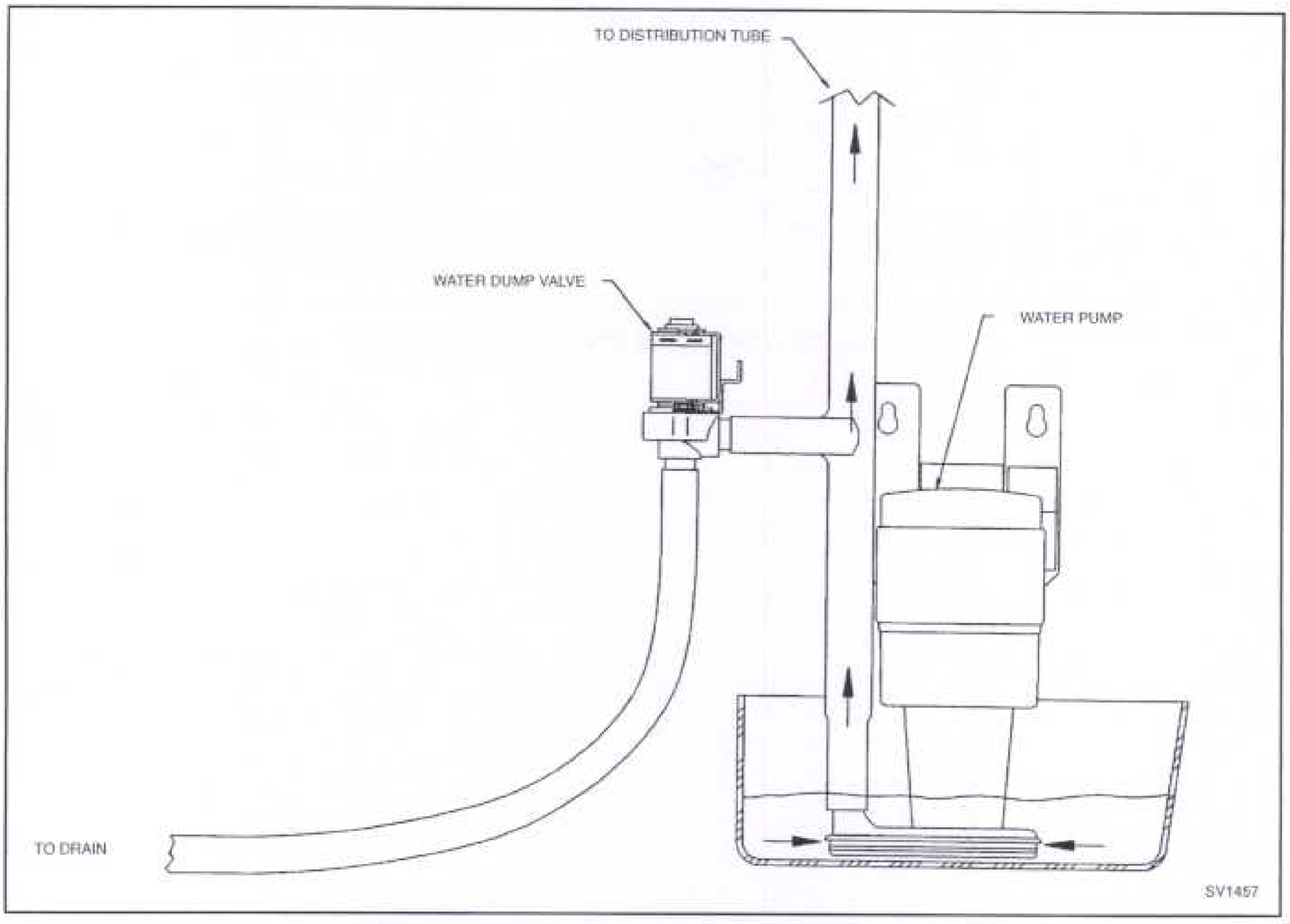

Figure 5-1. WATER FLOW OVER EVAPORATOR

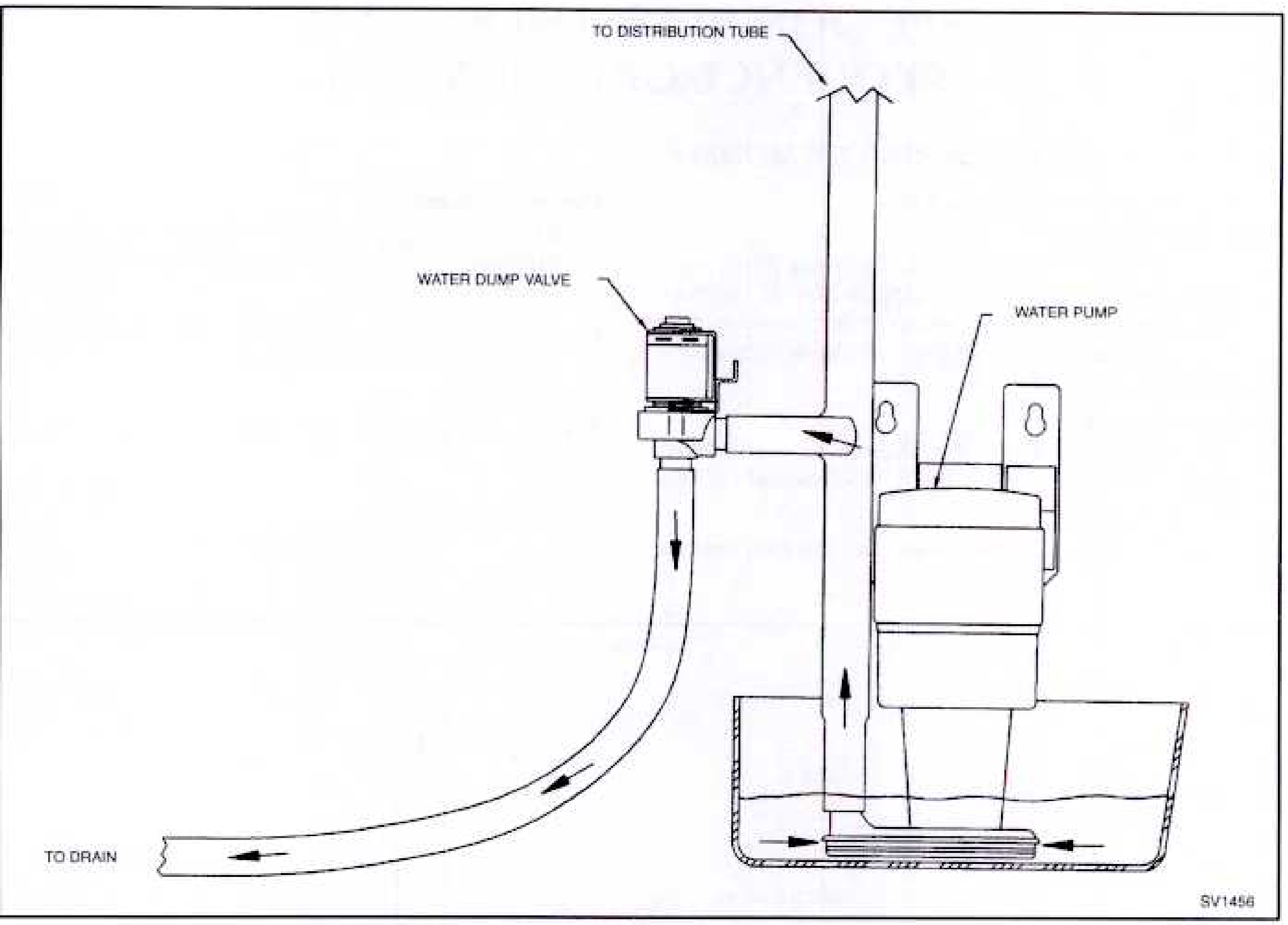

Figure 5-2. WATER FLOW DOWN DRAIN

SECTION 6 - ELECTRICAL SYSTEM

BASIC ENERGIZED PARTS CHARTS

Self-Contained Air- or Water-Cooled Models

SEQUENCE OF OPERATION	Control Board Relays				Contactor		Length of On Time
	1	2	3	4	4A	4B	
	Water Pump	Hot Gas Valve	Water Dump Valve	Contactor Coil	Compressor	Condenser Fan Motor	
Initial Start-Up/ Start-Up After Auto Shut-Off	ON	OFF	ON	OFF	OFF	OFF	45 Seconds
Freeze Sequence Prechill	OFF	OFF	OFF	ON	ON	May Cycle OFF/ON	30 Seconds
Freeze	ON	OFF	OFF	ON	ON	May Cycle OFF/ON	Water Contact with Ice Thickness Probe
Harvest Sequence Water Purge	ON	ON	ON	ON	ON	May Cycle OFF/ON	45 Seconds
Harvest	OFF	ON	OFF	ON	ON	May Cycle OFF/ON	Bin Switch
Auto Shut-Off	OFF	OFF	OFF	OFF	OFF	OFF	Until Bin Switch Recloses

Condenser Fan Motor: The condenser fan motor is wired through the fan cycle control. Therefore, it may cycle OFF and ON.

Safety Timers: The control board has the following non-adjustable safety timers:

Freeze Sequence: For the first 6 minutes, the ice machine is locked in the freeze sequence, not allowing the ice thickness probe to initiate a harvest sequence.
The maximum freeze time is 60 minutes, at which time the control board automatically initiates a harvest sequence.

Harvest Sequence The maximum harvest time is 3-1/2 minutes, at which time the control board automatically terminates the harvest sequence.

Remote Models

SEQUENCE OF OPERATION	Control Board Relays				L.P. Control	Contactor	Length of On Time
	1	2	3	4			
	Water Pump	A. Hot Gas Valve B. H.P.R. Valve	Water Dump Valve	Liquid Line Solenoid	Contactor Coil	A. Compressor B. Condenser Fan Motor	
Initial Start-Up/ Start-Up After Auto Shut-Off	ON	OFF	ON	OFF	OPEN	OFF	45 Seconds
Freeze Sequence Prechill	OFF	OFF	OFF	ON	CLOSED	ON	30 Seconds
Freeze	ON	OFF	OFF	ON	CLOSED	ON	Water Contact with Ice Thickness Probe
Harvest Sequence Water Purge	ON	ON	ON	ON	CLOSED	ON	45 Seconds
Harvest	OFF	ON	OFF	ON	CLOSED	ON	Bin Switch
Auto Shut-Off	OFF	OFF	OFF	OFF	OPEN	OFF	Until Bin Switch Recloses

H.P.R. - Harvest pressure regulating valve.

> **Note**
> A low pressure (L.P.) cutout control energizes and de-energizes the contactor coil.

Condenser Fan Motor: The condenser fan motor is wired through the fan cycle control. Therefore, it may cycle OFF and ON.

Safety Timers: The control board has the following non-adjustable safety timers:

Freeze Sequence: For the first 6 minutes, the ice machine is locked in the freeze sequence, not allowing the ice thickness probe to initiate a harvest sequence.
The maximum freeze time is 60 minutes, at which time the control board automatically initiates a harvest sequence.

Harvest Sequence: The maximum harvest time is 3-1/2 minutes, at which time the control board automatically terminates the harvest sequence.

WIRING DIAGRAM SEQUENCE OF OPERATION - SELF-CONTAINED MODELS

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

The water curtain must be on (bin switch closed) to start the ice machine.

When placing the toggle switch in the ICE position or after an Auto Shut-off, Control Board Relay contact #1 closes to energize the Water Pump, and Control Board Relay contact #3 closes to energize the Water Dump Valve.

Relays #1 and #3 open after 45 seconds to de-energize the Water Pump and Water Dump Valve.

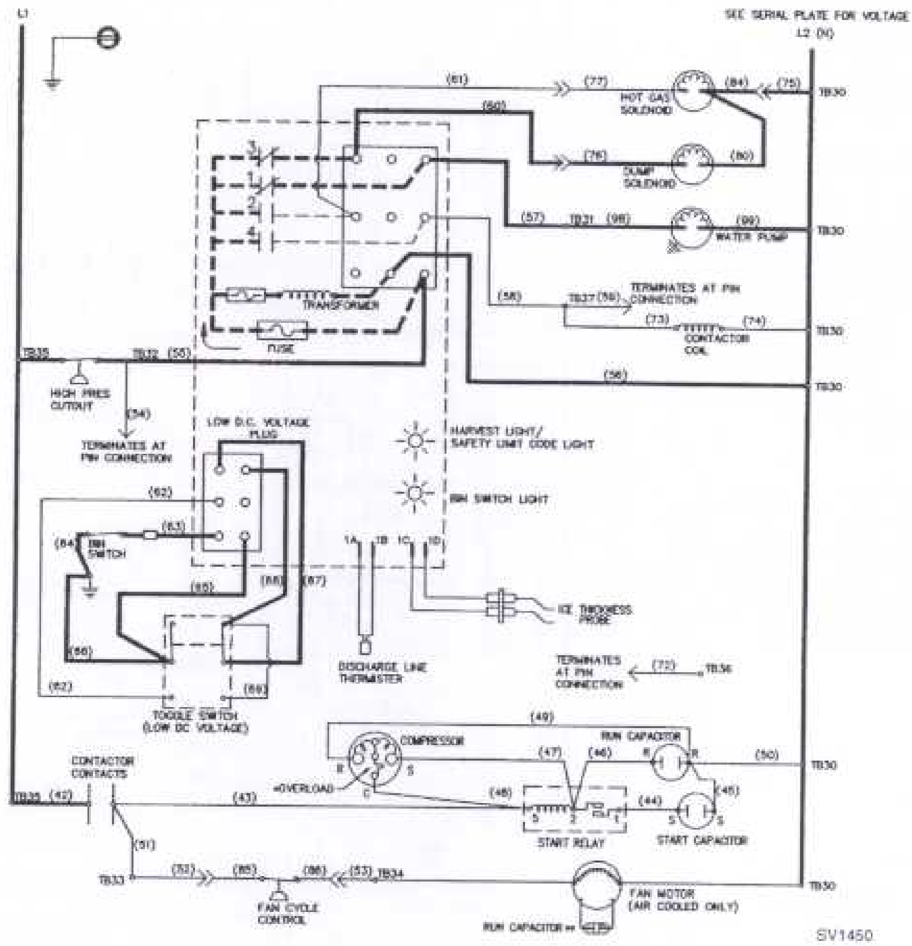

Figure 6-1.

Initial Start-Up Electrical Sequence (45 Seconds)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Closed
     - Water Pump .... ON
   - #2 .... Open
     - Hot Gas Solenoid .... OFF
   - #3 .... Closed
     - Water Dump Valve .... ON
   - #4 .... OPEN
     - Contactor Coil .... De-Energized
       - A. Compressor .... OFF
       - B. Condenser Fan Motor .... OFF
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Freeze Sequence - Pre-Chill

Control Board Relay contact #4 closes to energize the Contactor.

With the Contactor energized, the Compressor and Condenser Fan Motor are energized. (The fan motor, on air-cooled models only, may cycle off and on, as it is wired through a Fan Cycle Control.)

With the Compressor running without water flow, the evaporator is pre-chilling for 30 seconds prior to starting to freeze water.

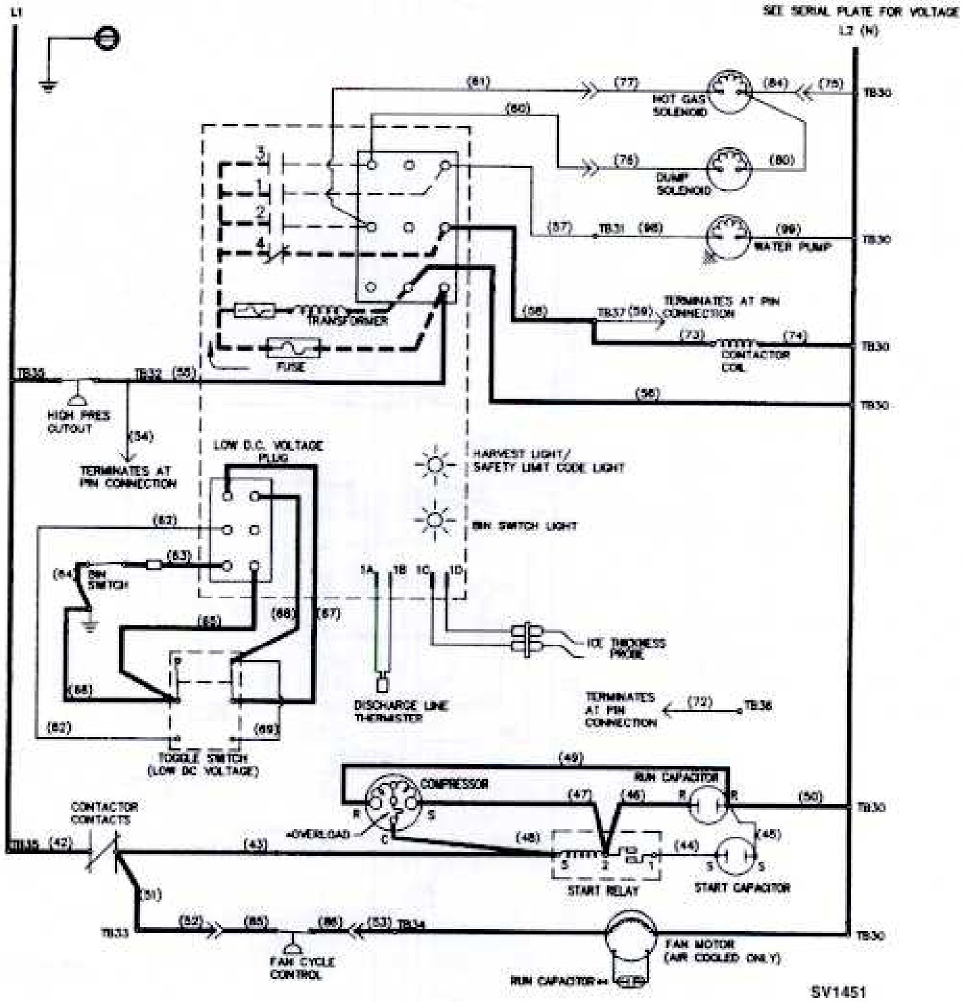

Figure 6-2.

Freeze - Pre-Chill Electrical Sequence (30 Seconds)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Open
     - Water Pump .... OFF
   - #2 .... Open
     - Hot Gas Solenoid .... OFF
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Closed
     - Contactor Coil .... Energized
       - A. Compressor .... ON
       - B. Condenser Fan Motor .... ON
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Freeze Sequence

Control Board Relay contact #4 remains closed to keep the Compressor and Condenser Fan Motor ON.

After pre-chill of the Evaporator is completed (30 seconds), Relay Board contact #1 closes to energize the Water Pump.

The Water Pump directs an even flow of water across the Evaporator and into each Cube Cell, where it freezes.

When sufficient ice has formed, the **water flow** (not the ice itself) contacts the Ice Thickness Probes. After approximately seven seconds, the harvest sequence is initiated. The ice machine must be in the freeze cycle for 6 minutes prior to harvest initiation. (Refer to freeze time lock-in feature, page 6-27).

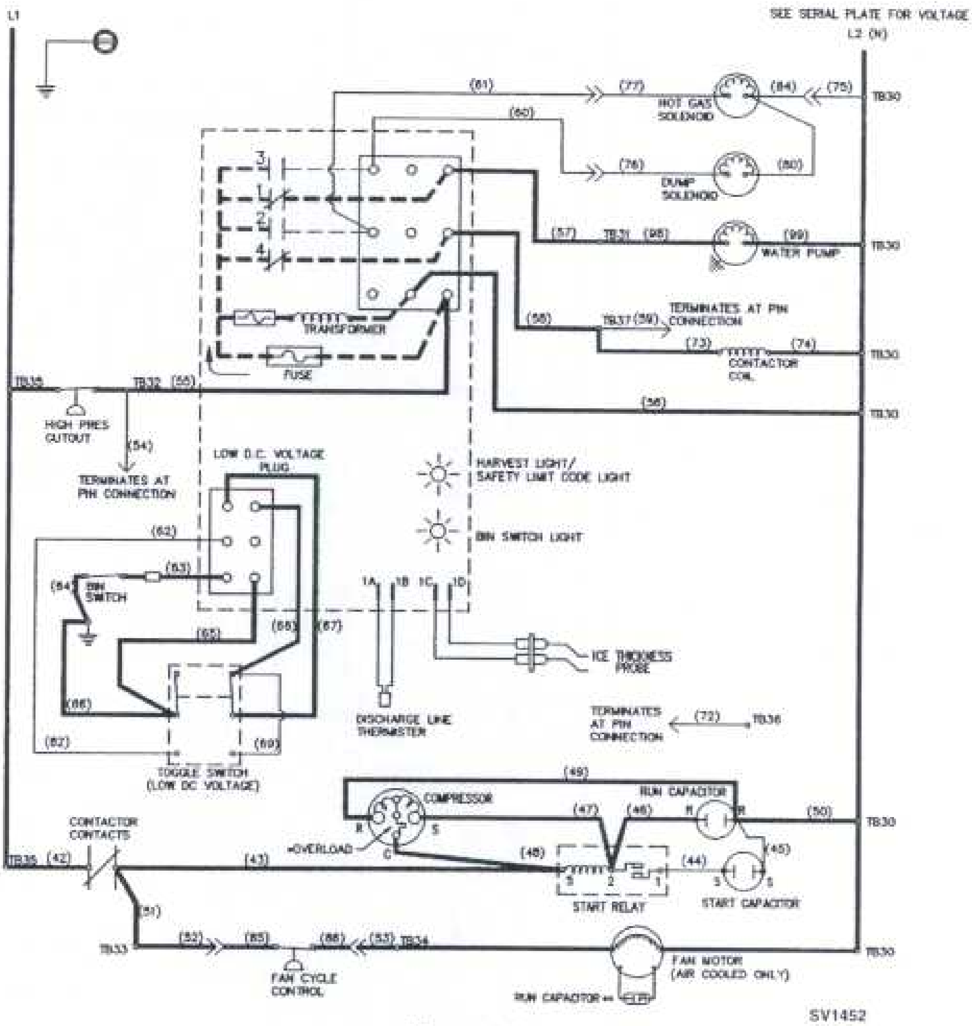

Figure 6-3.

Freeze Electrical Sequence (Until Water Contacts Ice Thickness Probes)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Closed
     - Water Pump .... ON
   - #2 .... Open
     - Hot Gas Solenoid .... OFF
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Closed
     - Contactor Coil .... Energized
       - A. Compressor .... ON
       - B. Condenser Fan Motor .... ON
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Harvest Purge

Control Board Relay contact #4 remains closed to keep the Compressor and Fan Motor ON. As discharge pressure drops, the Fan Motor may cycle off.

Control Board Relay contact #1 remains closed to keep the Water Pump ON.

Control Board Relay contact #3 closes to energize the Water Dump Valve.

Control Board Relay contact #2 closes to energize the Hot Gas Valve.

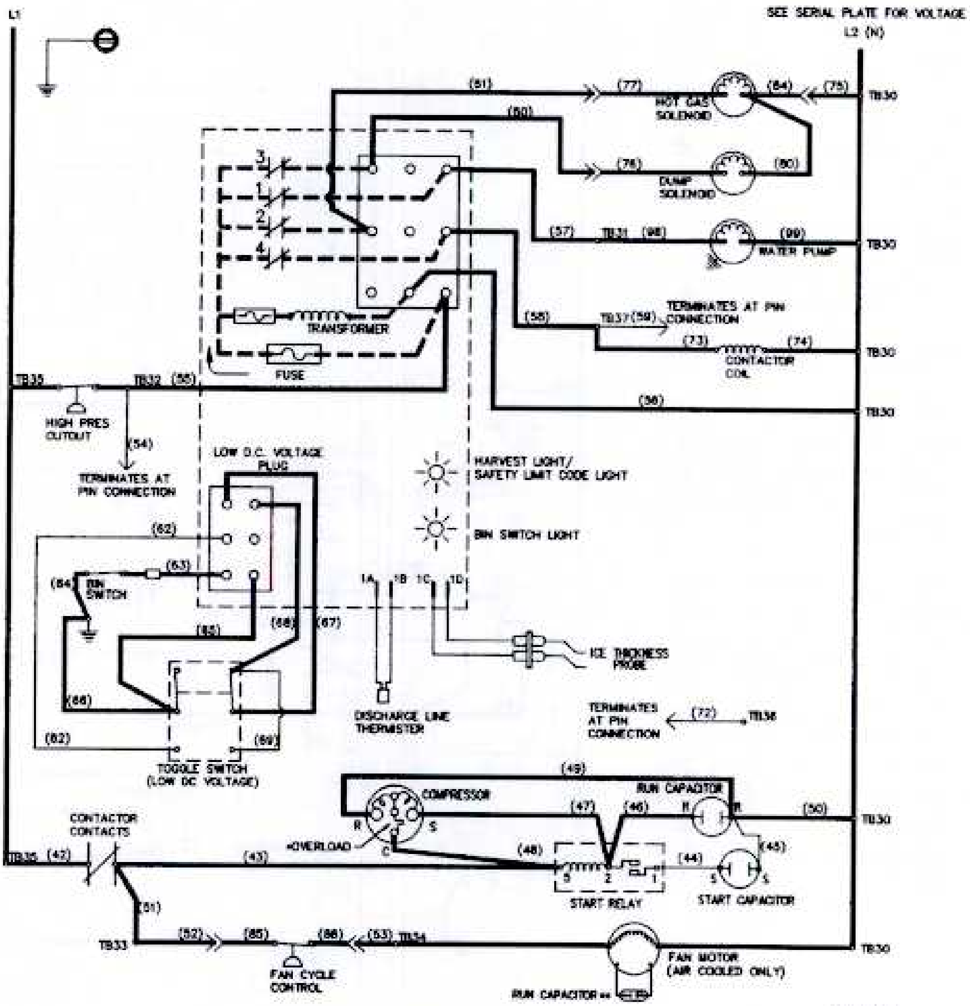

Figure 6-4.

Harvest - Purge Electrical Sequence (45 Seconds)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Closed
     - Water Pump .... ON
   - #2 .... Closed
     - Hot Gas Solenoid .... ON
   - #3 .... Closed
     - Water Dump Valve .... ON
   - #4 .... Closed
     - Contactor Coil .... Energized
       - A. Compressor .... ON
       - B. Condenser Fan Motor .... ON
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Harvest Sequence

Control Board Relay contact #4 remains closed to keep the Compressor and Condenser Fan Motor ON.

Control Board Relay contact #2 remains closed to keep the Hot Gas Valve open.

Control Board Relay contacts #1 and #3 open to de-energize the Water Pump and Water Dump Valve.

The hot refrigerant gas warms the evaporator, causing the cubes to slide, as a unit, off the evaporator and into the storage bin.

The sliding sheet of cubes swings the water curtain out, activating the Bin Switch. The momentary opening and reclosing of the Bin Switch (when the bin is empty) terminates the harvest sequence and returns the ice machine to the Freeze Sequence Pre-Chill.

