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Recreation Vehicle Industry Association

Recreation Vehicle
Refrigerators

Recreation Vehicle Industry Association
1896 Preston White Drive
Reston, VA 20191
Phone 703/620-6003 • Fax 703/620-5071

RV Refrigerators - 4th edition

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June 2012

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8 Table of Contents

8 List of Figures

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Chapter 8-1 Introduction to Absorption Refrigeration

- Recognize various types of absorption refrigerators.
- Interpret data plate information.
- Recognize, locate, and explain the cooling unit components