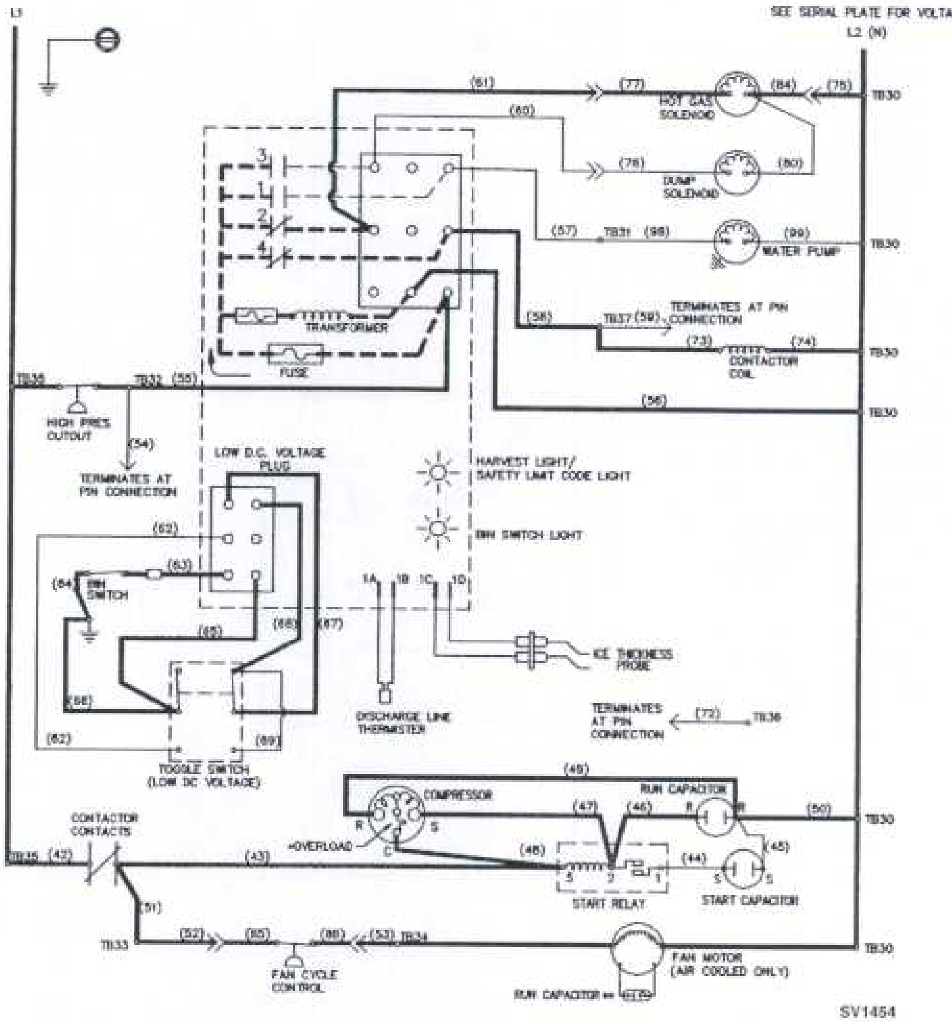

Figure 6-5.

Harvest Electrical Sequence

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Open
     - Water Pump .... OFF
   - #2 .... Closed
     - Hot Gas Solenoid .... ON
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Closed
     - Contactor Coil .... Energized
       - A. Compressor .... ON
       - B. Condenser Fan Motor .... ON
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Auto Shut-Off

At the end of a Harvest Sequence, if the Bin Switch is held open for more than 7 seconds, all four Control Board Relays open to shut the ice machine off. (When the storage bin is full, the last sheet of cubes holds the water curtain open.)

The ice machine remains off until sufficient ice is removed from the bin to allow the ice to clear the water curtain. As the water curtain swings back to operating position, the Bin Switch recloses and the ice machine restarts by returning to the Initial Start-Up Sequence.

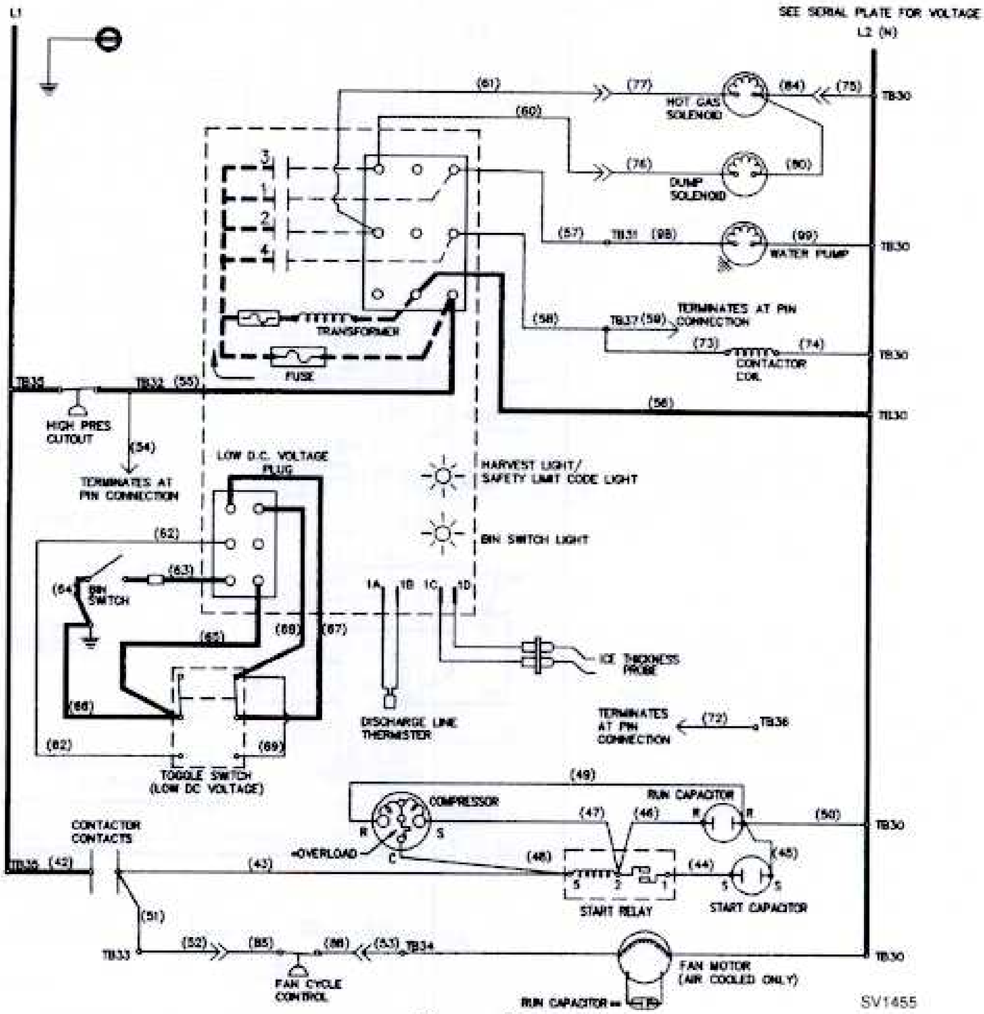

Figure 6-6.

Auto Shut-Off Electrical Sequence

1. Toggle Switch .... ICE
2. Bin Switch .... Open
3. Control Board Relays
   - #1 .... Open
     - Water Pump .... OFF
   - #2 .... Open
     - Hot Gas Solenoid .... OFF
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Open
     - Contactor Coil .... De-Energized
       - A. Compressor .... OFF
       - B. Condenser Fan Motor .... OFF
       - (Fan cycle control may cycle fan OFF and ON.)
4. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

WIRING DIAGRAM SEQUENCE OF OPERATION – REMOTE MODELS

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

The water curtain must be on (bin switch closed) to start the ice machine.

When placing the Toggle Switch in the ICE position or after an Auto Shut-Off, Control Board Relay contact #1 closes to energize the Water Pump and Control Board Relay contact #3 closes to energize the Water Dump Valve. Relays #1 and #3 open after 45 seconds to de-energize the Water Pump and Water Dump Valve.

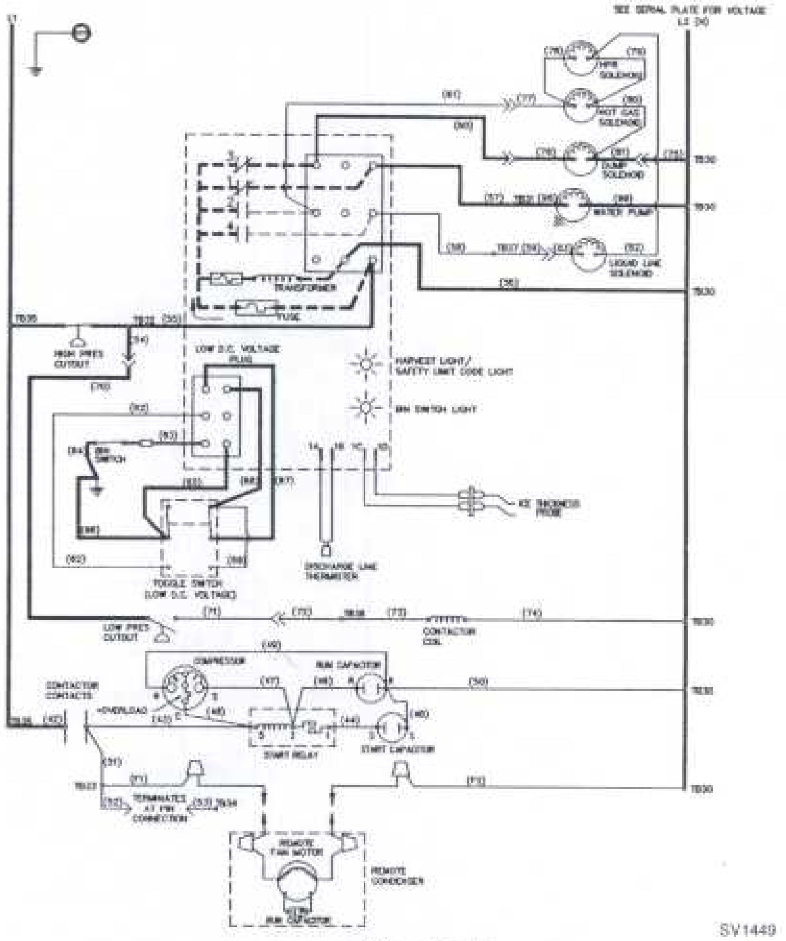

Figure 6-7.

Initial Start Electrical Sequence (45 Seconds)

1. Toggle Switch	ICE
2. Bin Switch	Closed
3. Control Board Relays	
#1	Closed
Water Pump	ON
#2	Open
A. Hot Gas Solenoid	OFF
B. Harvest Pressure Regulating (HPR) solenoid	OFF
#3	Closed
Water Dump Valve	ON
#4	Open
Liquid Line Solenoid	OFF
4.. Low Pressure Cut-Out Control	Open
Contactor Coil	De-Energized
A. Compressor	OFF
B. Remote Condenser Fan Motor	OFF
5. Safety Controls (Which could stop ice machine operation)	
A. High Pressure Cut-Out	Closed
B. Main Fuse (on control board)	Closed
C. Transformer Fuse (on control board)	Closed
D. Thermistor	Operation OK

Freeze Sequence - Pre-Chill

Control Board Relay contact #4 is closed to energize the Liquid Line Solenoid, causing the low side pressure to rise.

The Low Pressure Cut-Out Control is closed to energize the Contactor Coil. With the Contactor energized, the Compressor and Condenser Fan Motor are energized.

With the Compressor running without water flow, the Evaporator pre-chills for 30 seconds prior to starting to freeze water.

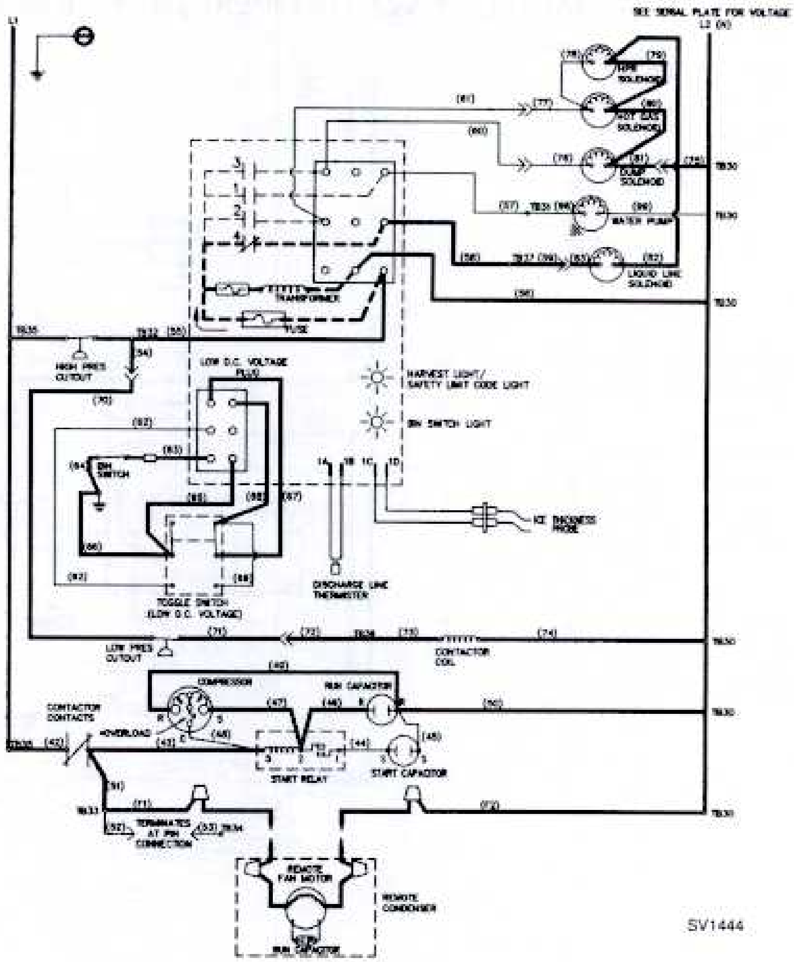

Figure 6-8.

Freeze Pre-Chill Electrical Sequence (30 Seconds)

1. Toggle Switch	ICE
2. Bin Switch	Closed
3. Control Board Relays	
#1	Open
Water Pump	OFF
#2	Open
A. Hot Gas Solenoid	OFF
B. Harvest Pressure Regulating (HPR) solenoid	OFF
#3	Open
Water Dump Valve	OFF
#4	Closed
Liquid Line Solenoid	ON
4.. Low Pressure Cut-Out Control	Closed
Contactor Coil	Energized
A. Compressor	ON
B. Remote Condenser Fan Motor	ON
5. Safety Controls (Which could stop ice machine operation)	
A. High Pressure Cut-Out	Closed
B. Main Fuse (on control board)	Closed
C. Transformer Fuse (on control board)	Closed
D. Thermistor	Operation OK

Freeze Sequence

Control Board Relay contact #4 remains closed to energize the Liquid Line Solenoid, which keeps the Compressor and Condenser Fan Motor ON.

After pre-chill of the Evaporator is completed (30 seconds), Relay Board contact #1 closes to energize the Water Pump.

The water pump directs an even flow of water across the Evaporator and into each Cube Cell, where it freezes.

When sufficient ice has formed, the water flow contacts the Ice Thickness Probes. After approximately seven seconds, the harvest sequence is initiated. The ice machine must be in the freeze cycle for 6 minutes prior to harvest initiation.

Refer to Freeze Time Lock In feature, page 6-27).

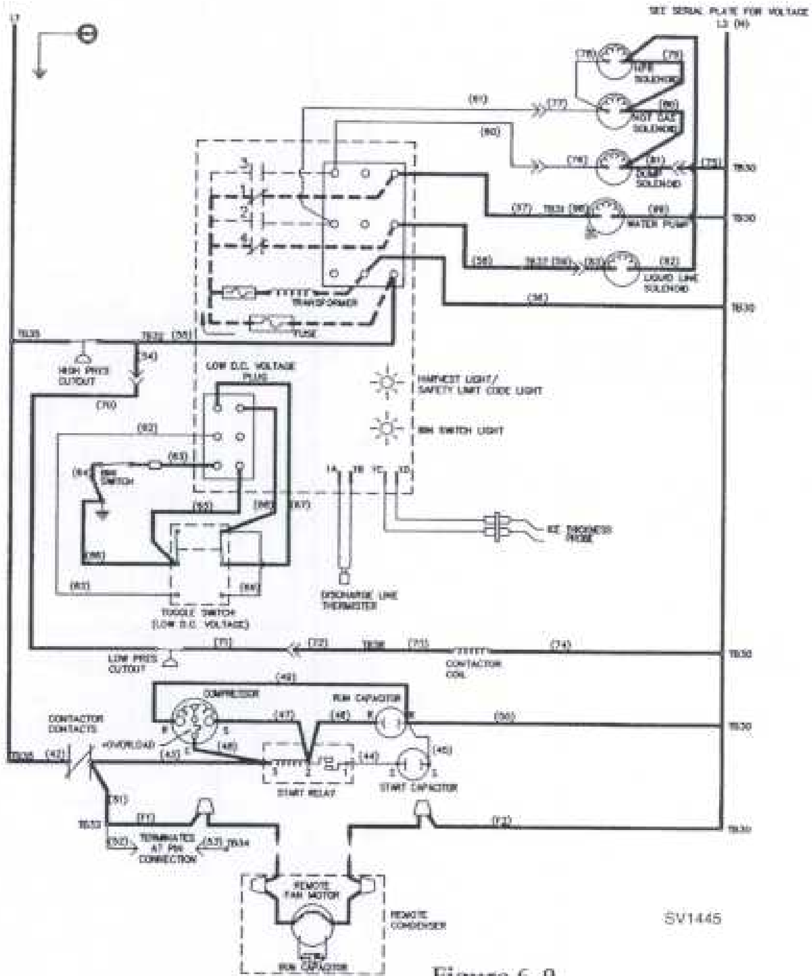

Figure 6-9.

Freeze Electrical Sequence (Until Water Contacts Ice Thickness Probes)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Closed
     - Water Pump .... ON
   - #2 .... Open
     - A. Hot Gas Solenoid .... OFF
     - B. Harvest Pressure Regulating (HPR) solenoid .... OFF
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Closed
     - Liquid Line Solenoid .... ON
4. Low Pressure Cut-Out Control .... Closed
   - Contactor Coil .... Energized
     - A. Compressor .... ON
     - B. Remote Condenser Fan Motor .... ON
5. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Harvest - Purge

Control Board Relay Contact #4 remains closed to energize the Liquid Line Solenoid, which keeps the Compressor and Condenser Fan Motor ON.

Control Board Relay contact #1 remains closed to keep the Water Pump ON.

Control Board Relay contact #3 closes to energize the Water Dump Valve.

Control Board Relay contact #2 closes to energize the Hot Gas Valve and HPR Valve.

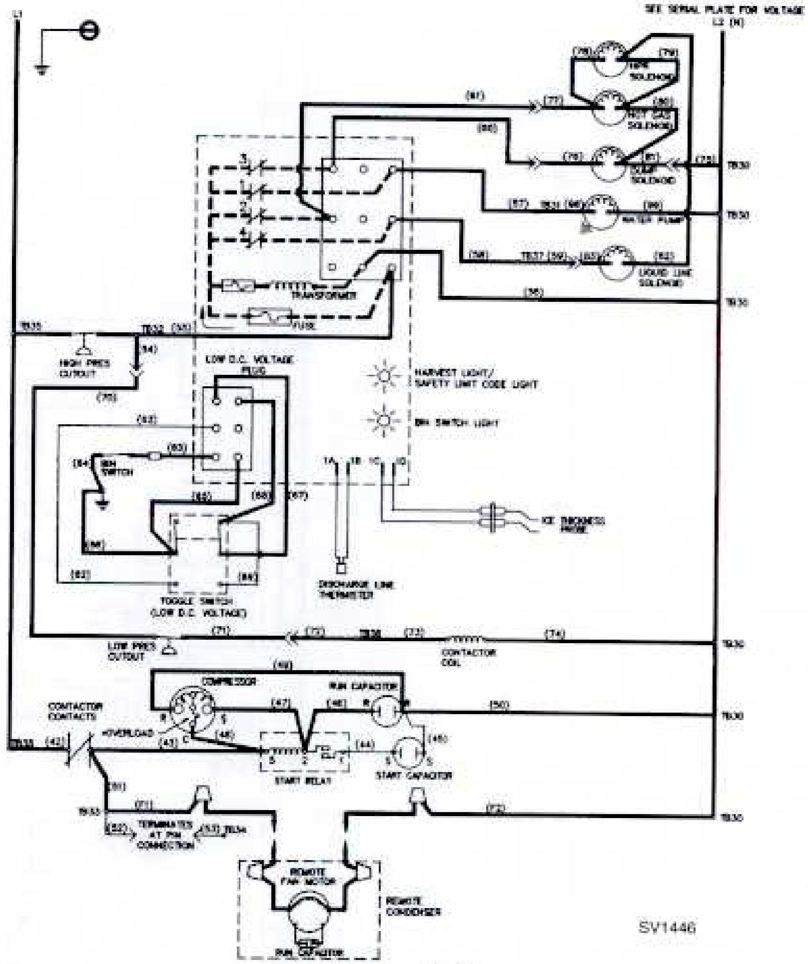

Figure 6-10.

Harvest - Purge Electrical Sequence (45 Seconds)

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Closed
     - Water Pump .... ON
   - #2 .... Closed
     - A. Hot Gas Solenoid .... ON
     - B. Harvest Pressure Regulating (HPR) solenoid .... ON
   - #3 .... Closed
     - Water Dump Valve .... ON
   - #4 .... Closed
     - Liquid Line Solenoid .... ON
4. Low Pressure Cut-Out Control .... Closed
   - Contactor Coil .... Energized
     - A. Compressor .... ON
     - B. Remote Condenser Fan Motor .... ON
5. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Harvest Sequence

Control Board Relay contact #4 remains closed to energize the Liquid Line Solenoid, which keeps the Compressor and Condenser Fan Motor ON.

Control Board Relay contact #2 remains closed to keep the Hot Gas Valve and HPR Valve open.

Control Board Relay contact #1 and #3 open to de-energize the Water Pump and Water Dump Valve.

The hot refrigerant gas warms the evaporator, causing the cubes to slide, as a unit, off the evaporator and into the storage bin.

The sliding sheet of cubes swings the water curtain out, activating the bin switch. The momentary opening and reclosing of the bin switch (when the bin is empty) terminates the harvest sequence and returns the ice machine to the Freeze Sequence Pre-Chill.

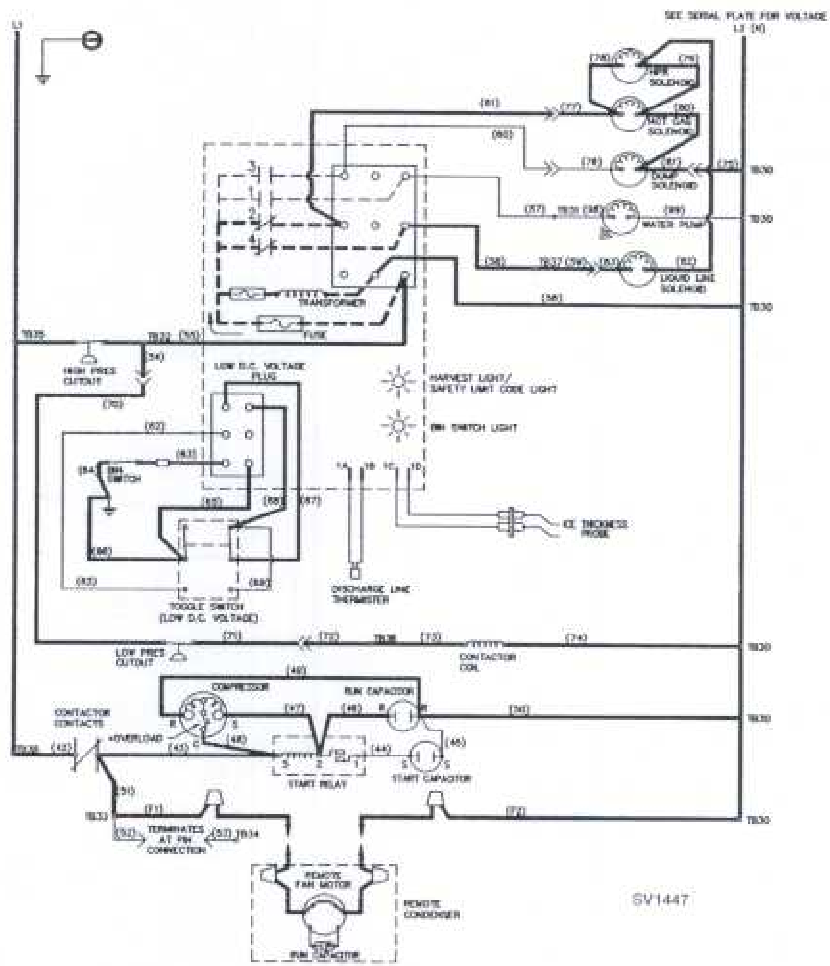

Figure 6-11.

Harvest Electrical Sequence

1. Toggle Switch	ICE
2. Bin Switch	Closed
3. Control Board Relays	
#1	Open
Water Pump	OFF
#2	Closed
A. Hot Gas Solenoid	ON
B. Harvest Pressure Regulating (HPR) solenoid	ON
#3	Open
Water Dump Valve	OFF
#4	Closed
Liquid Line Solenoid	ON
4.. Low Pressure Cut-Out Control	Closed
Contactor Coil	Energized
A. Compressor	ON
B. Remote Condenser Fan Motor	ON
5. Safety Controls (Which could stop Ice Machine Operation)	
A. High Pressure Cut-Out	Closed
B. Main Fuse (on control board)	Closed
C. Transformer Fuse (on control board)	Closed
D. Thermistor	Operation OK

Auto Shut-Off

When the ice storage bin becomes full, the last sheet of ice cubes holds the water curtain open. Thus the bin switch is held open for more than seven seconds, and all four Control Board relays remain open to shut the ice machine off. Control Board relay contact #4 opens to de-energize the Liquid Line Solenoid.

The ice machine will pump down the low side of the system until the low pressure control reaches its cut-out setting. This de-energizes the contactor coil, which stops the Compressor and Condenser Fan.

The ice machine remains off until sufficient ice is removed from the bin to allow ice to clear the water curtain. As the water curtain swings back to operating position, the bin switch recloses and the ice machine restarts by returning to the Initial Start-Up Sequence.

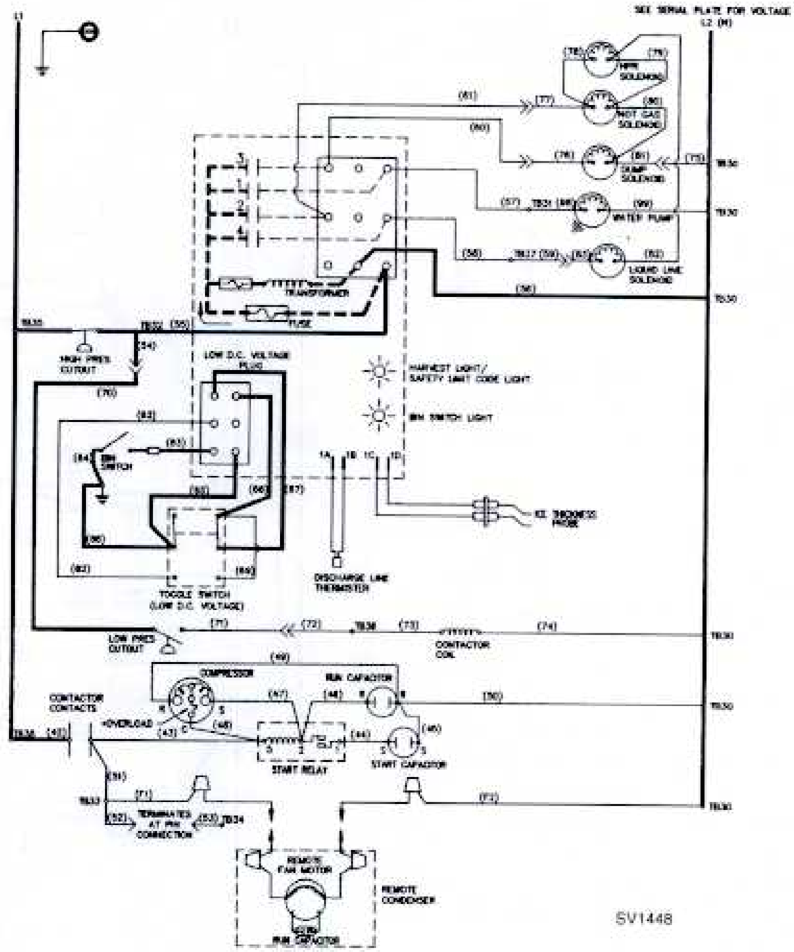

Figure 6-12.

Auto Shut-Off Electrical Sequence

1. Toggle Switch .... ICE
2. Bin Switch .... Closed
3. Control Board Relays
   - #1 .... Open
     - Water Pump .... OFF
   - #2 .... Open
     - A. Hot Gas Solenoid .... OFF
     - B. Harvest Pressure Regulating (HPR) solenoid .... OFF
   - #3 .... Open
     - Water Dump Valve .... OFF
   - #4 .... Open
     - Liquid Line Solenoid .... OFF
4. Low Pressure Cut-Out Control .... Open
   - Contactor Coil .... De-Energized
     - A. Compressor .... OFF
     - B. Remote Condenser Fan Motor .... OFF
5. Safety Controls (Which could stop ice machine operation)
   - A. High Pressure Cut-Out .... Closed
   - B. Main Fuse (on control board) .... Closed
   - C. Transformer Fuse (on control board) .... Closed
   - D. Thermistor .... Operation OK

Wiring Diagram Legend

Symbol on Diagram	Meaning
*	The wire diagrams show an internal compressor overload. Some models have external compressor overloads.
* *	The wire diagram shows a fan motor run capacitor. Some models do not incorporate a fan motor run capacitor.
T.B.	The letters T.B. followed by a number shows a connection at the terminal board. The T.B. numbers are printed on the actual terminal board.
( )	Numbers inside of "( )" are separate wire number designations. Each separate wire has its own number, and the number is marked at each end of the wire.
——> >——	This is the plastic multi-pin connector which wires pass through to exit the electrical box and enter into the refrigeration system area. (The arrows do not indicate direction of current flow.)
	electrical box side ——> >—— compressor compartment side

B MODEL SINGLE EVAPORATOR SELF-CONTAINED 1 PHASE

CAUTION: DISCONNECT POWER BEFORE WORKING ON ELECTRICAL CIRCUITRY.

DIAGRAM SHOWN DURING FREEZE CYCLE.

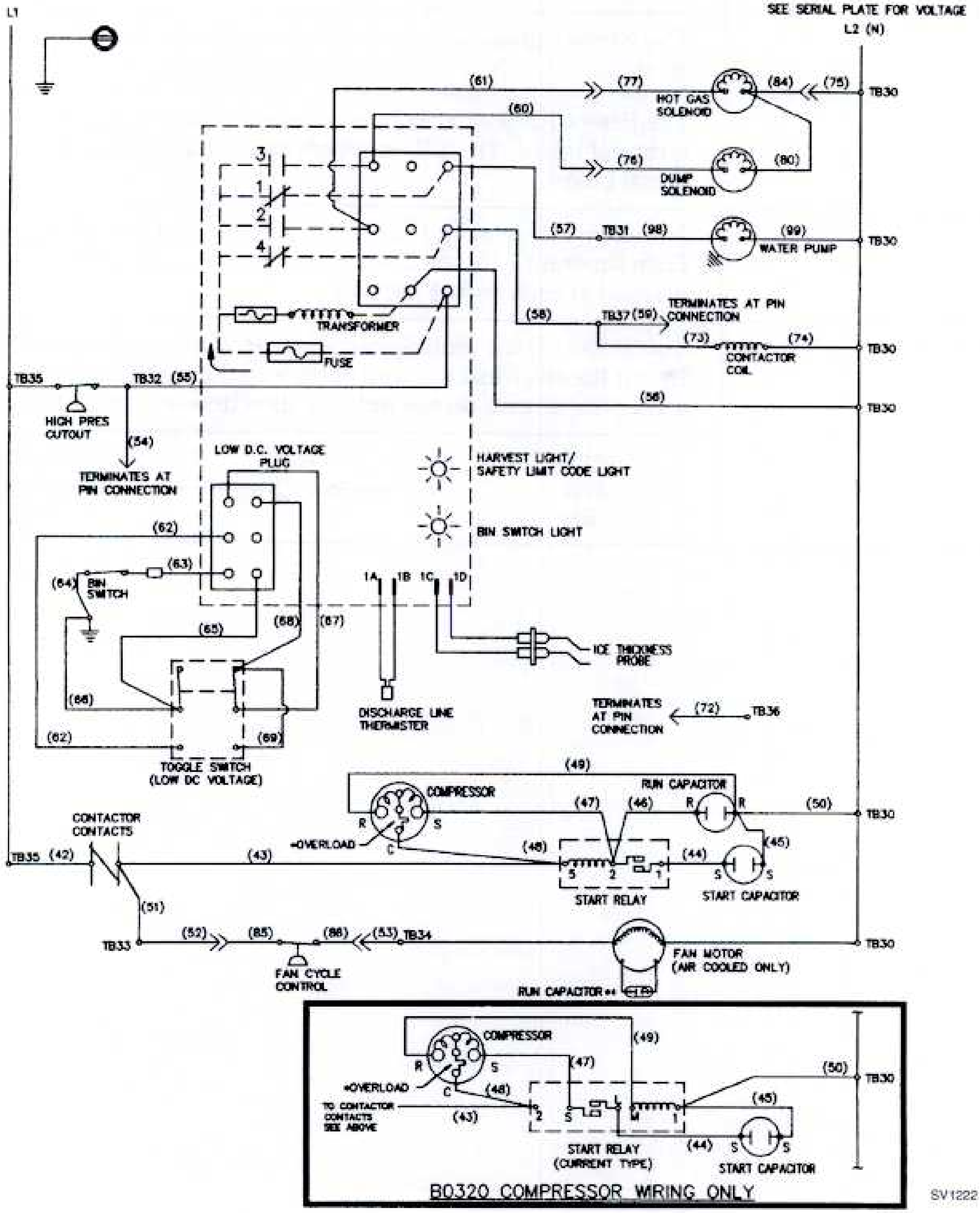

Figure 6-13.

B MODEL SINGLE EVAPORATOR SELF-CONTAINED 3 PHASE

CAUTION: DISCONNECT POWER BEFORE WORKING ON ELECTRICAL CIRCUITRY.

DIAGRAM SHOWN DURING FREEZE CYCLE.

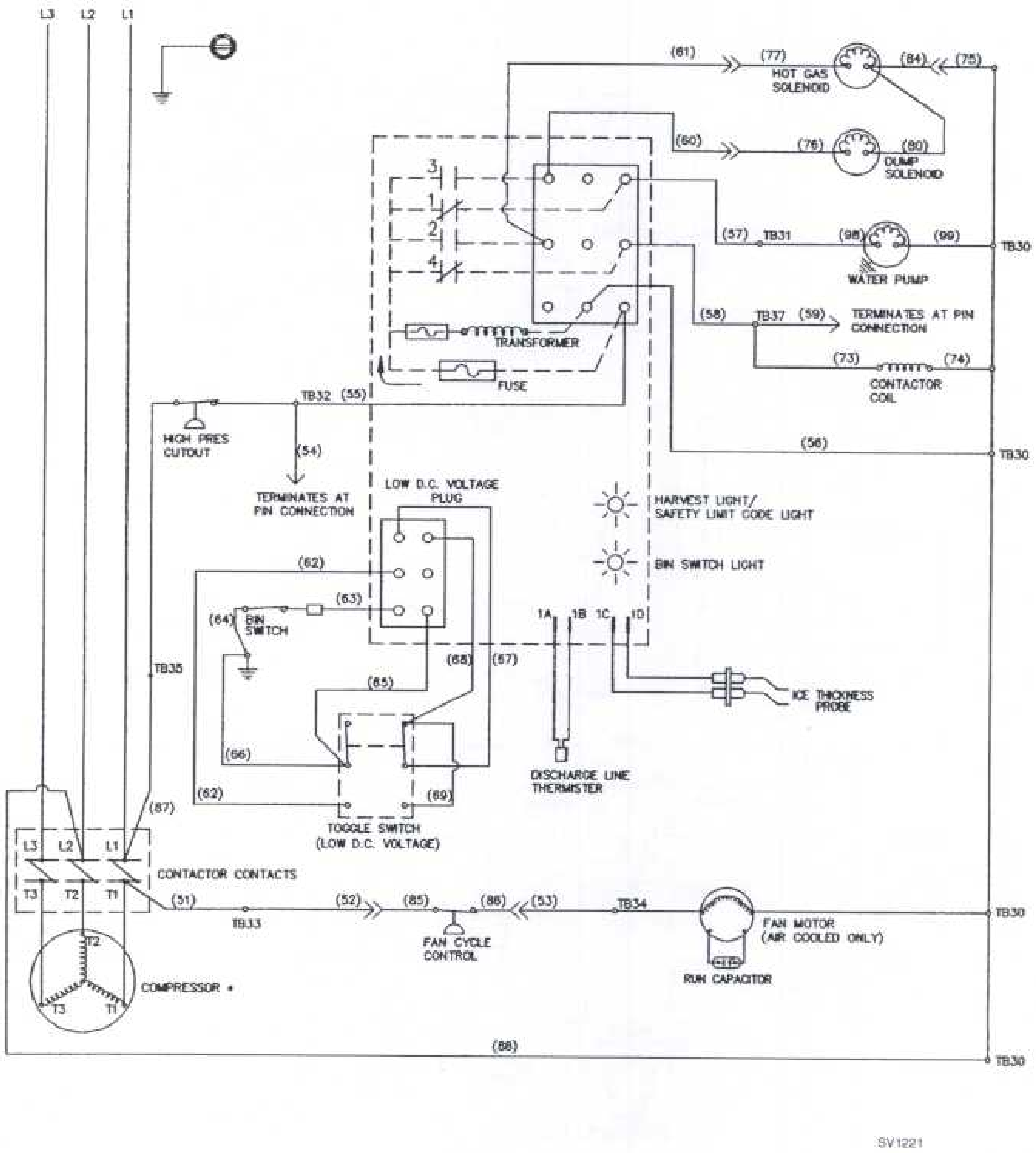

Figure 6-14.

B-SERIES SINGLE EVAPORATOR
REMOTE 1 PHASE

CAUTION: DISCONNECT POWER BEFORE WORKING ON ELECTRICAL CIRCUITRY.

DIAGRAM SHOWN DURING FREEZE CYCLE.

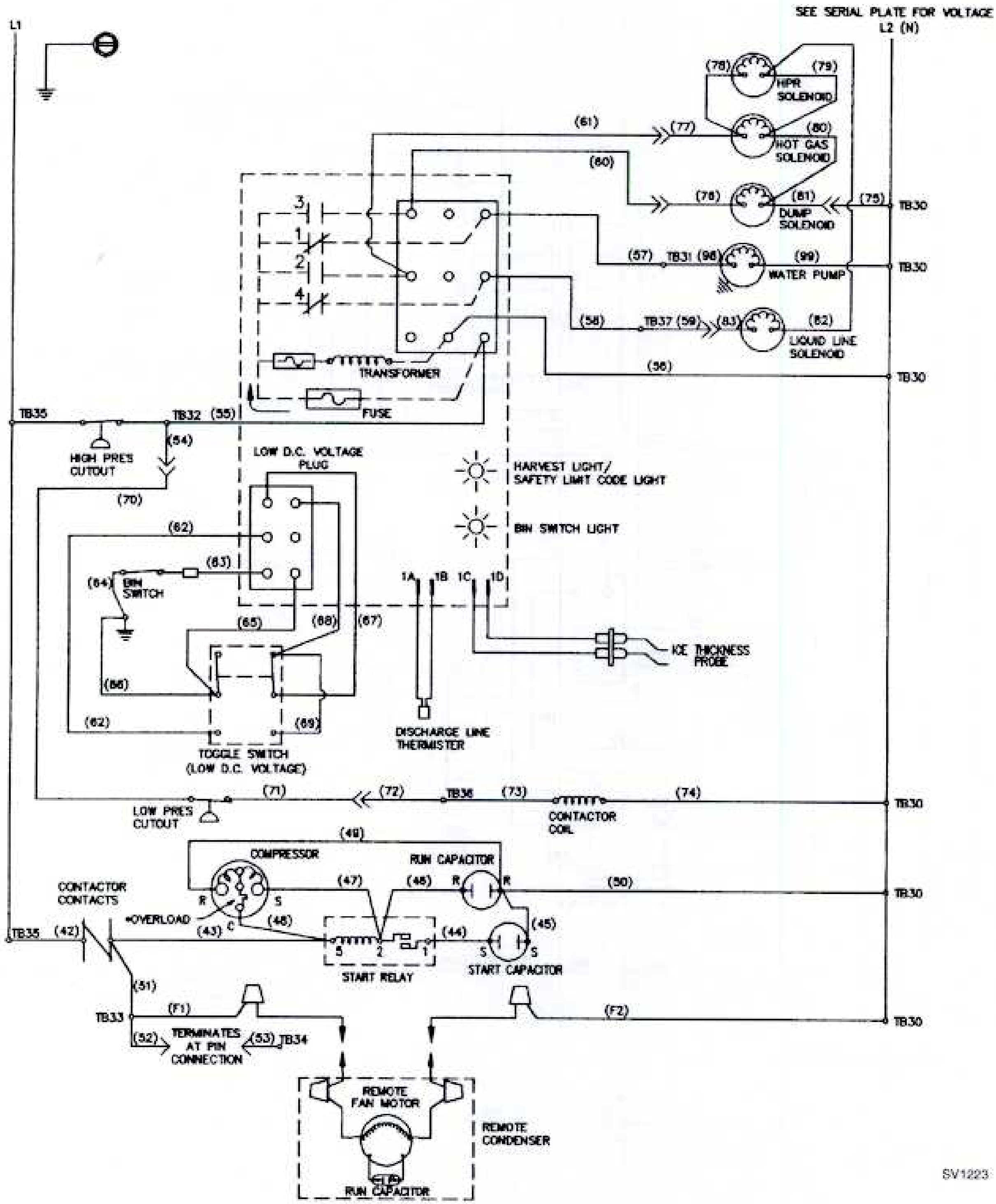

Figure 6-15.

B MODEL SINGLE EVAPORATOR SELF-CONTAINED 1 PHASE

CAUTION: DISCONNECT POWER BEFORE WORKING ON ELECTRICAL CIRCUITRY.

DIAGRAM SHOWN DURING FREEZE CYCLE.

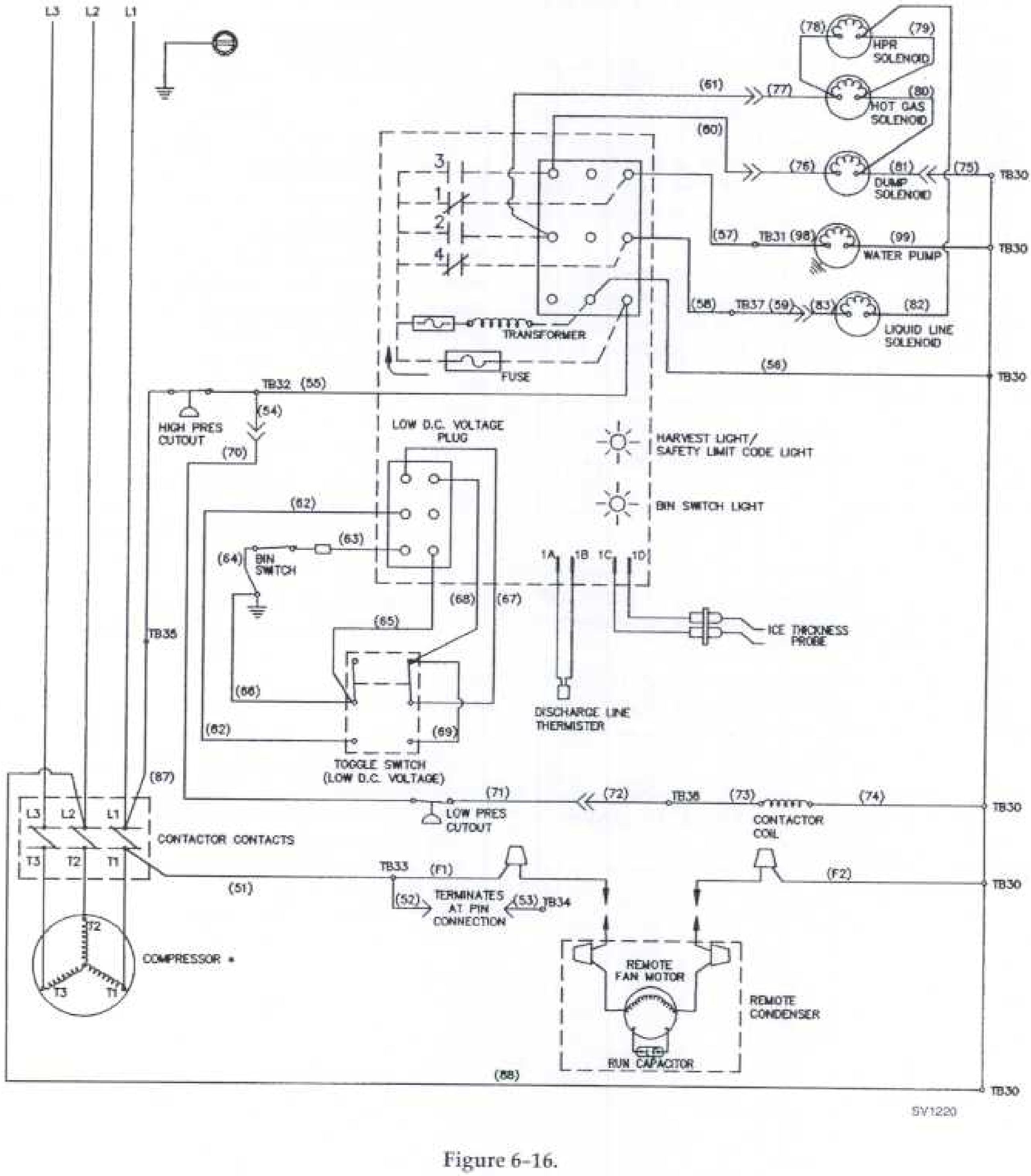

Figure 6-16.

COMPONENT SPECIFICATION AND DIAGNOSTICS

BIN SWITCH

Function

Bin switch operation is controlled by movement of the water curtain and has two functions:

1. The momentary opening of the bin switch terminates the harvest sequence and returns the ice machine to the freeze sequence.
2. Automatic ice machine shut off. The bin switch can be opened and closed at any point during the freeze cycle without interfering with the electrical control sequence. At the end of a harvest sequence, when the storage bin is full, the last sheet of cubes hold the water curtain open. When the bin switch is held open for more than 7 seconds, the ice machine will shut off.

   The ice machine remains off until sufficient ice is removed from the bin to allow the ice to clear the water curtain. As the water curtain swings closed, the bin switch recloses and the ice machine starts another freeze cycle.

> **Note**
> 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 hand corner of the water curtain. The switch portion is attached to the evaporator mounting bracket.

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

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

Check Procedure

1. Place the toggle switch in the OFF position.
2. Watch the bin switch light (bottom one) on the unitized ice sensor board.
3. With the water curtain toward the evaporator, the bin switch must close. The light "on" indicates the bin switch has properly closed.
4. With the water curtain pulled away from the evaporator, the bin switch must open. The light "off" indicates the bin switch has opened properly.

> **Note**
> The bin switch may also be checked by isolating it from other components and using an ohmmeter.

Water Curtain Removal

The water curtain must be on (Bin Switch closed) to start ice making. After it has started, the water curtain can be removed and replaced at any point during the freeze cycle without interfering with the electrical control sequence. If the ice machine goes into harvest while the curtain is removed, one of the following will happen:

a. Water curtain remains off.

   When the harvest cycle time reaches 3.4 minutes and the bin switch is not reclosed, the ice machine stops as though the bin were full.

b. Water curtain put back on:

   When the bin switch recloses prior to reaching the 3.5 minute point, the ice machine immediately returns to another freeze sequence prechill.

> **Important**
> When the ice machine cycles into harvest with the water curtain removed, **it is normal** for the harvest light to turn off and remain off, and for the ice machine to skip the water purge (first 45 seconds of harvest) even though the ice machine is in the harvest cycle.

COMPRESSOR ELECTRICAL DIAGNOSTICS

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

A. CHECK RESISTANCE (OHM) VALUES
Compressors 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 (approximately 120°F/48.9°C) to assure overload is closed and the resistance readings will be accurate.

1. Single Phase Compressors
   a. Disconnect power from cuber and remove wires from compressor terminals.
   b. With wires removed, the resistance values must be within guidelines for the compressor. The resistance value from C to S and C to R added together should equal the resistance value from S to R.
   c. An open overload will give a resistance reading from S to R and an "Open" reading from C to S and from C to R. Allow the compressor to cool, then recheck readings.
2. Three Phase Compressors
   a. Disconnect power from cuber and remove wires from compressor terminals.
   b. With wires removed, the resistance values must be within guidelines for the compressor. L1 to L2; L2 to L3; and L1 to L3, should all be equal to each other.
   c. An open overload will give a resistance reading of "Open" from L1 to L2; L2 to L3; and L1 to L3. Allow compressor to cool, then recheck readings.

B. CHECK MOTOR WINDINGS TO GROUND
Check continuity between all three terminals and the compressor shell or copper refrigeration line (be sure to scrape metal surface clean to get good contact). If continuity is present, the compressor windings are grounded and the compressor should be replaced.

C. DETERMINE IF THE COMPRESSOR IS "SEIZED"
Check the amp draw while compressor is trying to start.

1. Compressor drawing locked rotor.

   The two likely causes would be a defective starting component or a mechanically seized compressor. To determine which you have:
   a. Install high and low side gauges.
   b. Try to start the compressor (watch the pressures closely).
   c. If the pressures do not move, the compressor is seized up. Replace compressor.
   d. If the pressures move, the compressor is turning slowly and is not seized. Check capacitors and start relay.
2. Compressor drawing high amps
   The continuous amperage draw on start-up should not be near the maximum fuse size as indicated on the serial tag.

   The voltage at the time the compressor is trying to start must be within ±10% of the nameplate voltage.

D. DIAGNOSING CAPACITORS AND RELAYS

1. Capacitors
   If the compressor attempts to start, or hums and trips the overload protector, you must check the starting components before replacing the compressor.
   a. Capacitors can show visual evidence of failure, such as a bulged terminal end or a ruptured membrane. **Do not assume a capacitor is good** if no visual signs are evident.
   b. A good test is to install a known good substitute capacitor.
   c. Use a capacitor tester when checking a suspect capacitor. Remember to clip the bleed resistor off the capacitor terminals before testing.

2. Potential-type Relays
   Potential relay contacts are closed during the initial starting cycle, and open as the compressor comes up to speed. To check:
   a. Disconnect the power supply.
   b. Remove the wires from the relay.
   c. Use a high voltage ohm meter to check the relay coil. If open, replace. If continuity is present, it is ok.
   d. Use an ohm meter to check across the contacts. Potential relay contacts are normally closed.
3. Current-type Relays
   Current relay contacts are normally open. To check:
   a. Disconnect the power supply.
   b. If the relay is on the compressor, pull it off.
   c. Keeping relay upright, check continuity with ohm meter. If it is closed, replace it.

> **Note**
> Turning the relay upside down will give a closed reading.

   d. Check continuity through the relay coil. Replace if there is no continuity.

Manitowoc B-Model Ice Machine Compressors

Ice Machine	Compressor Part Number	Compressor Model Number	Voltage/ Cycle/Phase	Winding OHM Values			Locked Rotor Amps
				1PH C-S	C-R	R-S	
				3 PH T1-T2	T1-T3	T2-T3	
B150 B200 B250 B320	84-0122-3 84-0143-3 84-0127-3	AK9428E AK9428E AK9428E	115/60/1 208-230/60/1 220-240/50/1	4.50-4.60 6.23 7.13	0.68-0.69 2.75 3.15	5.18-5.29 8.98 10.28	48 23 21
B420 B450	84-0116-3 84-0137-3 84-0126-3	AK9458J AK9458J AK9458J	115/60/1 208-230/60/1 220-240/50/1	4.52-6.02 10.43 7.11	0.55-0.69 1.77 2.69	5.07-6.71 12.20 9.80	50 31 26.3
B600	84-0115-3 84-0078-3	M53B982BBCB H23B223ABHB	208-230/60/1 220-240/50/1	3.28 1.12	1.13 3.07	4.41 4.19	53 53
B800	84-0123-2 84-0125-3 84-0128-3	M53B143BBCB M51B143DBLB M51B143BBKB	208-230/60/1 208-230/60/3 220-240/50/1	2.45 2.00 5.05	0.81 2.00 1.18	3.26 2.00 6.23	66 48 53
B1000	84-0114-3 84-0139-3 84-0142-3	M53B203BBCB M53B203DBDB H25B32QABHB	208-230/60/1 208-230/60/3 220-240/50/1	2.47 1.35 2.76	0.61 1.35 0.83	3.08 1.35 3.59	60 60 80

Compressor part and model numbers may change without notice. Always refer to the Parts Manual and the Serial Tag on the compressor, and verify proper compressor specifications.

DISCHARGE LINE THERMISTOR

Function

Senses the compressor discharge line temperature. This is used in conjunction with the unitized ice sensor safety limits to stop the ice machine if the discharge line temperature falls below 85°F (29.4°C) or rises above 255°F (123.9°C).

Specifications

100,000 Ohms +/- 2% @ 77°F (25°C)

> **Important**
> Use only Manitowoc thermistors.

Thermistors generally fail because of moisture or physical damage. Manitowoc B-Model discharge line thermistors are encased in a specially-designed, moisture-sealed aluminum block. This eliminates physical damage and moisture-related concerns.

Check Procedure

Verify that the thermistor resistance is accurate and corresponding to the high and low temperature ranges.

1. Disconnect the discharge line thermistor from the terminals 1A and 1B on the unitized ice sensor board. Connect the ohm meter to the isolated thermistor wire leads.
2. Using a quality temperature meter capable of taking readings on curved copper lines, attach the temperature meter sensing device to the compressor discharge line next to the thermistor aluminum block.

> **Important**
> Do not simply "insert" probe (or other sensing device) under insulation. It must be "attached to" and reading the <u>actual</u> temperature of the copper compressor discharge line.

3. With the ice machine running, verify that the thermistor resistance (Step 1) corresponds to the temperature of the thermistor block on the compressor discharge line (Step 2). It is normal for the compressor discharge line temperature to rise during the freeze cycle and drop during the harvest cycle. Use the freeze cycle to verify that the thermistor is accurate at higher temperatures and the harvest cycle to verify it is accurate at lower temperatures.

> **Note**
> If the ice machine is inoperable, the thermistor may be removed and placed (for a short period of time) in an ice bath and then in boiling water to verify its accuracy.

If the thermister would fail closed:

On start-up, as soon as contact #4 on the control board closes (compressor starts or liquid line solenoid energizes), 15 seconds later, the ice machine stops on safety limit #4.

If the thermister would fail open:

The ice machine would start and run through two normal freeze and harvest cycles. During the third harvest cycle, the ice machine would stop on safety limit #3.

Discharge Line Thermistor Temperature Verses Resistance Relationship

As the temperature Rises at the thermistor "block", the resistance Drops.

Temperature (of thermistor "block")		Resistance
°F	°C	K ohms (x 1000)
32° (ice bath)	0° (ice bath)	376.7 - 283.6
50° - 60° 60° - 70° 70° - 80°	10.0° - 15.6° 15.6° - 21.1° 21.1° - 26.7°	198.9 - 153.1 153.1 - 118.8 118.8 - 92.9
80° - 90° 90° - 100° 100° - 110°	26.7° - 32.2° 32.2° - 37.8° 37.8° - 43.3°	92.9 - 73.3 73.3 - 58.2 58.2 - 46.6
110° - 120° 120° - 130° 130° - 140°	43.3° - 48.9° 48.9° - 54.4° 54.4° - 60.0°	46.6 - 37.5 37.5 - 30.5 30.5 - 24.9
140° - 150° 150° - 160° 160° - 170°	60.0° - 65.6° 65.6° - 71.1° 71.1° - 76.7°	24.9 - 20.4 20.4 - 16.8 16.8 - 14.0
170° - 180° 180° - 190° 190° - 200° 200° - 210°	76.7° - 82.2° 82.2° - 87.8° 87.8° - 93.3° 93.3° - 98.9°	14.0 - 11.7 11.7 - 9.8 9.8 - 8.2 8.2 - 7.0
212° (boiling water)	100° (boiling water)	7.3 - 6.2
220° - 230° 230° - 240° 240° - 250° 250° - 260°	104.4° - 110.0° 110.0° - 115.6° 115.6° - 121.1° 121.1° - 126.7°	5.9 - 5.1 5.1 - 4.3 4.3 - 3.7 3.7 - 3.3

Important

If ohm meter reads "O.L.", check the scale setting on the meter before changing the thermistor.

ICE/OFF/CLEAN TOGGLE SWITCH

Function

To place ice machine in ICE, OFF, or CLEAN mode of operation.

Specifications

Double pole, double throw switch.

The toggle switch is connected into a "varying" low D.C. voltage circuit. (Voltage does not remain constant.)

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 from other components by disconnecting all wires from the switch. Note where the wire numbers are connected to the switch terminals, or refer to wire diagram to take proper readings after wires have been disconnected.
3. Check across toggle switch terminals using a calibrated ohm meter. Correct readings are:

a. Switch set at ICE:

Terminals	Ohm reading
66-62	Open
67-68	Closed
67-69	Open

b. Switch set at CLEAN:

Terminals	Ohm reading
66-62	Closed
67-68	Open
67-69	Closed

c. Switch set at OFF:

Terminals	Ohm reading
66-62	Open
67-68	Open
67-69	Open

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

ELECTRONIC CONTROL BOARD

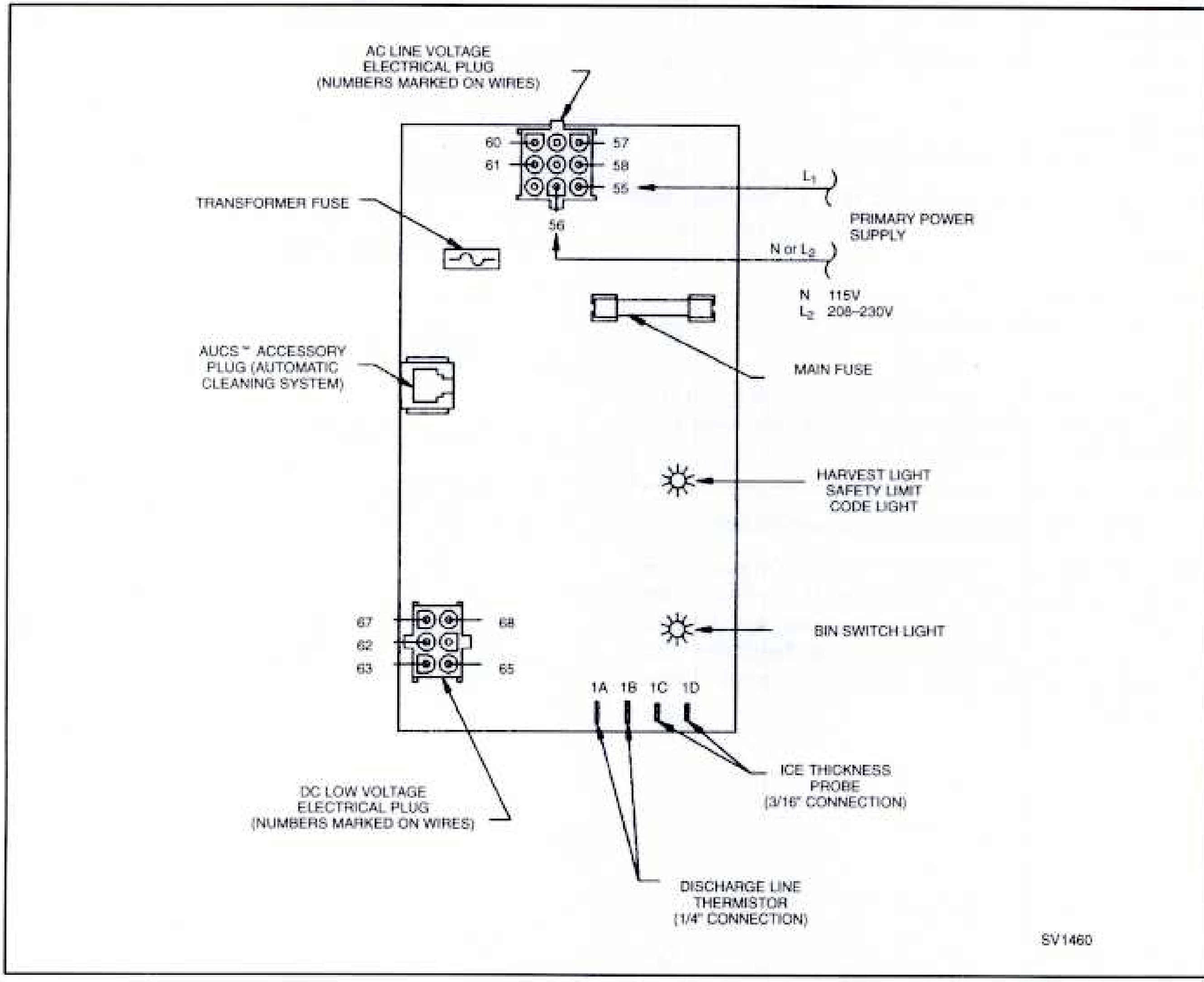

Figure 6-17. ELECTRONIC CONTROL BOARD

1. **General**
The control board controls all electrical components, including the ice machine sequence of operation. **Prior to diagnosing,** you must understand how this board functions (what it is supposed to do).

   Refer to wiring diagrams and ice machine sequence of operation sections for details, including:
   a. Initial start-up or start-up after auto shut-off mode
   b. Freeze sequence
   c. Harvest sequence
   d. Automatic shut-off
   e. Self-cleaning

2. **Harvest Initiation (Ice Thickness Probe)**
Manitowoc's patented solid state electronic sensing circuit which does not rely on the refrigeration system (pressure), temperature of evaporator, or timers, assures consistent ice formation. The ice machine must be in the freeze cycle for 6 minutes prior to harvest initiation.

   As the ice forms on the evaporator, water (not ice) will contact the ice thickness probes. After the water completes this circuit across the probes continually for 6-10 seconds, a harvest cycle is initiated.

3. **Bin Switch L.E.D.**
The light is ON when the bin switch (water curtain) is closed, and OFF when the bin switch is open.

This light functions any time power is supplied to the ice machine, even when the toggle switch is in the OFF or CLEAN position. This feature indicates the primary power supply (line voltage) at the control board is OK, without having to take a voltage reading.

4. **Harvest/Safety Limit L.E.D.**
Its primary function is to be ON as water contacts the ice thickness probes and remain on throughout the complete harvest cycle. The light will flicker as water splashes on the probes.

Its secondary function is to continually flash when the ice machine is shut off on a safety limit and to indicate which safety limit shut off the ice machine.

5. **Freeze Time Lock-In Feature**
This feature protects the ice machine from short cycling in and out of harvest.

The control board locks the ice machine in the freeze cycle for 6 minutes. If water contacts the ice thickness probes during the first 6 minutes of the freeze cycle, the harvest light will come on (to indicate water is in contact with the probes), but the ice machine stays in the freeze cycle. After the 6 minutes "lock-in" time, a harvest cycle will be initiated.

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

6. **Water Curtain Removal**
The water curtain must be on (Bin Switch closed) to start ice making. After it has started, the water curtain can be removed and replaced at any point during the freeze cycle without interfering with the electrical control sequence. If the ice machine goes into harvest while the curtain is removed, one of the following will happen:

   a. Water curtain remains off.

      When the harvest cycle time reaches 3.5 minutes and the bin switch is not reclosed, the ice machine stops as though the bin were full.

   b. Water curtain put back on:

      If the bin switch recloses prior to reaching the 3.5 minute point, the ice machine immediately returns to another freeze sequence prechill.

> **Important**
> When the ice machine cycles into harvest with the water curtain removed, **it is normal** for the harvest light to turn off and remain off and for the ice machine to skip the water purge (first 45 seconds of harvest) even though the ice machine is in the harvest cycle.

7. **Main Fuse**
This fuse stops the entire ice machine operation if electrical components fail causing high amp draw.

> **⚠ DANGER ⚠**
> High (line) voltage is applied to the control board (pin connector terminals #55 and #56) at all times. Removing 7 amp fuse or placing the toggle switch in OFF position <u>will not</u> remove power supplied to the control board.

Specifications: 250V, 7 Amp

Check Procedure:

1. If the bin switch light is on with water curtain closed, the 7 amp fuse is OK.

> **⚠ DANGER ⚠**
> Disconnect electrical power to the ice machine before proceeding.

2. Remove the fuse. Using an ohm meter, check the resistance across removed fuse.
   a. Open (OL) reading - replace fuse
   b. Closed (O) reading - fuse is okay

8. **Transformer Fuse**
This fuse stops all ice machine operation if the transformer fails, causing high amp draw.

Specifications:
50 Hz Control Boards
250V, .1 Amp
60 Hz Control Boards
150V, .125 Amp

Check Procedure
Follow the check procedure listed under Main Fuse, above.

9. **Safety Limits**
In addition to standard safety controls such as high pressure cut-out, the control board has four built-in <u>safety limits</u> which protect the ice machine from major component failures. Refer to page 7-10 for safety limit explanation.

DIAGNOSING ELECTRICAL CONTROL CIRCUITRY

Ice Machine Will Not Run

> **⚠ DANGER ⚠**
> High (line) voltage is applied to the control board (pin connector terminals #55 and #56) at all times. Removing 7 amp fuse or placing the toggle switch in OFF position will not remove power supplied to the control board.

Step	Check	Notes
1	Verify primary voltage supply to ice machine.	Verify that the fuse or circuit breaker is closed.
2	Verify the high pressure cut-out is closed.	The high pressure cut-out is closed if primary power voltage is present at pin connector (on control board) terminals #55 and #56.
3	Verify main and transformer control board fuses are both OK.	If bin switch light functions, the fuses are OK.
4	Verify the bin switch functions 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 control board.	Be sure Steps 1-6 were followed thoroughly. "Intermittent" problems are **not** usually control board related.

Ice Machine Operates but Will Not Cycle Into Harvest when water contacts the ice thickness probe.

This ice machine control system incorporates a freeze time "lock-in" feature which protects the ice machine from short cycling in and out of harvest. The control board locks the ice machine in the freeze cycle for 6 minutes. If water contacts the ice thickness probes during the first 6 minutes of the freeze cycle, the harvest light will come on (to indicate water is in contact with the probes), but the ice machine stays in the freeze cycle. After the 6 minutes "lock-in" time, a harvest cycle will be initiated.

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

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

> **Note**
> These procedures require the use of a jumper wire with clip ends attached.

1. Bypass the freeze time lock-in feature by setting the ICE/OFF/CLEAN toggle switch to OFF and then back to ICE.

   Wait (approximately 1.5 minutes) until the water starts to flow over the evaporator, then proceed to Step 2.

2. While monitoring the harvest light, clip the leads of the jumper wire to the ice thickness probe.

> **Important**
> When the ice machine cycles into harvest with the water curtain removed, **it is normal** for the harvest light to turn off and remain off, and for the ice machine to skip the water purge (first 45 seconds of harvest) even though the ice machine is in the harvest cycle.

Monitoring of Harvest Light	Correction
The harvest light comes on and 6-10 seconds later, the ice machine cycles from freeze to harvest.	The control circuitry is functioning properly. Check the following: a. Ice thickness probe adjustment. b. Ice thickness probe has scale build-up. Clean the probe.
The harvest light comes on but the ice machine stays in the freeze sequence.	Verify the ice machine is not in "Freeze Time Lock-In."
The harvest light does not come on.	Proceed to Step 3.

3. Disconnect the ice thickness probe wires from the control board, terminals 1C and 1D. While monitoring the harvest light, clip the leads of jumper wire to terminals 1C and 1D.

Monitoring of Harvest Light	Correction
The harvest light comes on and 6-10 seconds later, the ice machine cycles from freeze to harvest.	Replace ice thickness probe.
The harvest light comes on but the ice machine stays in the freeze sequence.	Verify the ice machine is not in "Freeze Time Lock-In".
The harvest light does not come on.	Replace the control board.

Ice Machine Operates but Cycles into Harvests Prematurely

This ice machine control system incorporates a freeze time "lock-in" feature which protects the ice machine from short cycling in and out of harvest. The control board locks the ice machine in the freeze cycle for 6 minutes. If water contacts the ice thickness probes during the first 6 minutes of the freeze cycle, the harvest light will come on (to indicate water is in contact with the probes), but the ice machine stays in the freeze cycle. After the 6 minutes "lock-in" time, a harvest cycle will be initiated.

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

> **Note**
> It is normal for the harvest light to flash as water begins to splash on the ice thickness probe.

1. Disconnect the ice thickness probe wires from control board terminals 1C and 1D.
2. Bypass the freeze time lock-in feature by setting the ICE/OFF/CLEAN toggle switch to off and then back to the ice making position. Wait (approximately 1.5 minutes) until the water starts to flow over the evaporator, then monitor the harvest light.

Monitoring of Harvest Light	Correction
The harvest light stays off and the ice machine remains in the freeze sequence.	The ice thickness probe is causing the malfunction. The ice thickness probe may be out of adjustment or dirty. Clean and check adjustment of probe **before replacing.**
The harvest light comes on and 6-10 seconds later, the ice machine cycles from freeze to harvest.	Replace the control board.

> **Important**
> When the ice machine cycles into harvest with the water curtain removed, **it is normal** for the harvest light to turn off and remain off and for the ice machine to skip the water purge (first 45 seconds of harvest) even though the ice machine is in the harvest cycle.

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SECTION 7 - REFRIGERATION SYSTEM

SEQUENCE OF OPERATION - SELF-CONTAINED AIR OR WATER-COOLED MODELS

B250/B320/B420/B450/B600/B800/B1000
SELF-CONTAINED AIR OR WATER-COOLED FREEZE CYCLE

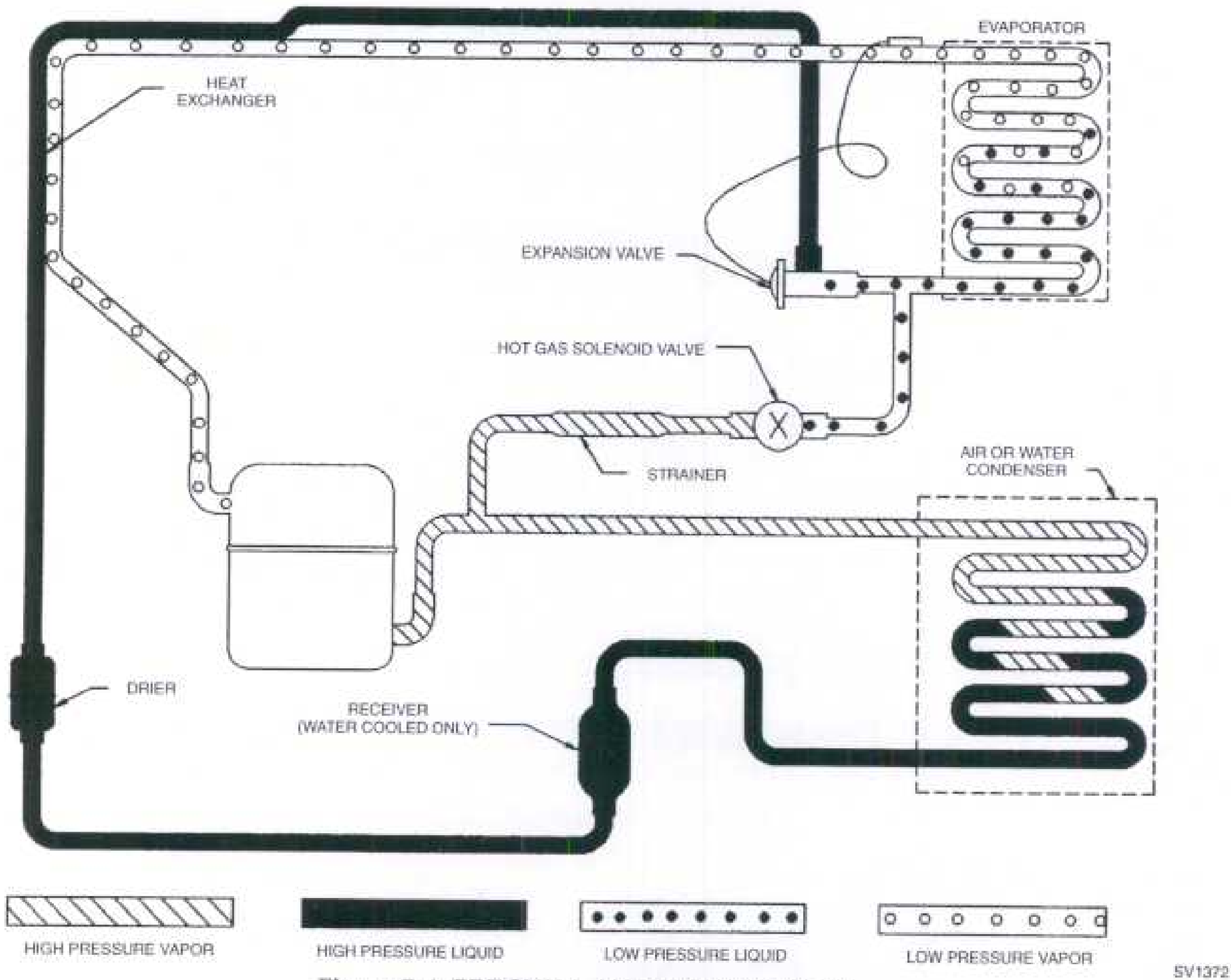

Figure 7-1. PRECHILL AND FREEZE CYCLE

Prechill Refrigeration Sequence
No water flows over the evaporator during the prechill. The refrigerant absorbs heat (picked up during the harvest cycle) from the evaporators. The suction pressure decreases during prechill.

Freeze Cycle Refrigeration Sequence
The refrigerant absorbs heat from water running over the evaporator surface. The suction pressure gradually drops as ice forms.

B250/B320/B420/B450/B600/B800/B1000
SELF-CONTAINED AIR OR WATER-COOLED HARVEST CYCLE

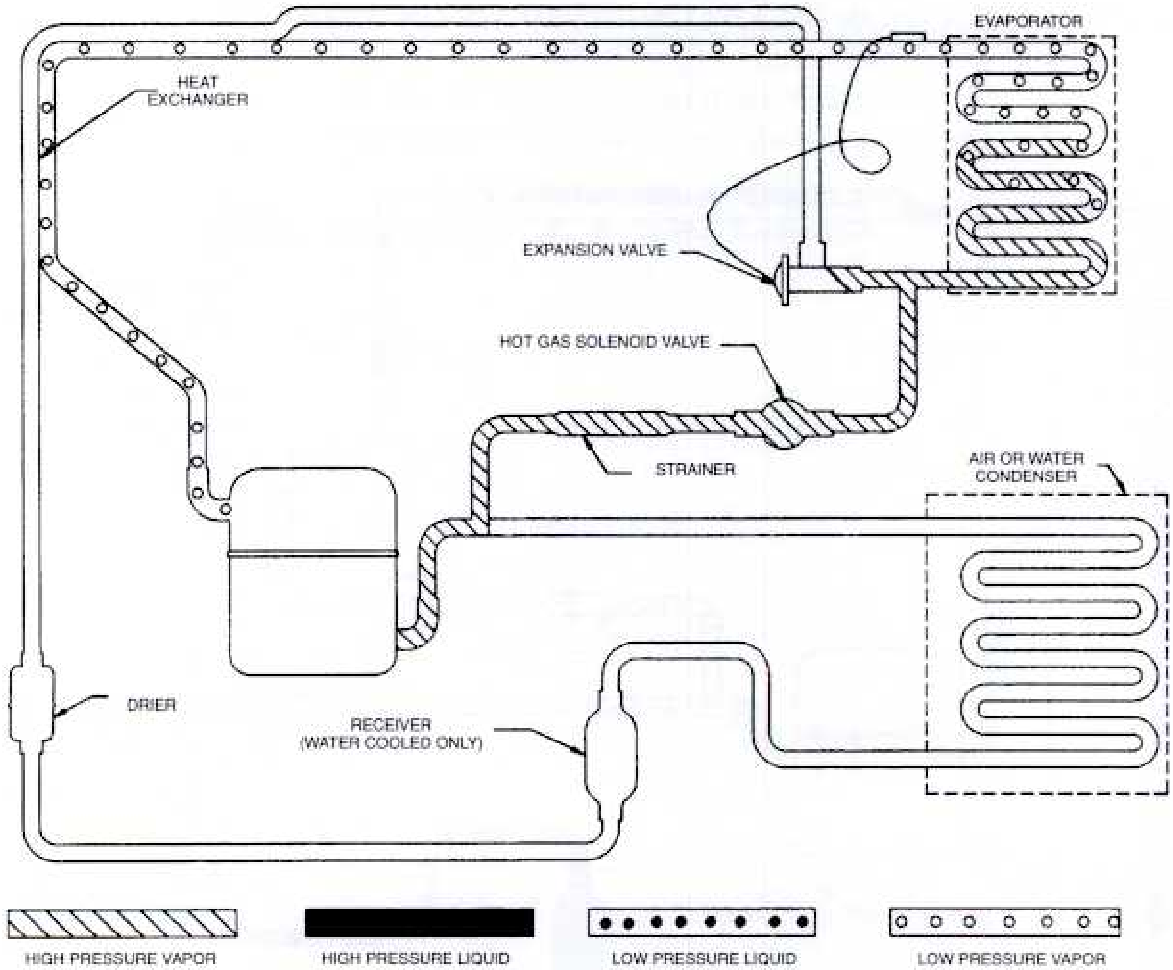

Figure 7-2. HARVEST CYCLE

Harvest Cycle Refrigeration Sequence

Hot gas flows through the energized hot gas valve, heating the evaporator. The hot gas valve is sized to allow the proper amount of refrigerant into the evaporator. This specific sizing (along with proper system refrigerant charge) assures proper heat transfer, without the refrigerant condensing and slugging the compressor.

SEQUENCE OF OPERATION - REMOTE MODELS

B450/B600/B800/B1000
REMOTE FREEZE CYCLE

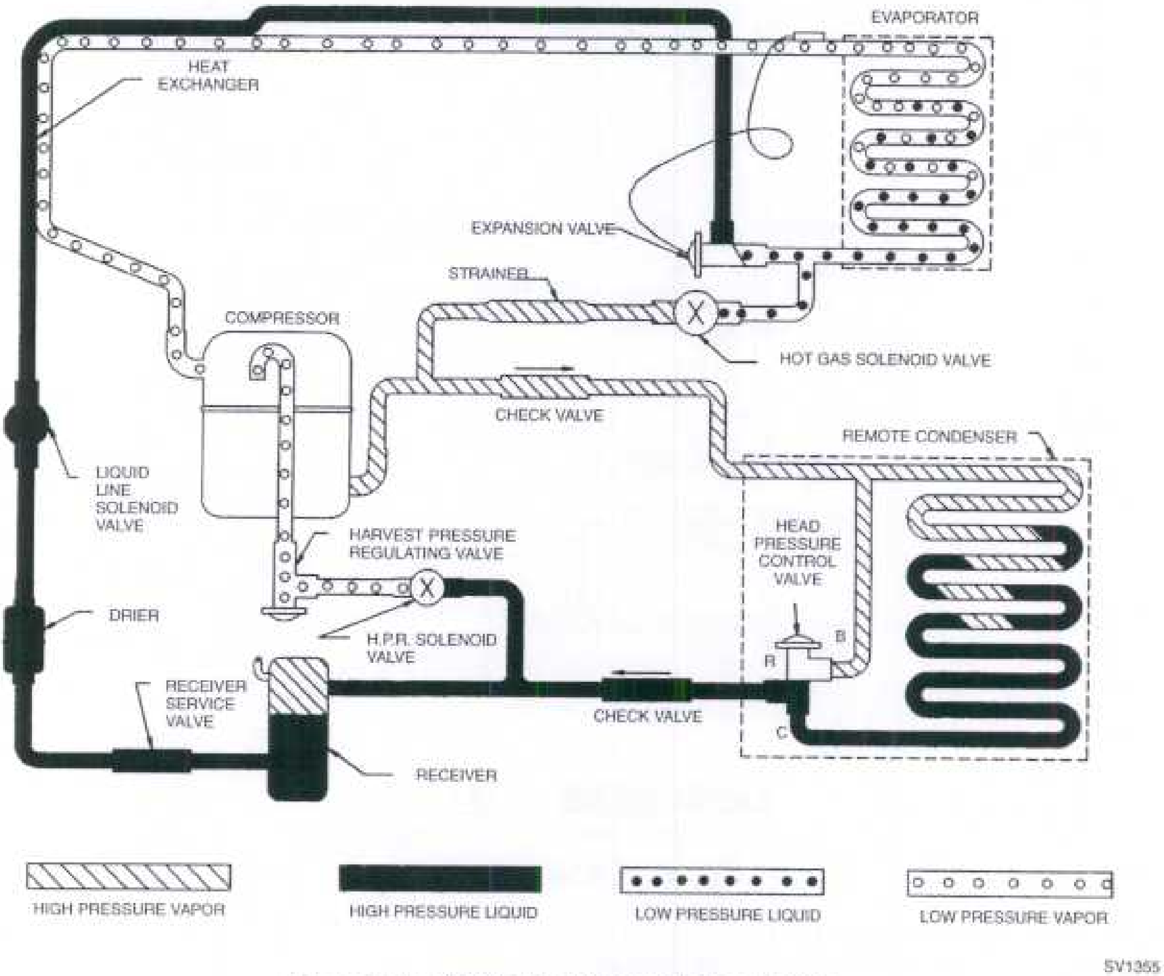

Figure 7-3. PRECHILL AND FREEZE CYCLE

Prechill Refrigeration Sequence
No water flows over the evaporator during the prechill. The refrigerant absorbs heat (picked up during the harvest cycle) from evaporators. The suction pressure decreases during prechill.

Freeze Cycle Refrigeration Sequence
The refrigerant absorbs heat from water running over the evaporator surface. The suction pressure gradually drops as ice forms.

The high pressure control valve maintains discharge pressure in cold ambient temperatures. (Refer to High Pressure Control Valve, page 7-24).

B450/B600/B800/B1000
REMOTE HARVEST CYCLE

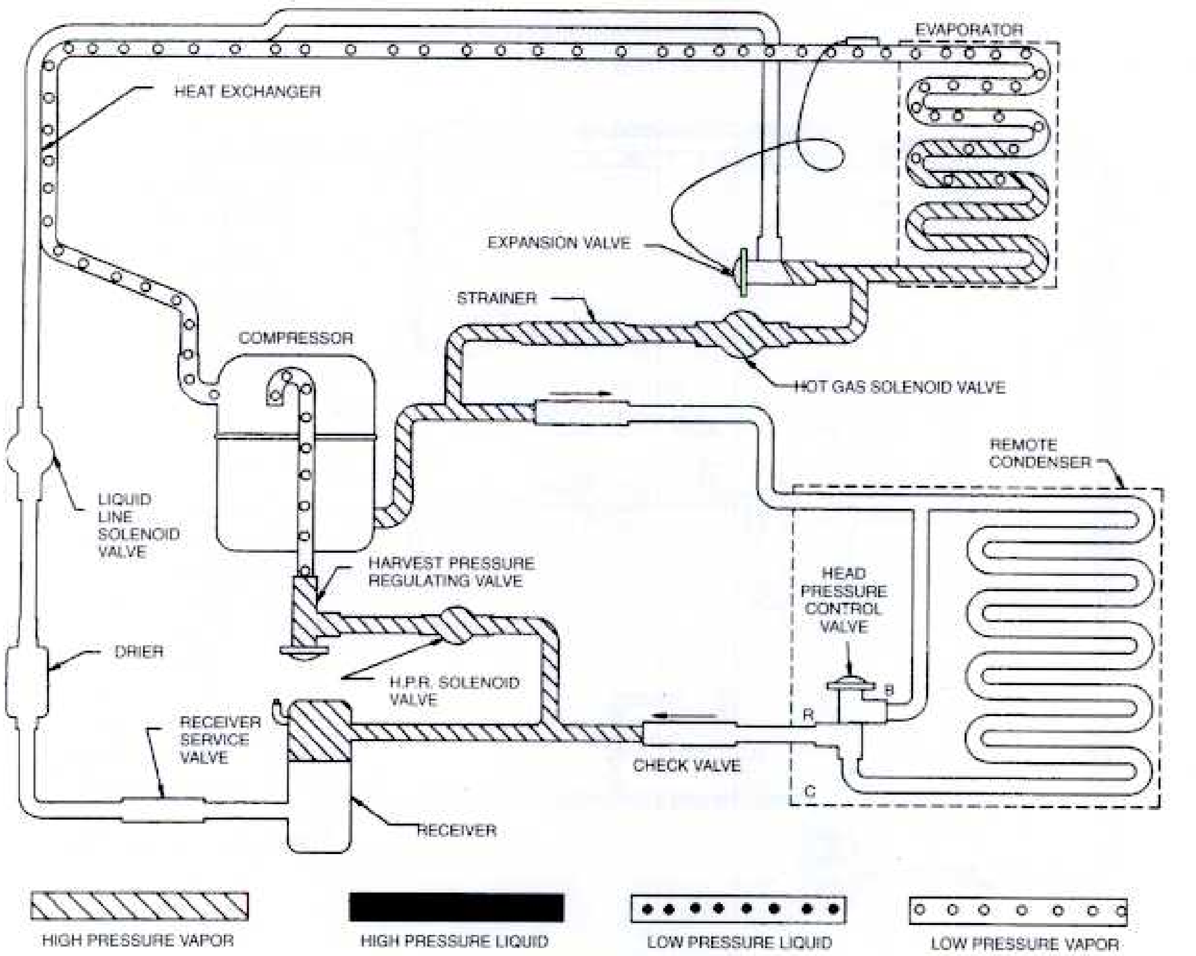

Figure 7-4. HARVEST CYCLE

Harvest Cycle Refrigeration Sequence

The harvest cycle begins with hot gas flowing through the hot gas valves to heat the evaporator. The hot gas valve is sized to allow the proper amount of hot gas into the evaporator. This specific hot gas valve sizing, along with the harvest pressure regulating (HPR) system, assures proper heat transfer, without the hot gas condensing to liquid and slugging the compressor.

The harvest pressure regulating (HPR) valve helps maintain the suction pressure during the harvest cycle. (Refer to HPR System, page 7-22.)

B450/B600/B800/B1000
REMOTE AUTO SHUT OFF

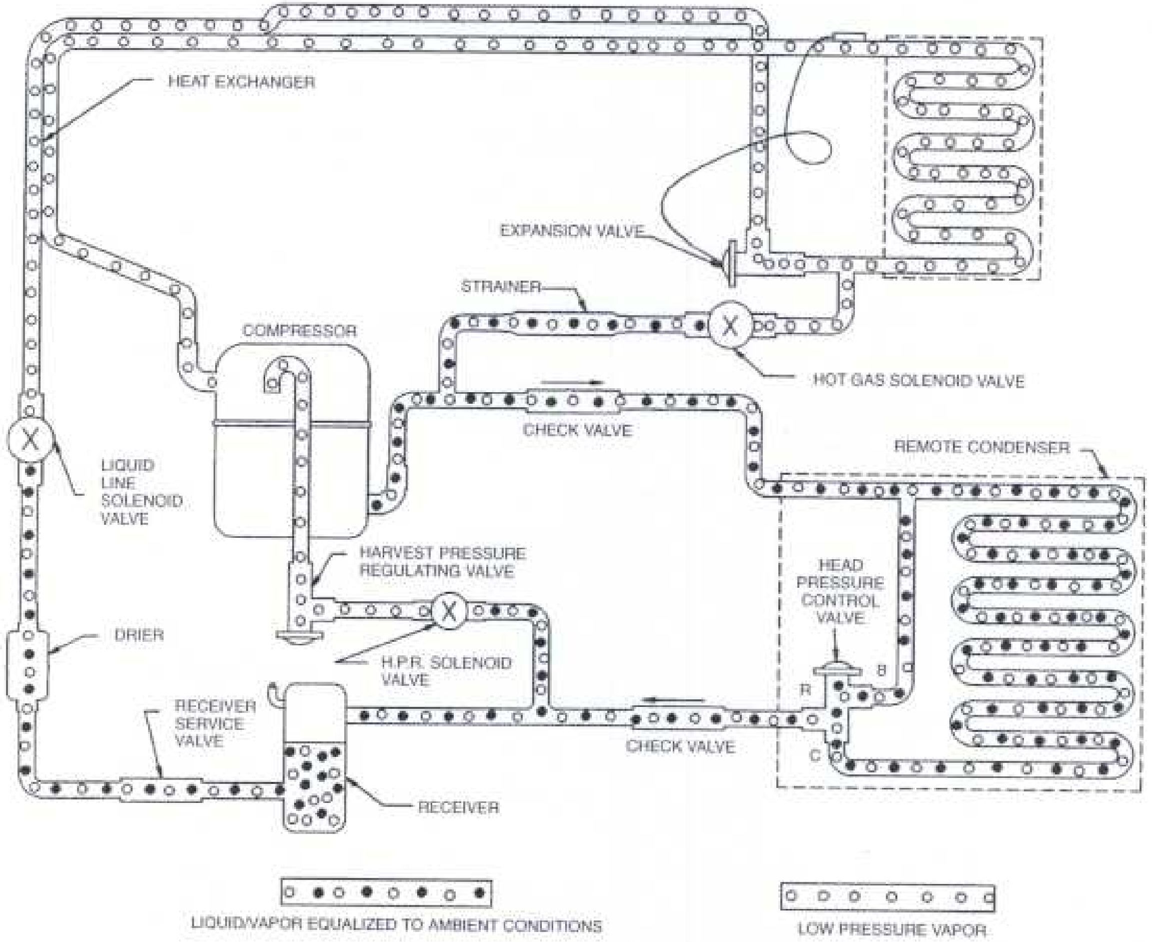

Figure 7-5. AUTOMATIC SHUT-OFF

SV1357

Automatic Shut-Off

The liquid line solenoid is de-energized, and the compressor continues to run, moving refrigerant out of the low side of the ice machine into the high side, past the check valve. The low pressure cut-out control opens when the low side pressure reaches approximately 12 psig. When the cut-out control opens the compressor is de-energized.

The check valve prevents refrigerant from migrating back into the high side during the off cycle, and the liquid line solenoid prevents refrigerant from migrating back into the low side. This protects the compressor from refrigerant migrating into it during the off cycle, preventing refrigerant slogging upon start-up.

> **Important**
>
> Do not shut down a remote machine at the circuit breaker panel. The machine will not pump down before de-energizing the compressor (for off cycle protection). Compressor failure may result when the ice machine is restarted.

B150 REFRIGERATION TUBING SCHEMATIC

B150
SELF CONTAINED AIR OR WATER COOLED MODELS

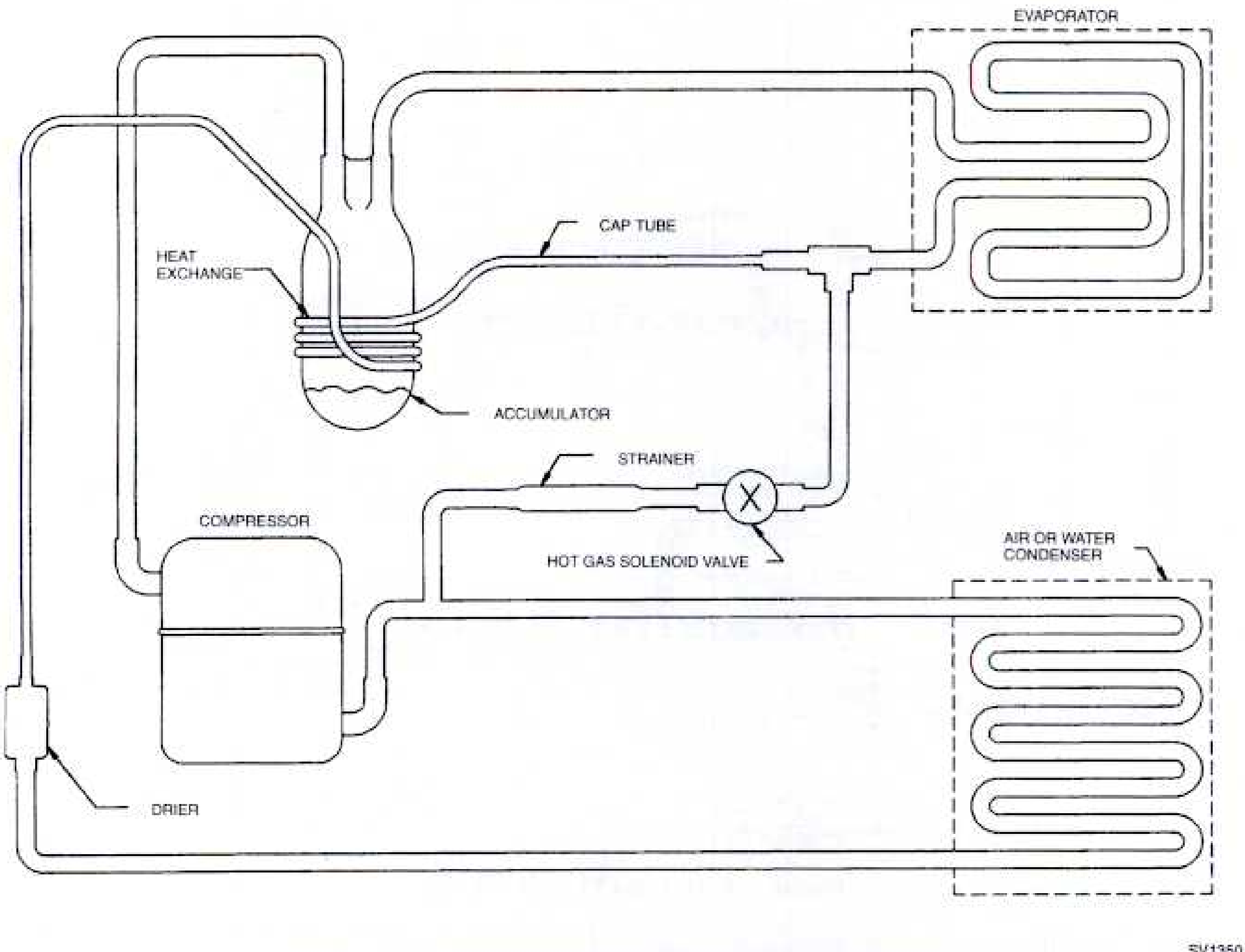

Figure 7-6. B150 REFRIGERATION TUBING SCHEMATIC

Prechill Refrigeration Sequence
No water flows over the evaporator during the prechill. The refrigerant absorbs heat (picked up during the harvest cycle) from the evaporators. The suction pressure decreases during prechill.

Freeze Cycle Refrigeration Sequence
The refrigerant absorbs heat from water running over the evaporator surface. The suction pressure gradually drops as ice forms.

Harvest Cycle Refrigeration Sequence
Hot gas flows through the energized hot gas valve, heating the evaporator. The hot gas valve is sized to allow the proper amount of refrigerant into the evaporator. This specific sizing assures proper heat transfer, without the refrigerant condensing and slugging the compressor.

OPERATIONAL ANALYSIS (DIAGNOSTICS)

GENERAL

When analyzing the refrigeration system, it is important to understand that different refrigeration component malfunctions may cause very similar symptoms. Also, external factors such as improper installation, incoming water supply being too hot, and water system malfunctions can often cause good refrigeration components to appear to be defective.

The following two examples illustrate how similar symptoms can result in a mis-diagnosis and the replacement of good components in error:

Example 1. An expansion valve bulb that is not securely fastened to the suction line and/or not insulated will cause a good expansion valve to flood. A service technician fails to check for proper expansion valve bulb mounting and replaces the expansion valve in error.

The ice machine now functions properly and the service technician erroneously thinks that the problem was properly diagnosed and corrected by replacing the expansion valve. In reality, the problem (loose bulb) was corrected when the service technician properly remounted the bulb of the replacement expansion valve.

In this example, the service technician's failure to check the expansion valve bulb for proper mounting (an external check) resulted in a misdiagnosis and the needless replacement of a good expansion valve.

Example 2. An ice machine that is low on charge may cause a good expansion valve to starve. A service technician fails to verify system charge and replaces the expansion valve in error. During the expansion valve replacement procedure, recovery, evacuation, and recharging are performed correctly. The ice machine now functions normally. The service technician mistakenly believes that the problem has been diagnosed correctly and that by replacing the expansion valve, the ice machine was restored to normal operation.

In this example, the service technician's failure to check the ice machine for a low charge condition resulted in the needless replacement of a good expansion valve.

When analyzing the refrigeration system, one can avoid replacing good refrigeration components caused by "external problems" by using a Refrigeration System Operational Analysis Table of detailed checklists and references.

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. The information the user provides helps the service technician start in the right direction, and may be a determining factor in the final diagnosis.

Following are a few questions to consider when talking to the ice machine user:

- When is the ice machine malfunctioning? (Night, day, all the time, during the freeze cycle, harvest cycle, etc.)
- When do you notice low production? (One day a week, every day, weekends, etc.)
- Can you describe exactly what the ice machine seems to be doing?
- Has anyone been working on the ice machine?
- Were items (such as boxes obstructing air flow) moved from around the ice machine before you arrived?
- During "store shutdown," is the circuit breaker, water supply, or air temperature altered?
- Can you think of any reason that might cause water pressure to 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 an ice machine produces more ice in a 70°F (21.2°C) room with 50°F (10.0°C) water than in a 90°F (32.2°C) room with 70°F (21.1°C) water.

1. Determine the ice machine operating conditions.

   Air temperature entering condenser ____

   Air temperature around ice machine ____

   Water temperature entering float valve ____

2. Refer to a 24 hour production chart for the ice machine model being tested.

   Using the operating conditions determined in Step 1, find the published 24 hour ice production: ______________

   This is the approximate amount of ice the ice machine is capable of producing at these operating conditions.

3. Perform an actual ice production check.

1.	______ Freeze Time	+	______ Harvest Time	=	______ Total Cycle Time
2.	1440 Min. in 24 hrs.	÷	______ Total Cycle Time	=	______ Cycles Per Day
3.	______ Weight of one Harvest	x	______ Cycles Per Day	=	______ Actual 24 hr. Ice Production

Important

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

Weighing the ice is the only 100% accurate check. Although, if ice pattern is normal and 1/8" thickness is maintained, the ice slab weights listed with the published 24 hr. ice production charts may be used.

4. Compare the actual 24 hr. ice production findings with the published 24 hr. ice production chart.

   The ice production is normal when the published 24 hr. ice production (Step 2) and actual production (Step 3) match closely. Determine if another ice machine is needed, more storage capacity is required, or if relocating existing equipment to lower load conditions will meet the customer's needs. (Contact the local Manitowoc Distributor for information on options and accessories available.)

INSTALLATION/VISUAL INSPECTION CHECKLIST

Possible Problem	Corrective Action
1. Ice machine is not level.	Level the ice machine.
2. Improper air clearance around top, sides, and/or back of ice machine.	Reinstall in accordance with Installation Manual.
3. Air-cooled condenser filter is dirty.	Clean the condenser and/or condenser filter.
4. Ice machine is not on independent electrical circuit.	Re-install electrical in accordance with Installation Manual.
5. Water filtration is plugged (if used).	Install a new water filter.
6. Water drains are not run separately and/or are not vented.	Run drains separately and vent according to Installation Manual.
7. Remote condenser line set is improperly installed.	Refer to Installation Instructions.

WATER SYSTEM CHECKLIST

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

Water system problems must be identified and eliminated prior to replacing refrigeration components. An example is a water dump valve leaking during the freeze cycle, low on charge, or starving TXV. The symptoms of all three of these problems are similar.

Possible Problem	Corrective Action
1. Water area (evaporator) is dirty.	Clean as needed.
2. Water inlet pressure is not between 20 and 80 psi.	Install a water regulator valve or increase the water pressure.
3. Incoming water supply temperature is not between 35°F (1.7°C) and 90°F (32.2°C).	Too hot – check the hot water line check valves in other store equipment.
4. Water filter is restricted (if used).	Replace the filter.
5. Water dump valve is leaking during the freeze cycle.	Clean the dump valve. Replace as needed.
6. Vent tube is not installed on water outlet drain.	See Installation Instructions.
7. Hoses, fittings, etc. are leaking water.	Repair/replace as needed.
8. Water float valve is stuck open or is out of adjustment.	Readjust or replace as needed.
9. Water is spraying out of the sump trough area.	Stop the water spray.
10. Water flow is uneven across the evaporator.	Clean the ice machine.
11. Water is freezing behind the evaporator.	Correct the water flow.
12. Plastic extrusions and gasket material are not securely mounted to the evaporator.	Remount or replace as needed.
13. Water does not start flowing over the evaporator (not trickle) immediately after 30-second prechill.	Readjust or replace the float valve.

ICE FORMATION PATTERN

Evaporator ice formation pattern analysis is helpful in ice machine diagnostics. However, an improper ice formation can be caused by any number of problems. Because of this, never analyze only the ice formation pattern to determine what is wrong with the ice machine. A good example of this is an ice formation that is "extremely thin on top". This could be caused by a hot water supply, a dump valve leaking water, a faulty float valve, low refrigerant charge, etc.

> **Important**
> The water curtain must be in place to ensure no water is being lost while checking the ice formation pattern.

(continued on next page)

Determining Ice Formation Pattern

1. NORMAL ICE FORMATION
   There is ice forming on the entire evaporator surface.

   At the beginning of the freeze cycle, it may appear that there is more ice forming on the bottom of the evaporator than on the top. However, by the end of the freeze cycle, the ice formation on the top will "catch up" and be close to, or just slightly thinner than, the ice formation on the bottom. This is normal. The "dimples" in the ice cubes on the top of the evaporator will be more pronounced than those on the bottom.

   The ice thickness probe must be set to maintain the ice bridge thickness at approximately 1/8". Ice forming uniformly on the entire evaporator surface, although not reaching the 1/8" setting in the proper amount of time, is considered "normal ice formation."

2. LESS (OR NO) ICE ON TOP
   There is no ice, or considerably less ice, on the top of evaporator compared to the bottom.

Examples:
a. No ice at all at the top of evaporator, but ice forms on the bottom half of evaporator.
b. The ice on the top of the evaporator reaches the 1/8" setting to initiate a harvest, but the bottom of the evaporator has 1/2"-1" of ice formation.

3. LESS (OR NO) ICE ON BOTTOM
   There is no ice, or considerably less ice formation on the bottom of the evaporator compared to the top.

Example: The ice on the top of the evaporator reaches the 1/8" setting to initiate a harvest, but there is little or no ice formation on the bottom of the evaporator.

4. "SPOTTY" ICE PATTERN
   There are small sections of no ice formation, such as a single corner or single spot in the middle of the evaporator. This is generally caused by loss of heat transfer from the tubing on backside of evaporator.

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

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

Safety Limit #2: If the harvest time reaches 3.5 minutes, the control board automatically returns the ice machine to the freeze cycle. If three consecutive 3.5-minute harvest cycles occur, the ice machine stops.

Safety Limit #3: If the compressor discharge line temperature falls below 85°F/29.4°C for three consecutive harvest cycles, the ice machine stops.

Safety Limit #4: If the compressor discharge line temperature reaches 255°F/123.8°C for 15 continuous seconds during a freeze or harvest cycle, the ice machine stops.

DETERMINING WHICH SAFETY LIMIT STOPPED THE ICE MACHINE

When a safety limit condition causes the ice machine to stop, the harvest light on the control board continually flashes on and off. Use the following procedures to determine which safety limit has stopped the ice machine.

Step 1 Move the toggle switch to OFF.

Step 2 Move the toggle switch back to ICE.

Step 3 Watch the harvest light. It will flash one to four times, corresponding to safety limits 1-4, to indicate which safety limit stopped the ice machine.

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

Notes

- 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 ON 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.

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, such as flooding or starving expansion valves, overcharge, undercharge, dirty condensers, water loss to 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 non-major problems or something external to the ice machine that may be causing the problem. This may be difficult to diagnose, as many external problems may occur intermittently.

An example of this would be an ice machine stopping intermittently on safety limit #1 - long freeze times. The service technician may find that at night the ambient temperature is dropping too low, the store has a water pressure drop problem, the water is being turned off one night a week, etc.

Remember that when a high pressure cut-out or a safety limit stops the ice machine, **they are doing what they are supposed to do:** stop the ice machine before a major component failure occurs.

Ice machine refrigeration and electrical component failures may also cause one of the safety limits. After all electrical components and all external causes are eliminated, and it appears 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. **Because there are many possible external problems, do not limit your diagnosis to only the items listed in the checklists.**

CONDITION FOUND	POSSIBLE CAUSE
I. **SAFETY LIMIT #1** stopped the ice machine. (Freeze time exceeded 60 minutes for three consecutive freeze cycles.) **Because there are many possible external problems, do not limit your diagnosis to only the items listed in the checklist.**	1. Improper installation • Refer to Installation/Visual Inspection Checklist 2. Water system • Incoming water pressure low • Excessive water pressure (80 psi maximum) • Excessive water temperature (90°F/32.2°C maximum) • Dirty (clogged) water distribution tube • Dirty/defective float valve • Dirty/defective water dump valve • Defective water pump 3. Electrical system • Ice thickness probe out of adjustment • Electrically not going into harvest • Contactor not energizing • Compressor (electrically non-operational) 4. Restricted condenser air flow (air-cooled models) • Inlet air temperature excessive • Condenser discharge air recirculation • Dirty condenser filter • Dirty condenser fins • Defective fan cycling control • Defective fan motor 5. Restricted condenser water flow (water-cooled models) • Insufficient water pressure (20 psi minimum) • Excessive water temperature (90°F/32.2°C maximum) • Dirty condenser and/or water regulating valve • Water regulating valve out of adjustment • Defective water regulating valve 6. Refrigeration system • Non-Manitowoc components • Under or over refrigerant charge • Defective head pressure control (remotes) • Defective hot gas valve • TXV starving or flooding (check bulb mounting)

CONDITION FOUND	POSSIBLE CAUSE
II. **SAFETY LIMIT #2** stopped the ice machine. (Harvest time exceeded 3.5 minutes for three consecutive harvest cycles.) **Because there are many possible external problems, do not limit your diagnosis to only the items listed in the checklist.**	1. Improper installation • Refer to Installation/Visual Inspection Checklist 2. Water system • Water area (evaporator) dirty • Dump valve malfunctioning/dirty • Vent tube not installed on water outlet drain • Water freezing behind evaporator • Plastic extrusions and gasket material not securely mounted to evaporator 3. Electrical system • Ice thickness probe out of adjustment • Ice thickness probe dirty • Bin switch defective • Premature harvest 4. Refrigeration system • Non-Manitowoc components • Water regulating valve dirty/defective • Under or over refrigerant charge • Defective head pressure control valve (remotes) • Defective harvest pressure control (HPR) valve (remotes) • Defective hot gas valve • TXV flooding (check bulb mounting) • Defective fan cycling control
III. **SAFETY LIMIT #3** stopped the ice machine. (Compressor discharge temperature fell below 85°F/29.4°C for three consecutive harvest cycles.) **Because there are many possible external problems, do not limit your diagnosis to only the items listed in the checklist.**	1. Improper installation • Refer to Installation/Visual Inspection Checklist 2. Ice thickness set too thin or too thick 3. Water system – loss or restricted water flow over evaporator • Incoming water pressure low • Loss of water from sump area • Dirty (clogged) water distributing tube • Dirty/defective float valve • Dirty/defective water dump valve • Defective water pump 4. Refrigeration system • Non-Manitowoc components • Defective head pressure control valve (remotes) • Defective harvest pressure control (H.P.R.) valve (remotes) • Defective fan cycle control • Under or over refrigerant charge • Defective hot gas valve • Flooding TXV (check bulb mounting) 5. Defective thermistor

CONDITION FOUND	POSSIBLE CAUSE
IV. **SAFETY LIMIT #4** stopped the ice machine. (Compressor discharge temperature exceeded 255°F/123.8°C for fifteen continuous seconds.) **Because there are many possible external problems, do not limit your diagnosis to only the items listed in the checklist.**	1. Improper installation • Refer to Installation/Visual Inspection Checklist 2. Restricted condenser air flow (air-cooled models) • Inlet air temperature above 110°F/43.3°C • Condenser discharge air recirculation • Dirty condenser filter • Dirty condenser fins • Defective fan cycling control • Defective fan motor 3. Restricted condenser water flow (water-cooled models) • Insufficient water pressure (20 psi minimum) • Inlet water temperature above 90°F/32.2°C • Dirty condenser and/or water regulating valve • Water regulating valve out of adjustment • Defective water regulating valve 4. Refrigeration system • Non-Manitowoc components • Defective head pressure control valve (remote models only) • Under or over refrigerant charge • Non-condensibles in refrigeration system • High side refrigerant lines (or component) restricted or plugged • TXV starving (check bulb mounting) • Defective compressor 5. Defective thermistor

HOT GAS VALVE TEMPERATURE CHECK

General

A hot gas valve requires a critical orifice size which meters the proper amount of hot gas flow into the evaporator during the harvest cycle. **Even a slightly too large or too small orifice will cause long harvest cycles.**

An orifice which is slightly too large causes refrigerant to condense to liquid in the evaporator during harvest, and can cause potential compressor damage. An orifice which is slightly too small will not allow enough hot gas into the evaporator, causing low suction pressure, not generating enough heat for a harvest cycle.

Replace defective hot gas valves with "original" Manitowoc replacement parts only. Normally a hot gas valve can be repaired by rebuilding it instead of changing the entire valve. Refer to the Parts Manual for proper valve application and rebuild kits.

Analyzing Hot Gas Valve

The following procedure by itself cannot indicate what is wrong with an ice machine. It is, however, beneficial to compare these temperatures to each other during the freeze cycle and use it along with Manitowoc's Refrigeration System Operational Analysis Table in determining what may be causing an ice machine malfunction.

1. Wait for 5 minutes into the freeze cycle.
2. Feel the **inlet** of the hot gas valve.
3. Feel the compressor discharge line.

> **⚠ Caution**
> The hot gas valve inlet and the compressor discharge could be hot enough to burn your hand. Just "touch" it momentarily.

4. Compare the compressor discharge line temperature to the hot gas valve **inlet** temperature.

> **Important**
> Feeling the hot gas valve outlet or feeling across the hot gas valve for any type of comparison **will not work.** The hot gas valve outlet, being on the suction (cool refrigerant) side of the ice machine, may be cool enough to touch, even if the valve is leaking.

Example of hot gas valve inlet and compressor discharge line temperature comparison.

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

EVAPORATOR INLET/OUTLET TEMPERATURES

The temperatures of the suction line entering and leaving the evaporator by itself cannot indicate what is wrong with an ice machine. It is, however, beneficial to compare these temperatures to each other during the freeze cycle and use it along with Manitowoc's Refrigeration System Operational Analysis Table in determining what may be causing an ice machine malfunction.

The actual temperatures entering and leaving the evaporator varies by model and changes throughout the freeze cycle. Therefore, it is difficult to document the "normal" inlet and outlet temperature readings at a given moment during the freeze cycle. The benefit is knowing the difference between the two temperatures after five minutes into the freeze cycle.

Use the following procedure to document freeze cycle evaporator inlet and outlet temperatures.

1. Use a quality 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 probe (or other sensing device) under the insulation - it must be "attached to" and reading the <u>actual</u> temperature of the copper lines.

3. **Five minutes into the freeze cycle,** record the temperature of the copper lines entering and leaving the evaporator. Use this with other information gathered on the Refrigeration System Operational Analysis Table to analyze the ice machine.

Temperature Findings
(After 5 minutes into freeze cycle)

Evaporator Inlet	Difference	Evaporator Outlet
______	______	______

ANALYZING DISCHARGE PRESSURE DURING FREEZE OR HARVEST CYCLE

1. **Determine the ice machine operating conditions.**

   Air temperature entering condenser ____

   Air temperature around ice machine ____

   Water temperature entering float valve ____

2. **Refer to operating pressure chart for the ice machine model being checked.**

   Using the operating conditions determined in Step 1, 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 between the published freeze or harvest cycle pressure range for the ice machine's operating conditions.

   When it is not normal, **refer to the appropriate high or low discharge pressure checklist.**

FREEZE CYCLE DISCHARGE PRESSURE HIGH CHECKLIST

Because there are so many possible external problems, do not limit your diagnosis to only the items listed in the checklist.

1. Non-Manitowoc components in system.
2. Improper installation
   - Refer to "Installation/Visual Inspection" Checklist
3. Restricted condenser air flow (air-cooled models)
   - Inlet air temperature above 110°F/43.3°C
   - Condenser discharge air recirculation
   - Dirty condenser filter
   - Dirty condenser fins
   - Defective fan cycling control
   - Defective fan motor
4. Restricted condenser water flow (water-cooled models)
   - Insufficient water pressure (20 psi minimum)
   - Inlet water temperature above 90°F/32.2°C
   - Dirty condenser and/or water regulating valve
   - Water regulating valve out of adjustment
   - Defective water regulating valve
5. Defective head pressure control valve (remote models)
6. Improper refrigerant charge
   - Over-charged
   - Non-condensibles in system
   - Wrong type of refrigerant
7. Restriction in high side refrigerant lines or components (before mid-condenser).

FREEZE CYCLE DISCHARGE PRESSURE LOW CHECKLIST

Because there are so many possible external problems, do not limit your diagnosis to only the items listed in the checklist.

1. Non-Manitowoc components in system.
2. Improper installation
   - Refer to "Installation/Visual Inspection" Checklist
3. Improper refrigerant charge
   - Under-charged
   - Wrong type of refrigerant
4. Defective head pressure control (remote models)
5. Water regulating valve (water-cooled condensers)
   - Out of adjustment
   - Defective
6. Fan cycle control defective.

ANALYZING SUCTION PRESSURE DURING FREEZE CYCLE

The suction pressure gradually drops throughout the freeze cycle. The actual suction pressure (and drop rate) change as the air and water temperature entering the ice machine change, affecting the freeze cycle times. To analyze and identify the proper suction pressure drop throughout the freeze cycle, compare the published suction pressure (listed in "Operating Pressure" charts) to the published freeze cycle time (listed in "Cycle Times" charts).

Remember to analyze discharge pressure prior to analyzing suction pressure. High or low discharge pressure may be causing the suction pressure to be high or low.

STEP	Example using BY454A 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 float valve 70°F/21.1°C
2. A. 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.	15.5-18.1 minutes Published freeze cycle time 46-30 PSIG Published freeze cycle suction pressure
2. B. Compare the published freeze cycle time to the published freeze cycle suction pressure. (Developing a chart is helpful when doing this.)	Published freeze cycle time (minutes) 0 2 4 6 8 10 12 14 16 18 46 44 42 40 38 36 34 32 30 Published freeze cycle suction pressure (PSIG) In this example, the proper suction pressure should be approximately 42 PSIG at 5 minutes, 38 PSIG at 10 minutes, etc.
3. Perform an actual suction pressure check at the beginning, middle, and end of freeze cycle. It is also helpful to note the time during the freeze cycle that the readings are taken.	The gauges were connected to example ice machine and suction pressure readings taken as follows: Beginning of freeze cycle 46 PSIG (at 5 min.) Middle of freeze cycle 46 PSIG (at 10 min.) End of freeze cycle 40 PSIG (at 18 min.)
4. Compare the actual freeze cycle suction pressure (Step 3) to the published freeze cycle time and pressure comparison (Step 2B).	In this example, the suction pressure is considered high throughout the freeze cycle. It should have been: Approximately 42 PSIG (at 5 minutes) - not 46 Approximately 38 PSIG (at 10 minutes) - not 46 Approximately 30 PSIG (at 18 minutes) - not 40

ANALYZING SUCTION PRESSURE DURING HARVEST CYCLE

1. **Determine the ice machine operating conditions.**

   Air temperature entering condenser ____

   Air temperature around ice machine ____

   Water temperature entering float valve ____

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

   Using the operating conditions determined in Step 1, find the published normal harvest cycle suction pressures

   Published harvest cycle suction pressure ____

3. **Perform an actual Harvest Cycle Suction Pressure Check.**

	PSIG
Beginning of harvest cycle	______
Middle of harvest cycle	______
End of harvest cycle	______

4. **Compare the actual Harvest Suction Pressure (Step 3) with the Published Harvest Suction Pressure (Step 2).**

   The harvest cycle suction pressure is normal when the actual pressure falls between the published pressure ranges for the ice machine operating conditions.

FREEZE CYCLE SUCTION PRESSURE HIGH CHECKLIST

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

1. Non-Manitowoc components in system.
2. Improper installation
   - Refer to "Installation/Visual Inspection" Checklist
3. **IMPORTANT:**
   - Freeze cycle discharge pressure high affecting low side. (Refer to "Freeze Cycle Discharge Pressure High" Checklist.)
4. Improper refrigerant charge
   - Wrong type of refrigerant
   - Over-charged
5. Harvest pressure regulating solenoid (H.P.R.) leaking. (This usually also causes extreme frosting on compressor.)
6. Hot gas valve stuck open.
7. TXV flooding (check bulb mounting).
8. Defective compressor.

FREEZE CYCLE SUCTION PRESSURE LOW CHECKLIST

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

1. Non-Manitowoc components in system.
2. Improper installation
   - Refer to "Installation/Visual Inspection" Checklist
3. **IMPORTANT:**
   - Freeze cycle discharge pressure low affecting low side. (Refer to "Freeze Cycle Discharge Pres sure Low" Checklist.)
4. Improper water supply over evaporator
   - Refer to "Water System" Checklist
5. Loss of heat transfer from tubing on backside of evaporator.
6. Restricted or plugged liquid line drier, or tubing in suction side of refrigeration system.
7. Improper refrigerant charge
   - Under-charged
   - Wrong type of refrigerant
8. Expansion valve starving (check bulb mounting).

HOW TO USE THE REFRIGERATION SYSTEM OPERATIONAL ANALYSIS TABLE

The tables list 5 different defects that may affect the ice machine's operation. There are only 4 columns listed across the top. A low-on-charge ice machine and a starving expansion valve have very similar characteristics and are therefore listed under the same column.

Before starting, refer to "Before Beginning Service" for a few questions to ask when talking to the ice machine user.

1. **Complete "Operational Analysis" Column**
Read down the left "Operational Analysis" column. Perform all procedures and check all information listed. All items under "Operational Analysis" have supporting reference material to help analyze each step.

   While analyzing each item separately, you may find an "external problem" **causing a good refrigeration component to appear defective, or other refrigeration component (not listed on the chart) defective.** Correct problems as they are found. If the operational problem is found, it is not necessary to complete the remaining procedures.

2. **Enter Check Marks (✓) In Small Square Boxes**
Each time the actual findings of an item under the "Operational Analysis" column matches the published findings on the table, enter a check mark in the appropriate box.

Example: Freeze cycle suction pressure is determined to be low. Check the symptoms listed across the "Freeze Cycle Suction" column, and enter a check mark (✓) only in the box marked "low". The other three boxes indicate "high", which does not match the actual finding of low.

3. **Add the Check Marks Listed Under Each Column**
Add the number of check marks listed under each of the 4 columns. When completed, there will be 4 separate totals. If two columns have matching high numbers, a procedure was not performed properly and/or supporting material was not analyzed correctly. Refer to "Final Analysis" and the column with the highest number of check marks prior to changing a refrigeration component.

FINAL ANALYSIS

The column with the highest total number of check marks identifies the refrigeration problem. It is important to eliminate refrigeration components not listed on the table and to analyze all detailed charts, check lists, and other references to eliminate external items for causing a good refrigeration component to appear defective.

Refer to column with highest number of check marks and follow appropriate procedures below.

Column 1 - Hot Gas Valve Leaking
Normally, a leaking hot gas valve can be repaired with a rebuild kit without changing the entire valve. Rebuild or replace the hot gas valve as required.

Column 2 - Low on Charge/Expansion Valve Starving
Verify the ice machine is not low on charge before replacing an expansion valve. A starving expansion valve normally only affects the freeze cycle pressures and not the harvest cycle pressures. A low refrigerant charge normally affects both freeze and harvest cycle pressures.

1. Add refrigerant charge in 2 to 4 oz. (50-100 g) increments as a diagnostic procedure to verify a low charge.
2. If the problem is not corrected by adding charge, an expansion valve is faulty.
3. If the problem is corrected by adding charge, the ice machine is low on charge. **Find the refrigerant leak!**

   The ice machine must operate with proper nameplate charge. If no leak is found, the ice machine must still be evacuated and recharged using proper procedures which include charging the drier.

Column 3 - Expansion Valve Flooding
A loose or improperly mounted expansion valve bulb causes the expansion valve to flood. Verify bulb mounting, insulation, etc., prior to changing valve.

Column 4 - Compressor
Replace the compressor.

To receive warranty credit, compressor ports must be properly sealed by crimping and soldering closed.

REFRIGERATION SYSTEM OPERATIONAL ANALYSIS TABLE - SINGLE EVAPORATOR

This table must be used with detailed charts/checklists and other references to eliminate refrigeration components not listed on the table and external items (or problems) which can cause good refrigeration components to appear defective.

OPERATIONAL ANALYSIS (Listed below)	1	2	3	4
Ice Production	Published 24 hour ice production ____________ Calculated (actual) ice production ____________ NOTE: The ice machine is operating properly if the ice production and ice formation pattern is normal.			
Installation and Water System	Installation and/or water related problems can simulate a refrigeration component malfunction. Refer to "Installation/Visual Inspection Checklist" and "Water System Checklist" and correct all problems before proceeding.			
Ice Formation Pattern ______ ____________ Refer to "Determining Ice Formation Patterns" for further details.	1. Ice formation is extremely thin on top of evaporator – or – 2. No ice formation on entire evaporator ☐	1. Ice formation is extremely thin on top of evaporator – or – 2. No ice formation on entire evaporator ☐	1. Ice formation is normal – or – 2. Ice formation is extremely thin on bottom of evaporator – or – 3. No ice formation on entire evaporator ☐	1. Ice formation is normal (it is normal for "dimples" in top ice cubes of evaporator to be more pronounced than dimples in ice cubes in bottom of evaporator.) – or – 2. No ice formation on entire evaporator ☐
Safety Limits Refer to "Analyzing Safety Limits" to eliminate problems and/or components not listed on this table.	Stops on Safety Limit 1 ☐	Stops on Safety Limit 1 or 4 ☐	Stops on Safety Limit 1 or 2 or 3 ☐	Stops on Safety Limit 4 ☐
After 5 minutes into freeze cycle, compare compressor discharge line temperature to the **hot gas valve inlet temperature.** Comp disc ____ Hot gas inlet ____	The inlet of hot gas valve is hot and approaches the temperature of a hot compressor discharge line. ☐	The inlet of hot gas valve is cool enough to hold hand on and the compressor discharge line is hot. ☐	Both the inlet of hot gas valve and compressor discharge line are cool enough to hold hand on. ☐	The inlet of hot gas valve is cool enough to hold hand on and the compressor discharge line is hot. ☐
Compare inlet to outlet temperature of evaporator after 5 min. into freeze cycle: Inlet ____ Outlet _____	Inlet and outlet temperature within 7°F of each other. ☐	Not within 7°F and inlet is colder than outlet. ☐	1. Not within 7°F and inlet is warmer than outlet – or – 2. Inlet and outlet temperature within 7°F of each other. ☐	Inlet and outlet temperatures within 7°F of each other. ☐
Freeze cycle discharge pressure _______/_______/_______ Beginning Middle End	**Normal** discharge pressure – refer to "Analyzing Discharge Pressure" to determine if normal. **High or low** discharge pressure – refer to a freeze cycle high or low discharge pressure checklist, to eliminate problems and/or components not listed on this table, before proceeding.			
Freeze cycle suction pressure _______/_______/_______ Beginning Middle End	Normal suction pressure – suction pressure frops through freeze cycle. Refer to "Analyzing Suction Pressure" to determine if dropping normally. High or low suction pressure – refer to a freeze cycle high or low suction pressure checklist to eliminate problems and/or components not listed on this table before proceeding. High ☐	Low ☐	High ☐	High ☐
Miscellaneous Enter miscellaneous items in proper boxes.	☐	☐	Frost on compressor ☐	Compressor dome extremely hot ☐
Final Analysis Going downward, enter total number of boxes checked in each column.	Total boxes checked ________ HOT GAS VALVE LEAKING	Total boxes checked ________ LOW ON CHARGE – OR – TXV STARVING	Total boxes checked ________ TXV FLOODING	Total boxes checked ________ COMPRESSOR

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P/N 83–5452–9 (Rev A 2/95) – Order additional analysis tables through local Manitowoc Distributor

REMOTES ONLY

HARVEST PRESSURE REGULATING (H.P.R.) SYSTEM

General

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

1. **Harvest pressure regulating solenoid valve** (H.P.R. solenoid)

   This is an electrically operated valve which opens when energized, and closes when de-energized.

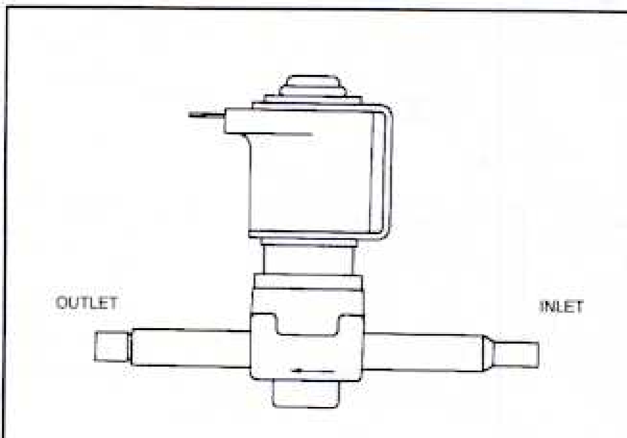

Figure 7-7. H.P.R. SOLENOID

2. **Harvest pressure regulating valve** (H.P.R. valve)

   This is a non-adjustable pressure regulating valve which modulates open and closed, based on the refrigerant pressure at the outlet of the valve. The valve closes completely and stops refrigerant flow when the pressure at the outlet rises above the setting of the valve.

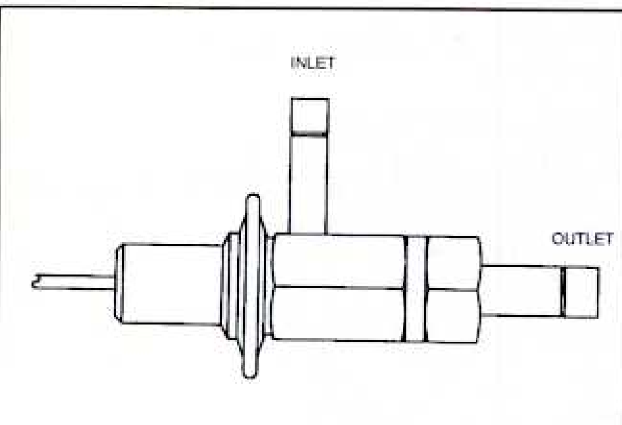

Figure 7-8. H.P.R. VALVE

Normal Operation

FREEZE CYCLE

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

HARVEST CYCLE

The check valve in the discharge line prevents refrigerant in the remote condenser and receiver from back-feeding into the evaporator and condensing to liquid during the harvest cycle. The H.P.R. solenoid is opened (energized) during the harvest cycle, allowing refrigerant gas from the top of the receiver to flow into the H.P.R. valve. The H.P.R. valve modulates open and closed, raising the suction pressure high enough to sustain heat for the harvest cycle without refrigerant condensing to liquid in the evaporator.

In general, the harvest cycle suction pressure rises, then stabilizes in the range of 75-100 psig (517-758 Kpa).

Exact pressures, which vary from model to model, are found by referring to the appropriate "Operational Refrigeration Pressure" chart.

H.P.R. SYSTEM FAILURE CHART

<table>
<tr><th colspan="2">SYMPTOMS</th><th>POSSIBLE CAUSE</th></tr>
<tr><td>Freeze Cycle

Harvest Cycle</td><td>The ice machine functions properly (the H.P.R. solenoid is closed, preventing refrigerant flow into the H.P.R. valve).

The discharge pressure is low or normal and the suction pressure is low, which causes extended harvest times.

The ice machine usually continues to run, although with extended harvest times, ice production decreases.

If the harvest time exceeds 3.5 minutes for three consecutive cycles, the control board stops ice machine operation on Safety Limit #2.

Low discharge pressure during the freeze cycle causes H.P.R. valve to appear as though it is not feeding properly during harvest. Verify discharge pressure during the freeze is normal (correct if necessary) <u>prior to</u> assuming the H.P.R. valve is faulty.</td><td>H.P.R. Solenoid remains closed

- OR -

H.P.R. Valve remains closed</td></tr>
<tr><td>Freeze Cycle

Harvest Cycle</td><td>The discharge pressure is normal and the suction pressure is high. Frost forms on the compressor outward from where the H.P.R. system enters the compressor. (Not the large return suction line from evaporators.)

The discharge pressure is slightly low or normal and the suction pressure slightly low or normal. Although the frost usually disappears during the harvest cycle, the compressor remains cold, which causes extremely long harvest cycles.

During harvest, the compressor discharge gas usually drops below 85°F (29.4°C). After three consecutive cycles of this, the control board stops the ice machine on Safety Limit #3. The control board de-energizes the liquid line solenoid, although with the H.P.R. solenoid internally stuck open, the compressor cannot "pump down" and shut off.

As the compressor runs without the liquid line solenoid or other components energized, it heats up and cycles off on internal overload.</td><td>H.P.R. Solenoid leaks or remains open</td></tr>
</table>

HIGH PRESSURE CONTROL VALVE (HEADMASTER)

Manitowoc remote systems require high pressure control valve with special settings. Replace defective headmaster control valves only with "original" Manitowoc replacement parts.

Operation

The high pressure control valve has a non-adjustable setting of 225 psig. At ambient temperatures of approximately 70°F (21.1°C) or above, refrigerant flows through the valve from the condenser to the receiver inlet. At temperatures below approximately 70°F (21.1°C), the head pressure control dome's nitrogen charge closes the condenser port and opens the bypass port from the compressor discharge line. In this modulating mode, the valve maintains minimum head pressure by building up liquid in the condenser and bypassing discharge gas directly to the receiver.

Diagnosing High Pressure Valve

1. Determine air temperature entering the remote condenser.
2. Determine if head pressure is high or low in relation to the outside temperature (refer to an Operation Pressure Chart for the model of ice machine on which you are working). If the air temperature is below approximately 70°F (21.1°C), the head pressure should be modulating around 225 psig.
3. Determine the temperature of the liquid line entering the receiver by feeling it with your hand. This line is normally "body temperature" (warm).
4. Using the symptoms gathered in Steps 2 and 3, refer to Failure Chart below.

> **Note**
> An ice machine with a failed high pressure control valve that will not bypass, will function properly with condenser air temperatures of approximately 70°F (21.1°C) or above. When the temperature drops below approximately 70°F (21.1°C), the headmaster fails to bypass, and the ice machine malfunctions.

Low On Charge Verification

The remote ice machine requires more refrigerant charge at lower ambient temperatures than at higher temperatures. A low on charge ice machine may function properly during the day (higher condenser air temperature) and malfunction during the night (when the temperature drops).

If after using the Head Pressure Control Valve failure chart, you cannot verify that the ice machine is low on charge:

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

HEAD PRESSURE (HEADMASTER) CONTROL VALVE FAILURE CHART

Possible Problem	Probable Cause	Corrective Measure
Valve not maintaining pressure	Non-approved valve	Install Manitowoc High Pressure Control Valve with proper setting
a. Discharge pressure extremely high b. Liquid line entering receiver feels hot	Valve stuck in bypass	Replace valve
a. Discharge pressure low b. Liquid line entering receiver extremely cold	Valve not bypassing	Replace valve
a. Discharge pressure low b. Liquid line entering receiver is warm-to-hot	Ice machine low on charge	Refer to "Low on charge verification" listed above

PRESSURE CONTROL SPECIFICATIONS AND DIAGNOSTICS

FAN CYCLE CONTROL (SELF-CONTAINED AIR-COOLED MODELS ONLY)

Function

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

The fan cycle control is normally closed and opens on a drop in discharge pressure.

Specifications (± 5 psig)
Cut-out -- 200 P.S.I.G. (fan cycles off)
Cut-in -- 250 P.S.I.G. (fan cycles on)

Check Procedure

1. Verify fan motor windings are not open or grounded and fan spins freely.
2. Connect manifold gauges to ice machine.
3. Hook voltmeter in parallel (across) to the fan cycle control, leaving wires attached.
4. Pressure above listed specification - read 0 volts and fan should be running.

   Pressure below listed specification - read line voltage and fan should be off.

HIGH PRESSURE CUT-OUT CONTROL

Function

Safety control which stops the ice machine if subjected to excessive high-side pressure. The H.P.C.O. control is a normally closed, and opens on a rise in discharge pressure.

Specifications (+20/-0)
Cut-out -- 440 P.S.I.G.
Cut-in -- manual reset (below 300 P.S.I.G. to reset)

Check Procedure

1. Set ICE/OFF/CLEAN switch to OFF and reset H.P.C.O. (if tripped).
2. Connect manifold gauges.
3. Hook voltmeter in parallel (across) to the H.P.C.O. leaving wires attached.
4. a. Water-Cooled Models - Close the water service valve to the water condenser inlet.

   b. Self-Contained Air-Cooled and Remote Models - Disconnect fan motor.
5. Set ICE/OFF/CLEAN switch to ICE.

   No water or air flowing through the condenser will cause the H.P.C.O. control to turn the ice machine off because of excessive high pressure. Watch the high-pressure gauge and record the pressure at which the cut-out takes place.

Caution

Stop ice machine operation by turning the toggle switch to OFF if the discharge pressure is exceeding 440 psig and the H.P.C.O. did not open to stop the ice machine.

Replace the H.P.C.O. control if:

1. The control will not reset.

Note

High-side pressure must be below listed specifications before resetting.

2. The control does not open at the specified cut-out point.

LOW PRESSURE CUT-OUT CONTROL
(REMOTE ICE MACHINES ONLY)

Function

The low pressure control opens and closes by suction pressure to energize and de-energize the contactor, which starts and stops the compressor and remote fan motor.

A drop in suction pressure opens the low pressure cut-out control.

Specifications

Cut-out -- 12 P.S.I.G. (±3) (Contactor de-energizes)
Cut-in -- 35 P.S.I.G. (±5) (Contactor energizes)

NOTE: Early production models may have a setting of 5 P.S.I.G. cut-out and 40 P.S.I.G. cut-in. All replacement controls have a new setting of 12 P.S.I.G. cut-out and 35 P.S.I.G. cut-in.

Check Procedure

1. Connect manifold gauges.
2. Connect a voltmeter in parallel (across) to the L.P. control, leaving wires attached.
3. Set the toggle switch to OFF.
4. The liquid line solenoid valve will de-energize and the suction pressure will begin to decrease. The low pressure cut-out control will open at the listed specification. The voltage across the L.P. cut-out control will be "line voltage."
5. Set toggle switch to ICE. The liquid line solenoid valve will energize and the suction pressure will rise. The low pressure cut-out control will close the listed specification and the compressor and remote fan motor will start.

   Voltage across the low pressure cut-out must be "0" volts with the compressor running.
6. Replace the low pressure cut-out control when it does not open and close properly or does not maintain proper settings.

B150 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	15.3-17.6	17.7-20.3	20.9-23.3	1-2.5
80/26.7	15.9-18.2	18.4-21.1	21.9-25.1	
90/32.2	17.7-20.3	20.9-23.3	25.4-29.0	
100/37.8	20.0-22.9	24.1-27.6	30.1-34.4	

Based on average ice slab weight of 1.87 lb. to 2.12 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	160	140	120
80/26.7	155	135	115
90/32.2	140	120	100
100/37.8	125	105	85

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-250	36-26	170-200	80-95
70/21.1	200-250	36-26	170-200	80-95
80/26.7	200-250	36-26	180-210	85-100
90/32.2	230-280	38-28	200-230	90-105
100/37.8	280-330	40-30	220-250	100-115
110/43.3	310-380	42-32	240-270	110-125

*Suction pressure drops gradually througout freeze cycle.

B150 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	13.9-16.0	17.1-19.6	20.0-22.9	1-2.5
80/26.7	14.3-16.5	17.7-20.3	20.9-23.3	
90/32.2	14.3-16.5	17.7-20.3	20.9-23.3	
100/37.8	14.8-17.0	18.4-21.1	21.9-25.1	

Based on average ice slab weight of 1.87 lb. to 2.12 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	175	145	125
80/26.7	170	140	120
90/32.2	170	140	120
100/37.8	165	135	115

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	150	260	1650

At 225 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	220-230	36-28	150-180	80-95
70/21.1	220-230	36-28	150-180	85-100
80/26.7	220-230	36-28	150-180	85-100
90/32.2	220-230	36-28	160-190	90-105
100/37.8	220-230	36-28	170-200	90-105
110/43.3	220-230	36-28	170-200	95-110

*Suction pressure drops gradually througout freeze cycle.

B150 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	15.3-17.6	17.7-20.3	20.9-23.3	1-2.5
80/26.7	15.9-18.2	18.4-21.1	21.9-25.1	
90/32.2	17.7-20.3	20.9-23.3	25.4-29.0	
100/37.8	20.0-22.9	24.1-27.6	30.1-34.4	

Based on average ice slab weight of 1.87 lb. to 2.12 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	160	140	120
80/26.7	155	135	115
90/32.2	140	120	100
100/37.8	125	105	85

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	200-250	36-26	170-200	80-95
70/21.1	200-250	36-26	170-200	80-95
80/26.7	200-250	36-26	180-210	85-100
90/32.2	230-280	38-28	200-230	90-105
100/37.8	280-330	40-30	220-250	100-115
110/43.3	310-380	42-32	240-270	110-125

*Suction pressure drops gradually througout freeze cycle.

B150 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	13.9-16.0	17.1-19.6	20.0-22.9	1-2.5
80/26.7	14.3-16.5	17.7-20.3	20.9-23.3	
90/32.2	14.3-16.5	17.7-20.3	20.9-23.3	
100/37.8	14.8-17.0	18.4-21.1	21.9-25.1	

Based on average ice slab weight of 1.87 lb. to 2.12 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	175	145	125
80/26.7	170	140	120
90/32.2	170	140	120
100/37.8	165	135	115

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	150	260	1650

At 225 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	220-230	36-28	150-180	80-95
70/21.1	220-230	36-28	150-180	85-100
80/26.7	220-230	36-28	150-180	85-100
90/32.2	220-230	36-28	160-190	90-105
100/37.8	220-230	36-28	170-200	90-105
110/43.3	220-230	36-28	170-200	95-110

*Suction pressure drops gradually througout freeze cycle.

B200 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	12.6-14.7	14.8-17.3	16.5-19.3	1-2.5
80/26.7	13.8-16.1	16.5-19.3	18.6-21.6	
90/32.2	15.2-17.8	18.6-21.6	21.2-24.6	
100/37.8	17.5-20.4	21.9-25.5	25.5-29.6	

Based on average ice slab weight of 2.44 lb. to 2.81 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	250	215	195
80/26.7	230	195	175
90/32.2	210	175	155
100/37.8	185	150	130

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-250	48-28	120-150	75-90
70/21.1	200-250	48-28	120-150	80-95
80/26.7	210-270	50-28	120-150	85-100
90/32.2	240-300	54-30	130-160	90-105
100/37.8	270-350	60-32	130-160	95-110
110/43.3	300-390	64-32	140-170	100-115

*Suction pressure drops gradually througout freeze cycle.

B200 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	13.1-15.4	15.2-17.8	18.6-21.6	1-2.5
80/26.7	13.1-15.4	15.2-17.8	18.6-21.6	
90/32.2	13.5-15.7	15.6-18.2	19.2-22.3	
100/37.8	13.5-15.7	15.6-18.2	19.2-22.3	

Based on average ice slab weight of 2.44 lb. to 2.81 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	240	210	175
80/26.7	240	210	175
90/32.2	235	205	170
100/37.8	235	205	170

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	175	325	1750

At 230 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	225-235	48-28	130-160	80-95
70/21.1	225-235	48-28	130-160	80-95
80/26.7	225-235	50-28	130-160	85-100
90/32.2	225-235	50-28	140-170	85-100
100/37.8	225-245	50-30	140-170	90-105
110/43.3	225-255	50-30	150-180	90-105

*Suction pressure drops gradually througout freeze cycle.

B250 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	12.0-14.1	13.8-16.1	15.6-18.2	1-2.5
80/26.7	12.8-15.0	14.8-17.3	17.0-19.8	
90/32.2	14.8-17.3	17.5-20.4	20.5-23.8	
100/37.8	16.5-19.3	19.8-23.0	23.6-27.4	

Based on average ice slab weight of 2.44 lb. to 2.81 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	260	230	205
80/26.7	245	215	190
90/32.2	215	185	160
100/37.8	195	165	140

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-250	48-28	170-200	75-90
70/21.1	200-250	48-28	170-200	75-90
80/26.7	220-280	48-30	180-210	85-95
90/32.2	250-310	50-32	190-220	90-105
100/37.8	290-350	52-34	210-240	100-120
110/43.3	320-380	54-36	260-270	110-130

*Suction pressure drops gradually througout freeze cycle.

B250 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	12.6-14.7	14.8-17.3	17.0-19.8	1-2.5
80/26.7	12.6-14.7	14.8-17.3	17.0-19.8	
90/32.2	12.8-15.0	15.2-17.8	17.5-20.4	
100/37.8	12.8-15.0	15.2-17.8	17.5-20.4	

Based on average ice slab weight of 2.44 lb. to 2.81 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	250	215	190
80/26.7	250	215	190
90/32.2	245	210	185
100/37.8	245	210	185

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE		
	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	190	360	1300

At 225 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	220-230	48-28	170-200	80-95
70/21.1	220-230	48-28	170-200	85-95
80/26.7	220-230	50-30	180-210	85-100
90/32.2	220-230	50-30	180-210	85-100
100/37.8	220-230	50-30	180-210	85-100
110/43.3	220-230	52-33	180-210	90-105

*Suction pressure drops gradually througout freeze cycle.

B320 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2	HARVEST TIME
70/21.1	11.3-12.9	12.6-14.4	14.1-16.1	1-2.5
80/26.7	12.6-14.4	14.1-16.1	16.1-18.4	
90/32.2	14.1-16.1	16.1-18.4	18.6-21.2	
100/37.8	16.1-18.4	18.6-21.2	21.9-25.0	

Based on average ice slab weight of 2.93 lb. to 3.31 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
70/21.1	330	300	270
80/26.7	300	270	240
90/32.2	270	240	210
100/37.8	240	210	180

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	200-250	50-36	150-180	75-90
70/21.1	200-250	50-36	160-190	80-95
80/26.7	210-260	50-36	170-200	85-100
90/32.2	230-280	52-38	180-210	90-105
100/37.8	260-330	54-40	200-230	100-115
110/43.3	280-360	56-42	220-250	110-125

*Suction pressure drops gradually througout freeze cycle.

B320 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2	HARVEST TIME
70/21.1	12.3-14.1	14.7-16.8	17.7-20.2	1-2.5
80/26.7	12.6-14.4	15.1-17.2	18.1-20.7	
90/32.2	12.8-14.7	15.8-17.6	18.6-21.2	
100/37.8	13.1-14.9	15.7-18.0	19.1-21.8	

Based on average ice slab weight of 2.93 lb. to 3.31 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
70/21.1	305	260	220
80/26.7	300	255	215
90/32.2	295	250	210
100/37.8	290	245	205

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
Gal/24 hours	230	410	1665

At 230 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	215-225	50-36	150-180	75-90
70/21.1	215-225	50-36	160-190	80-95
80/26.7	215-225	50-36	160-190	85-100
90/32.2	215-225	50-36	170-200	85-100
100/37.8	220-240	52-36	170-200	90-105
110/43.3	220-240	52-36	180-210	95-110

*Suction pressure drops gradually througout freeze cycle.

B420/B450 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2	HARVEST TIME
70/21.1	11.1-13.1	12.6-14.8	14.5-17.0	1-2.5
80/26.7	11.7-13.7	13.3-15.6	17.0-18.1	
90/32.2	13.3-15.6	15.5-18.1	18.3-21.3	
100/37.8	15.0-17.5	17.6-20.6	20.5-23.8	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
70/21.1	470	420	370
80/26.7	450	400	350
90/32.2	400	350	300
100/37.8	360	310	270

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	200-250	44-30	140-170	85-100
70/21.1	200-250	46-30	150-180	90-105
80/26.7	200-250	46-30	160-190	95-110
90/32.2	230-280	46-30	170-200	100-115
100/37.8	270-330	48-32	200-230	110-125
110/43.3	300-360	54-36	230-270	120-135

*Suction pressure drops gradually througout freeze cycle.

B420/B450 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2	HARVEST TIME
70/21.1	12.0-14.1	13.3-15.6	15.2-17.8	1-2.5
80/26.7	12.1-14.2	13.5-15.8	15.5-18.1	
90/32.2	12.3-14.4	13.7-16.0	15.7-18.3	
100/37.8	12.6-14.8	14.1-16.5	16.2-18.9	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
70/21.1	440	400	355
80/26.7	435	395	350
90/32.2	430	390	345
100/37.8	420	380	335

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C 50/10.0	70/21.1	90/32.2
Gal/24 hours	315	580	2800

At 230 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE HEAD PRESSURE PSIG	FREEZE CYCLE SUCTION PRESSURE PSIG	HARVEST CYCLE HEAD PRESSURE PSIG	HARVEST CYCLE SUCTION PRESSURE PSIG
50/10.0	225-235	48-30	175-200	90-105
70/21.1	225-235	48-30	175-200	95-110
80/26.7	225-235	48-30	175-200	95-110
90/32.2	225-235	48-30	175-200	100-115
100/37.8	230-240	48-30	185-210	100-115
110/43.3	230-240	50-32	185-210	100-115

*Suction pressure drops gradually througout freeze cycle.

B420/B450 SERIES REMOTE

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
-20 to 70/-28.9 to 21.1	12.6-14.8	14.5-17.0	16.5-19.2	1-2.5
80/26.7	12.8-15.0	14.8-17.2	16.8-19.6	
90/32.2	13.0-15.2	15.0-17.5	17.0-19.9	
100/37.8	13.3-15.6	15.5-18.1	17.6-20.6	
110/43.3	14.1-16.5	15.9-18.6	18.3-21.3	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
-20 to 70/-28.9 to 21.1	420	370	330
90/32.2	410	360	320
100/37.8	400	350	310
110/43.3	380	340	300

Regular cube derate 7%
Rating using BC0495 condenser, dice or half-dice cubes

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
-20 to 50/ -28.9 to 10.0	220-250	46-30	150-180	85-100
70/21.1	220-250	46-30	150-180	85-100
80/26.7	230-260	48-30	150-180	85-100
90/32.2	240-270	50-32	150-180	85-100
100/37.8	250-290	50-32	160-190	90-105
110/43.3	280-330	52-34	160-190	95-110

*Suction pressure drops gradually througout freeze cycle.

B600 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	7.2-8.6	8.4-9.9	9.5-11.2	1-2.5
80/26.7	7.8-9.2	9.1-10.7	10.4-12.2	
90/32.2	8.6-10.1	10.1-11.9	12.0-14.1	
100/37.8	9.7-11.4	11.7-13.7	14.1-16.5	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	680	600	540
80/26.7	640	560	500
90/32.2	590	510	440
100/37.8	530	450	380

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-250	40-22	130-160	75-90
70/21.1	200-250	40-22	140-170	80-95
80/26.7	210-260	44-24	150-180	85-100
90/32.2	230-290	46-24	160-190	90-105
100/37.8	260-330	50-28	180-210	100-115
110/43.3	310-380	55-36	200-240	120-135

*Suction pressure drops gradually througout freeze cycle.

B600 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	7.6-9.0	8.9-10.5	10.4-12.2	1-2.5
80/26.7	7.8-9.2	9.1-10.7	10.6-12.5	
90/32.2	7.9-9.4	9.3-10.9	10.9-12.8	
100/37.8	8.1-9.5	9.5-11.2	11.1-13.1	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	650	570	500
80/26.7	640	560	490
90/32.2	630	550	480
100/37.8	620	540	470

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE		
	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	410	740	3100

At 230 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	225-235	40-24	150-180	85-100
70/21.1	225-235	40-24	150-180	85-100
80/26.7	225-235	42-24	160-190	90-105
90/32.2	225-235	42-24	160-190	95-110
100/37.8	225-235	44-26	170-200	95-110
110/43.3	230-240	44-26	180-210	95-110

*Suction pressure drops gradually througout freeze cycle.

B600 SERIES REMOTE

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
-20 to 70/-28.9 to 21.1	8.1-9.5	9.5-11.2	10.9-12.8	1-2.5
80/26.7	8.2-9.7	9.7-11.4	11.1-13.1	
90/32.2	8.4-9.9	9.9-11.7	11.4-13.4	
100/37.8	8.7-10.3	10.4-12.2	12.0-14.1	
110/43.3	9.7-11.4	11.1-13.1	13.0-15.2	

Based on average ice slab weight of 4.12 lb. to 4.75 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
-20 to 70/-28.9 to 21.1	620	540	480
90/32.2	600	520	460
100/37.8	580	500	440
110/43.3	530	470	410

Regular cube derate 7%
Rating using BC0895 condenser, dice or half-dice cubes

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
-20 to 50/ -28.9 to 10.0	220-250	44-26	140-170	80-95
70/21.1	220-250	44-26	150-180	85-100
80/26.7	220-250	44-26	150-180	85-100
90/32.2	230-260	46-28	150-180	90-105
100/37.8	250-290	48-30	150-180	90-105
110/43.3	280-330	54-32	160-190	95-110

*Suction pressure drops gradually througout freeze cycle.

B800 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	8.6-9.9	10.0-11.5	11.2-12.9	1-2.5
80/26.7	8.7-10.1	10.2-11.7	11.4-13.1	
90/32.2	9.3-10.7	10.9-12.5	12.3-14.1	
100/37.8	10.7-12.3	12.8-14.6	14.7-16.9	

Based on average ice slab weight of 5.75 lb. to 6.50 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	820	720	650
80/26.7	810	710	640
90/32.2	770	670	600
100/37.8	680	580	510

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-240	35-20	140-170	65-80
70/21.1	200-240	35-20	140-170	65-80
80/26.7	220-260	35-20	150-180	70-85
90/32.2	250-300	40-22	160-190	75-90
100/37.8	280-330	42-24	180-210	80-95
110/43.3	310-350	44-26	200-230	85-100

*Suction pressure drops gradually througout freeze cycle.

B800 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME WATER TEMP. °F/°C			HARVEST TIME
	50/10.0	70/21.1	90/32.2	
70/21.1	8.4-9.6	9.3-10.7	11.1-12.7	1-2.5
80/26.7	8.4-9.7	9.3-10.7	11.1-12.8	
90/32.2	8.5-9.8	9.4-10.8	11.2-12.9	
100/37.8	8.5-9.9	9.5-10.9	11.3-13.0	

Based on average ice slab weight of 5.75 lb. to 6.50 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	840	770	660
80/26.7	835	765	655
90/32.2	830	760	650
100/37.8	825	755	645

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	500	1000	2025

At 220 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	215-225	35-20	140-170	70-85
70/21.1	215-225	35-20	140-170	70-85
80/26.7	215-225	35-20	140-170	70-85
90/32.2	215-225	36-22	150-180	70-85
100/37.8	220-230	38-22	150-180	70-85
110/43.3	220-240	38-24	160-190	70-85

*Suction pressure drops gradually througout freeze cycle.

B800 SERIES REMOTE

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
-20 to 70/-28.9 to 21.1	8.9-10.2	10.2-11.7	11.9-13.6	1-2.5
80/26.7	8.9-10.3	10.2-11.8	12.0-13.7	
90/32.2	9.0-10.3	10.3-11.9	12.1-13.8	
100/37.8	9.5-11.0	11.1-12.7	13.0-14.9	
110/43.3	10.7-12.3	12.5-14.4	15.1-17.2	

Based on average ice slab weight of 5.75 lb. to 6.50 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
-20 to 70/-28.9 to 21.1	800	710	620
90/32.2	790	700	610
100/37.8	750	660	570
110/43.3	680	590	500

Regular cube derate 7%
Rating using BC0895 condenser, dice or half-dice cubes

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
-20 to 50/ -28.9 to 10.0	220-250	38-22	160-190	80-95
70/21.1	220-250	38-22	160-190	80-95
80/26.7	225-260	38-22	160-190	80-95
90/32.2	230-270	40-22	170-200	85-100
100/37.8	250-300	40-24	180-210	90-105
110/43.3	290-340	42-26	190-220	95-110

*Suction pressure drops gradually througout freeze cycle.

B1000 SERIES SELF CONTAINED AIR-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	8.9-9.6	10.0-10.8	11.3-12.2	1-2.5
80/26.7	9.2-9.9	10.4-11.1	11.8-12.6	
90/32.2	10.0-10.8	11.3-12.2	13.0-13.9	
100/37.8	11.3-12.2	13.0-13.9	15.2-16.2	

Based on average ice slab weight of 7.75 lb. to 8.25 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	1070	970	870
80/26.7	1040	940	840
90/32.2	970	870	770
100/37.8	870	770	670

Regular cube derate 7%

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	200-250	38-20	140-170	75-90
70/21.1	200-250	40-20	140-170	75-90
80/26.7	210-270	40-20	150-180	75-90
90/32.2	230-300	42-22	170-200	85-100
100/37.8	260-340	44-22	200-230	95-110
110/43.3	280-360	46-22	210-240	100-115

*Suction pressure drops gradually througout freeze cycle.

B1000 SERIES WATER-COOLED

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
70/21.1	8.8-9.5	9.7-10.4	10.9-11.7	1-2.5
80/26.7	9.0-9.7	9.9-10.6	11.2-12.0	
90/32.2	9.2-9.9	10.1-10.9	11.5-12.3	
100/37.8	9.3-10.0	10.2-11.0	11.6-12.5	

Based on average ice slab weight of 7.75 lb. to 8.25 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. AROUND ICE MACHINE °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
70/21.1	1080	1000	900
80/26.7	1060	980	880
90/32.2	1040	960	860
100/37.8	1030	950	850

Regular cube derate 7%

CONDENSER WATER CONSUMPTION	90/32.2 AIR TEMPERATURE		
	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
Gal/24 hours	725	1275	4250

At 230 PSIG head pressure

OPERATING PRESSURES

AIR TEMP. AROUND ICE MACHINE °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
50/10.0	225-235	38-20	150-180	75-90
70/21.1	225-235	38-20	150-180	75-90
80/26.7	225-235	38-20	160-190	80-95
90/32.2	225-235	40-22	170-200	85-100
100/37.8	225-235	40-22	180-210	85-100
110/43.3	230-240	40-22	180-210	90-105

*Suction pressure drops gradually througout freeze cycle.

B1000 SERIES REMOTE

These characteristics may vary depending on operating conditions.

CYCLE TIMES

Freeze Time + Harvest Time = Total Cycle Time

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE TIME			HARVEST TIME
	WATER TEMP. °F/°C			
	50/10.0	70/21.1	90/32.2	
-20 to 70/-28.9 to 21.1	9.0-9.7	10.2-11.0	11.6-12.5	1-2.5
80/26.7	9.1-9.8	10.4-11.1	11.8-12.6	
90/32.2	9.1-9.8	10.5-11.3	12.0-12.8	
100/37.8	9.4-10.2	10.8-11.6	12.3-13.2	
110/43.3	10.4-11.1	11.0-11.9	13.2-14.1	

Based on average ice slab weight of 7.75 lb. to 8.25 lb.
Times in minutes

24 HOUR ICE PRODUCTION

AIR TEMP. ENTERING CONDENSER °F/°C	WATER TEMP. °F/°C		
	50/10.0	70/21.1	90/32.2
-20 to 70/-28.9 to 21.1	1060	950	850
90/32.2	1050	930	830
100/37.8	1020	910	810
110/43.3	940	890	760

Regular cube derate 7%
Rating using BC1095 condenser, dice or half-dice cubes

OPERATING PRESSURES

AIR TEMP. ENTERING CONDENSER °F/°C	FREEZE CYCLE		HARVEST CYCLE	
	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG	HEAD PRESSURE PSIG	SUCTION PRESSURE PSIG
-20 to 50/ -28.9 to 10.0	220-250	38-24	150-180	75-90
70/21.1	220-250	38-24	160-190	75-90
80/26.7	220-250	38-24	160-190	80-95
90/32.2	240-280	40-24	170-200	85-100
100/37.8	250-300	40-24	180-210	90-105
110/43.3	300-350	42-26	190-220	95-110

*Suction pressure drops gradually througout freeze cycle.

REFRIGERANT RECOVERY/EVACUATION AND RECHARGING

REMOVAL OF REFRIGERANT

Do not purge refrigerant to the atmosphere. Capture refrigerant using recovery equipment by following specific 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.

NORMAL SELF-CONTAINED MODEL PROCEDURES

Refrigerant Recovery/Evacuation

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

CONNECTIONS

1. Suction side of compressor through suction service valve.
2. Discharge side of compressor through discharge service valve.

SELF-CONTAINED RECOVERY/EVACUATION

1. Place toggle switch in OFF position.
2. Install manifold gauges, charging cylinder/scale, and recovery unit or 2-stage vacuum pump (Figure 7-9).
3. Open (backseat) high and low side ice machine service valves, and open high and low side on manifold gauges.
4. Recovery: Operate recovery unit per manufacturer's instructions.

   Evacuation prior to recharging: Pull system down to 250 microns. Allow pump to run for 1/2 hour after reaching 250 microns. Turn off vacuum pump, ensure pressures do not rise. (Standing vacuum leak check.)

> **Note**
> Recheck for leaks with a halide or electronic leak detector after charging ice machine.

5. Charge the ice machine. Follow Charging Procedures on next page.

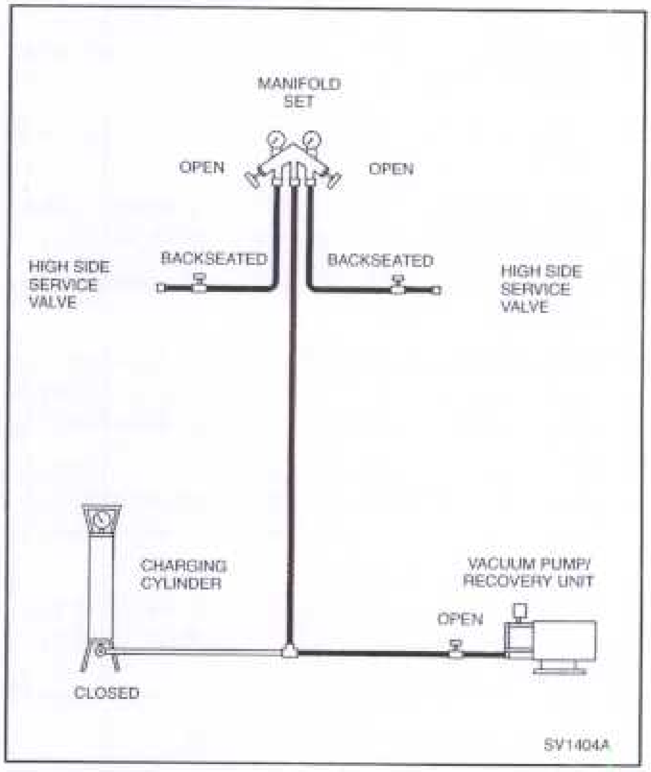

Figure 7-9. SELF-CONTAINED RECOVERY/ EVACUATION CONNECTIONS

CHARGING PROCEDURES

> **Important**
> The charge is critical on all Manitowoc Series ice machines. Use a weight or a charging cylinder to determine the proper charge.

1. Ensure toggle switch is in OFF position.
2. Close vacuum pump valve, low side service valve, and low side valve on manifold gauge.
3. Open high side manifold gauge valve, backseat high side service valve.
4. Open charging cylinder and add measured name-plate charge through discharge service valve.
5. Allow system to "settle" for 2 or 3 minutes after charging.
6. Place toggle switch in ICE position. Close high side on manifold gauge set, and add remaining vapor charge through suction service valve (if necessary).
7. Ensure all vapor in charging hoses is drawn into the ice machine before disconnecting manifold gauges.

> **Note**
> Manifold gauges must be properly removed to ensure no refrigerant contamination or loss occurs.

a. Run ice machine in freeze cycle.
b. Close high side service valve at ice machine.
c. Open low side service valve at ice machine.
d. Open both high and low side valves on manifold gauge set. Refrigerant in lines will be pulled into the low side of system. Allow pressures to equalize with ice machine still in freeze cycle.
e. Close low side service valve at ice machine.
f. Remove hoses from ice machine and install caps.

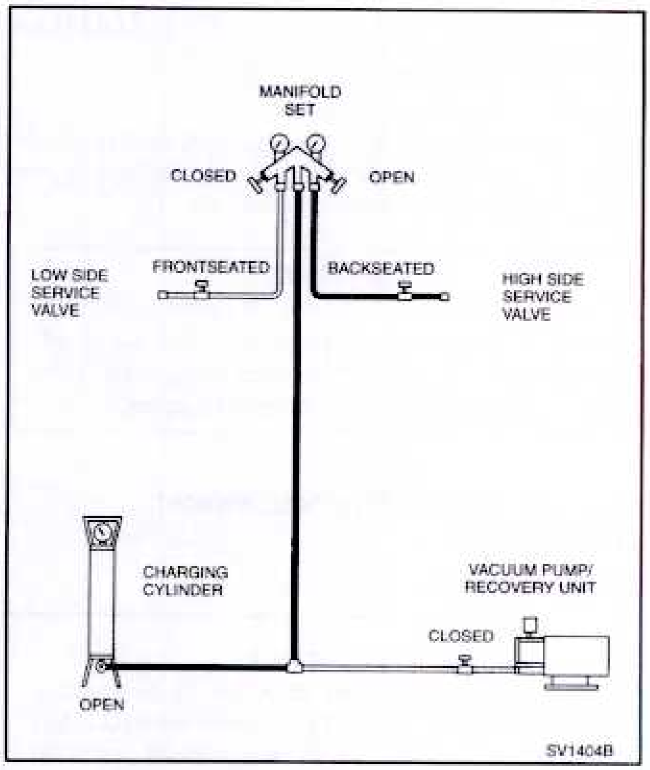

Figure 7-10. SELF-CONTAINED CHARGING CONNECTIONS

NORMAL REMOTE MODEL PROCEDURES

CONNECTIONS

Recovery/Evacuation of remote systems requires connections at 4 points for complete system evacuation.

1. Suction side of compressor through suction service valve.
2. Discharge side of compressor through discharge service valve.
3. Receiver outlet service valve. (Evacuates area between check valve in liquid line and pump-down solenoid.)
4. Access (Schraeder) valve on discharge line quick connect fitting on outside of compressor/evaporator compartment. This connection is necessary to evacuate the condenser. Without this connection, the magnetic check valves would close upon the pressure drop produced by evacuation, prohibiting complete condenser evacuation.

> **Note**
> Manitowoc recommends using an access valve core removal and installation tool on the discharge line quick connect fitting. The tool permits removal of the access valve core for faster evacuation and charging without removing the manifold gauge hose.

REMOTE RECOVERY/EVACUATION

1. Place toggle switch in OFF position.
2. Install manifold gauges, scale, and recovery unit or 2-stage vacuum pump.
3. Open (backseat) high and low side ice machine service valves, position receiver service valve 1/2 open, and open high and low side on manifold gauge set.
4. Recovery: Operate recovery unit per manufacturer's instructions.

   Evacuation prior to recharging: Pull system down to 250 microns. Allow pump to run for 1 hour after reaching 250 microns. Turn off vacuum pump, ensure pressures do not rise. (Standing vacuum leak-check).

> **Note**
> Recheck for leaks with a halide or electronic leak detector after charging ice machine.

5. Charge the ice machine. Follow the Charging Procedures on page 7-41.

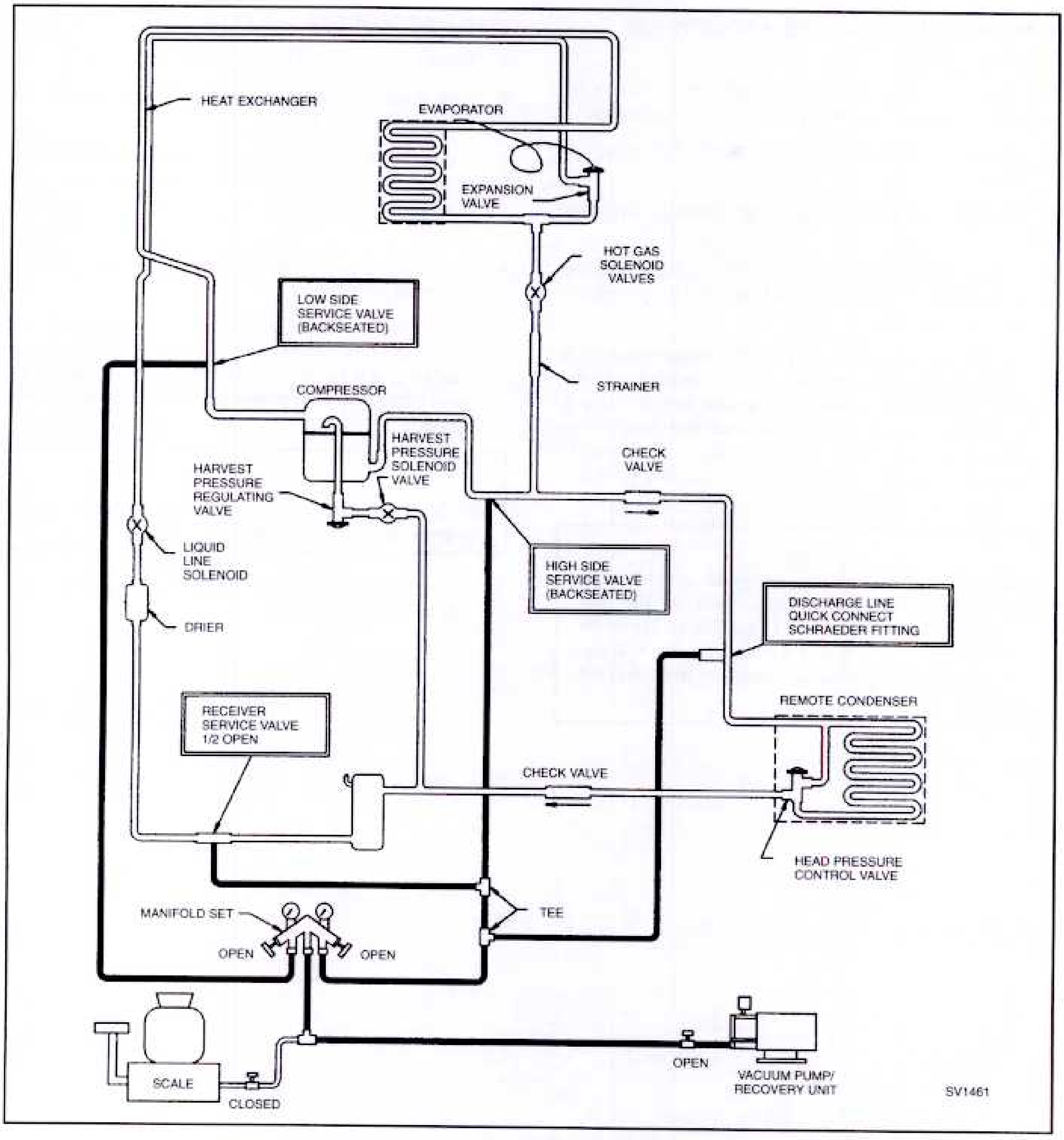

Figure 7-11. REMOTE RECOVERY/EVACUATION CONNECTIONS

CHARGING PROCEDURES

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

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

a. Run ice machine in freeze cycle.
b. Close high side service valve at ice machine.
c. Open low side service valve at ice machine.
d. Open both high and low side valves on manifold gauge set. Refrigerant in lines will be pulled into the low side of system. Allow pressures to equalize with ice machine still in freeze cycle.
e. Close low side service valve at ice machine.
f. Remove hoses from ice machine and install caps.

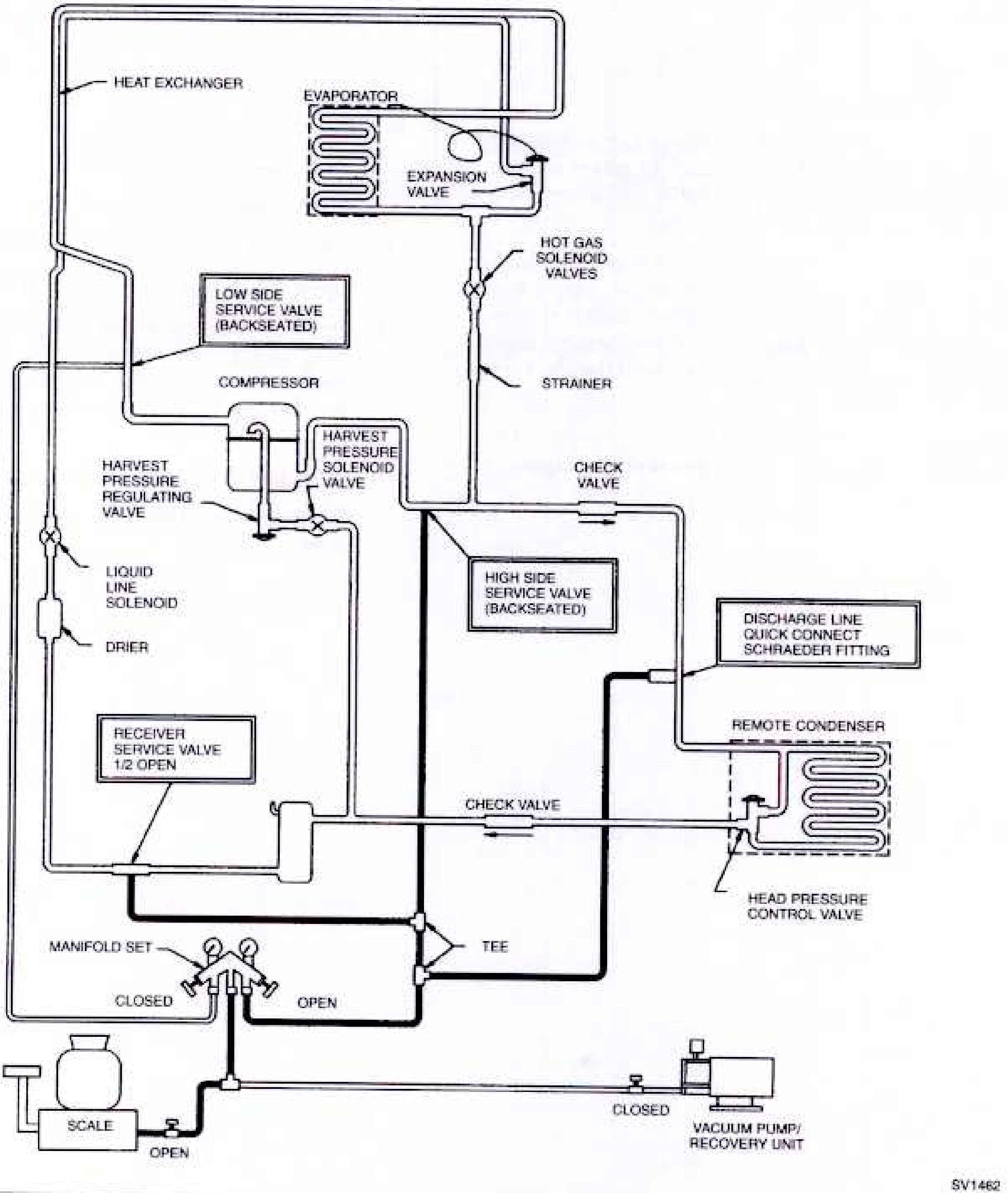

Figure 7-12. REMOTE CHARGING CONNECTIONS

SEVERE 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 use of contaminated refrigerant. Damage resulting from the use of contaminated recovered or recycled refrigerant is the sole responsibility of the servicing company.

Determining Severity Of Contamination and Clean-Up Procedures

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

Inspection of the refrigerant usually provides the first indication of contaminants in the system. If obvious moisture or an acrid odor indicating burnout is present in the refrigerant, steps must be taken to determine the severity of contamination as well as the required clean-up procedure.

If visible moisture or an acrid odor is detected, or if contamination is suspected, the use of a Total Test Kit from Totaline or similar diagnostic tool is recommended. These devices read refrigerant, eliminating the need for an initial oil sample for testing.

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

1. Remove refrigerant charge from ice machine.
2. Remove compressor from the system.
3. Check odor and appearance of the oil.
4. Inspect open suction and discharge lines at compressor for burnout deposits.
5. Perform an acid oil test if contamination signs are not evident to ensure no harmful contamination is present.

The following chart lists findings and matches them with required clean-up procedure. Use this chart for determining the type of clean-up required.

Contamination/Clean-Up Chart

Symptoms/Findings	Required Clean-Up Procedure
No symptoms or suspicion of contamination	Normal evacuation and recharging procedures.
Moisture / Air Contamination (one or more of the following conditions will exist) • Refrigeration system open to atmosphere for prolonged periods • Refrigeration test kit and / or acid oil test shows contamination • Leak in water-cooled condenser • No burnout deposits in open compressor lines	Mild contamination clean-up procedures.
Mild Compressor Burnout • Oil appears clean with acrid odor and / or • Refrigeration test kit or acid oil test shows harmful acid content • No burnout deposits in open compressor lines	Mild contamination clean-up procedures.
Severe Compressor Burnout • Oil discolored and acidic with acrid odor, burnout deposits in compressor, discharge and suction lines and other components	Severe contamination clean-up procedures.

Mild System Contamination Clean-Up Procedures

1. Replace failed components if applicable. If compressor checks good, change oil in compressor.
2. Replace liquid line drier.
3. Follow normal evacuation procedure except replace the evacuation step with the following:

> **Note**
> If contamination is from moisture, the use of heat lamps or heaters is recommended during evacuation. Place heat lamps at the compressor, condenser, and at the evaporator prior to evacuation. (Ensure heat lamps are not positioned too close to plastic components such as evaporator extrusions, water trough, etc., as they could melt, warp, etc.)

> **Important**
> Dry nitrogen is recommended for this procedure. This will prevent C.F.C. release into the atmosphere.

   a. Pull vacuum to 1000 microns. Break vacuum with dry nitrogen and sweep system. Pressurize to a minimum of 5 psi.

   b. Pull vacuum to 500 microns. Break vacuum with dry nitrogen and sweep system. Pressurize to a minimum of 5 psi.

   c. Change vacuum pump oil. Pull system down to 250 microns. Run vacuum pump for 1/2 hour on self-contained models, 1 hour for remotes.

   A standing vacuum test may be performed as a preliminary means of leak checking. However, the use of an electronic leak detector after the system has been charged is recommended.

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

Severe System Contamination Clean-Up Procedures

1. Remove refrigerant charge.
2. Remove compressor.
3. Disassemble hot gas solenoid valve. If burnout deposits are found inside valve, install rebuild kit and replace TXV and harvest pressure regulating valve.
4. Check discharge and suction lines at compressor for burnout deposits. Wipe out as necessary.
5. Sweep through open system with dry nitrogen.

> **Note**
> Refrigerant sweeps are not recommended, as they release C.F.C.'s into the atmosphere.

6. Installation Procedures:
   a. Install new compressor and start components.
   b. Install an adequately sized suction line filter-drier (with acid/moisture removal capability) and inlet/outlet access valves. Place the filter-drier as close to the compressor as practical.
   c. Replace liquid line filter-drier.

7. Follow normal evacuation procedures except replace the evacuation step with the following:

> **Important**
> Dry nitrogen is recommended for this procedure to prevent C.F.C. release into the atmosphere.

a. Pull vacuum to 1000 microns. Break vacuum with dry nitrogen and sweep system. Pressurize to a minimum of 5 psi.

b. Change vacuum pump oil. Pull vacuum to 500 microns. Break vacuum with dry nitrogen and sweep system. Pressurize to a minimum of 5 psi.

c. Change vacuum pump oil. Pull system down to 250 microns. Run vacuum pump for 1/2 hour for self-contained models, 1 hour for remotes.

A standing vacuum test may be performed as a preliminary means of leak checking. However, the use of an electronic leak detector after the system has been charged is recommended.

8. Charge system with proper refrigerant to nameplate charge.

9. Operate ice machine.

a. Check pressure drop across the suction line filter-drier after 1 hour running time. If pressure drop is not excessive (up to 1 psi differential), the filter-drier should be adequate for complete clean-up. Proceed to step 10.

b. If pressure drop is greater than 1 psi after 1 hour run time, change the suction line filter-drier and liquid line drier. Repeat step 9 until ice machine will run 1 hour without pressure drop.

10. Remove suction line filter-drier after 48-72 hours run time. Change liquid line drier and follow normal evacuation procedures.

REPLACING PRESSURE CONTROLS WITHOUT REMOVING REFRIGERANT CHARGE

The following procedure prevents opening of the refrigeration system and reduces repair time and cost. Use this procedure when one of the following components requires replacing and the refrigeration system is leak free and operational.

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

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

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

1. Disconnect power to ice machine. **Follow all manufacturer's instructions supplied with "pinch-off" tool.**

2. Position pinch-off tool around tubing as far away from pressure control as feasible. Clamp down on tubing until pinch-off is complete. (Figure 7-13A., next page.)

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

3. Leaving pinch-off tool securely in place, **cut tubing** of defective component with a small tubing cutter.

4. Install new component. Allow solder joint to cool.

5. Remove pinch-off tool.

6. To re-round tubing, position wide angle of pinched tubing into corresponding diameter hole of pinch-off tool. Tighten wing nuts until block is tight and tubing is rounded. (Figure 7-13B, next page.)

> **Note**
> Pressure controls will operate normally once "pinched off" tubing is re-rounded. (Tubing may not re-round 100%.)

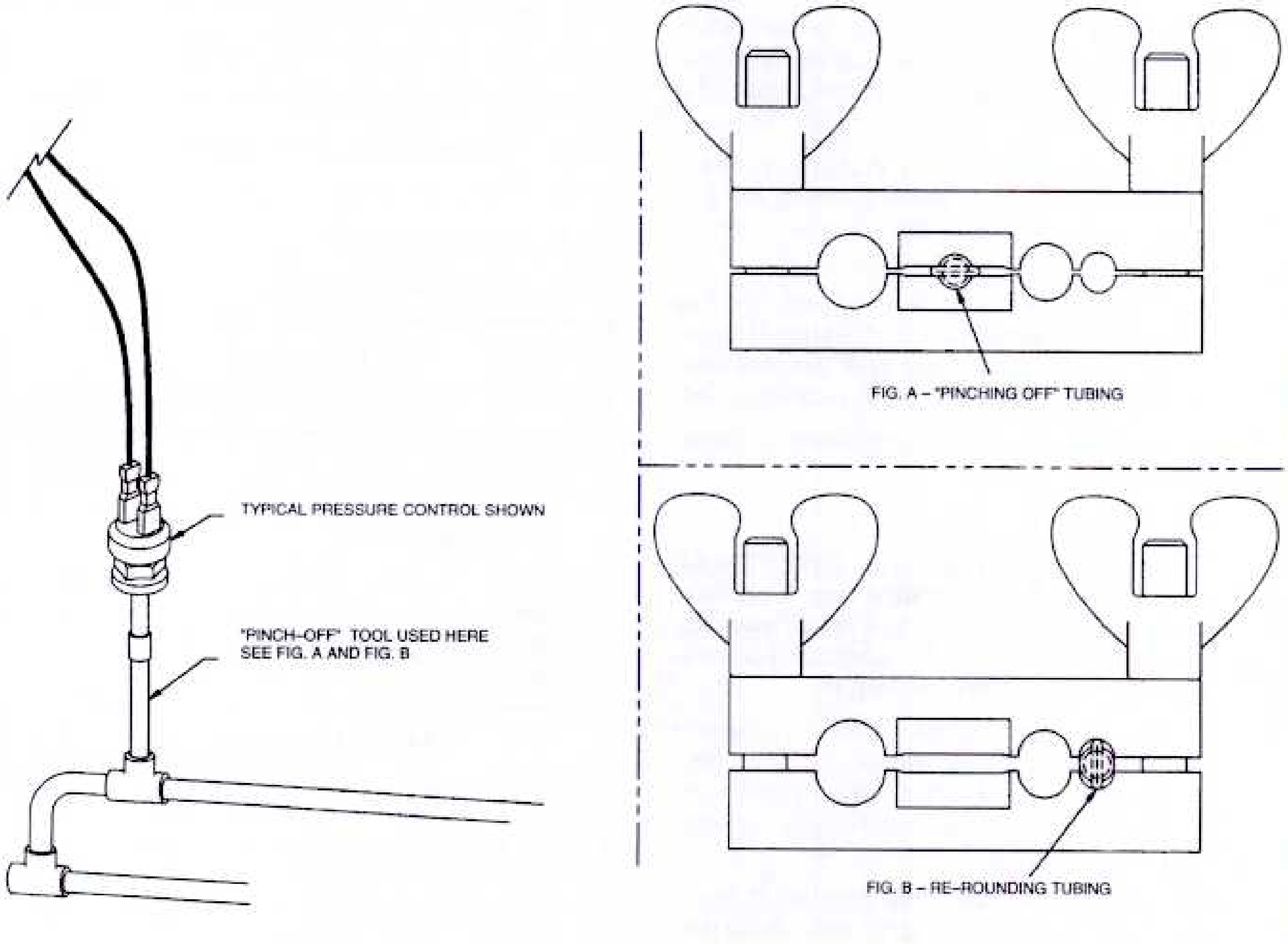

Figure 7-13. REPLACING PRESSURE CONTROLS WITHOUT REMOVING REFRIGERANT CHARGE

FILTER-DRIERS

The size of the filter-drier is important. The refrigerant charge is critical and use of an oversized or undersized drier will cause the ice machine to be improperly charged.

Listed below are the recommended O.E.M. field replacement driers:

Machine Size	Drier Size	End Connection Size	Part No.
B150, B250 B200, B320 B420, B450 B600	"032"	1/4"	12-3005-1
B800, B1000	"082"	1/4"	89-3010-3

> **Important**
> Driers are covered as a warranty part and are to be replaced any time the system is opened for repairs.

TOTAL SYSTEM REFRIGERANT CHARGES

> **Important**
> Refer to machine serial tag to verify system charge.

Machine	Charge	Refrigerant
B150 Series		
Air-Cooled	14 oz.	R-402B
Water-Cooled	10 oz.	R-402B
B200 Series		
Air-Cooled	20 oz.	R-402B
Water-Cooled	12 oz.	R-402B
B250 Series		
Air-Cooled	18 oz.	R-402B
Water-Cooled	14 oz.	R-402B
B320 Series		
Air-Cooled	20 oz.	R-402B
Water-Cooled	15 oz.	R-402B
B420/B450 Series		
Air-Cooled	26 oz.	R-402B
Water-Cooled	20 oz.	R-402B
Remote (B450)	8 lb.	R-402B
B600 Series		
Air-Cooled	32 oz.	R-402B
Water-Cooled	24 oz.	R-402B
Remote	10 lb.	R-402B
B800 Series		
Air-Cooled	35 oz.	R-402B
Water-Cooled	32 oz.	R-402B
Remote	10 lb.	R-402B
B1000 Series		
Air-Cooled	38 oz.	R-402B
Water-Cooled	34 oz.	R-402B
Remote	10 lb.	R-402B

R-402B is DuPont SUVA® HP81

CHARGING R-402B (HP81) USING CHARGING CYLINDERS

1. Charge cylinder with R-402B (HP81).
2. Read pressure indicated on the charging cylinder gauge.
3. Using the R-502 scale, rotate the charging cylinder to the pressure listed in the chart.

Pressure Reading on Gauge	Rotate Dial to R-502 Scale Listed Below
75 to 81	110
82 to 90	120
91 to 100	130
101 to 109	140
110 to 119	150
120 to 129	160
130 to 138	170
139 to 148	180
149 to 159	190
160 to 169	200
170 to 179	210
180 to 190	220
191 to 200	230
201 to 211	240
212 to 220	250

REFRIGERANT DEFINITIONS

Recovery

To remove refrigerant in any condition from a system and store it in an external container, without necessarily testing or processing it in any way.

Recycling

To clean refrigerant for reuse by oil separation and single or multiple passes through devices, such as replaceable core filter-driers, which reduce moisture, acidity, and particular matter. This term usually applies to procedures implemented at the field job site or at a local service shop.

Reclaim

To reprocess refrigerant to new product specifications by means which may include distillation. Will require chemical analysis of the refrigerant to determine that appropriate product specifications are met. This term usually implies the use of processes or procedures available only at a reprocessing or manufacturing facility.

Notes Regarding Reclaim

"New product specifications" currently means ARI Standard 700 (latest edition). Note that chemical analysis is required to assure that this standard is met.

Chemical analysis is the key requirement in the definition of "Reclaim." Regardless of the purity levels reached by a reprocessing method, the refrigerant is not "reclaimed" unless it has been chemically analyzed and meets ARI Standard 700 (latest edition).

REFRIGERANT RE-USE POLICY

Manitowoc recognizes and supports the need for proper handling, re-use of, or disposal of, CFC and HCFC refrigerants. Manitowoc service procedures require recapturing of refrigerants, not venting them to the atmosphere.

It is not necessary, in or out of warranty, to reduce or compromise the quality and reliability of your customers' products to achieve this.

Manitowoc **approves** the use of:

1. **New refrigerant** (original name plate type).
2. **Reclaimed refrigerant** (original name plate type) - must meet A.R.I. Standard 700 (latest edition) specifications.
3. **Recovered or recycled refrigerant** re-use:
   a. Refrigerant must be recovered and/or recycled in accordance with latest local, state, and federal laws.

   b. Refrigerant must be recovered from the same Manitowoc product which it will be re-used in. Recovered or recycled refrigerant re-use from other products is not approved.

   c. Recycling equipment must be certified to A.R.I. Standard 740 (latest edition) and be maintained to consistently meet this standard.

   d. Refrigerant recovered and reused must come from a "contaminant free" system. "Contaminant free" decision is influenced by type of previous failures, how the system was cleaned, evacuated, and recharged properly after previous failures, and whether the present failure contaminated the system. Compressor motor burnouts and systems not serviced properly in the past (an acid test can help determine system condition) prevent re-use of recovered refrigerant.

      If you are not sure of the contaminant level, refer to service manual for "Severe System Clean-Up Procedures."

   e. Whether recovering and re-using, or recycling, the **service person is responsible** to assure the refrigerant is not mixed with air, other refrigerants, etc., and is "contaminant free" prior to re-use.

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

4. **"Substitute" or "Alternative" refrigerant:**
   a. Must use only Manitowoc-approved alternative refrigerants.

   b. Must follow Manitowoc-published conversion procedures.

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R402B (DUPONT SUVA® HP81) QUESTIONS AND ANSWERS

IS R-402B FLAMMABLE? No - it is U.L. and ASHRAE classified as "practically non-flammable". The same rating is given to R-22 and R-502. R-402B ignition temperature of 641°C is actually less flammable than R-22 (632°C)!

IS R-402B TOXIC? The EPA exposure limit rating for R-402B is 1000 ppm, the highest rating given by the EPA for a refrigerant. R-402B carries the same rating as R-12, R-22, and R-502.

IS A SPECIAL COMPRESSOR OIL REQUIRED WITH R-402B? No - Manitowoc products use standard mineral- or alkylbenzene-type compressor oils with R-402B (The same as R-22 and R-502.)

HOW DO I LEAK CHECK A SYSTEM CONTAINING R-402B? Standard soap bubbles, halide torches, and standard electronic leak detectors work.

DO I HAVE TO RECOVER R-402B? Yes - like other refrigerants, government regulations require recovering R-402B.

WILL R-402B SEPARATE IF I HAVE A LEAK IN THE SYSTEM? No - like R-502, the degree of separation is too small to detect.

HOW DO I CHARGE A SYSTEM WITH R-402B? The same as R-502. It is recommended to charge liquid refrigerant only into the high side of the system.

CAN I PUT R-402B INTO R-502 G-MODEL ICE MACHINES? Yes - R-402B refrigerant can be used as an alternative replacement refrigerant in Manitowoc G-Model (R-502) ice machines. **Contact Manitowoc distributor for field conversion kit 76-2559-3.**

WHERE CAN I PURCHASE R-402B? DuPont refrigerants, including SUVA products, are available through more than 1,300 authorized distributors in the U.S.

IS SPECIAL EQUIPMENT REQUIRED TO SERVICE R-402B? No - standard refrigeration gauges, hoses, recovery systems, driers, vacuum pumps, etc. are compatible with R-402B.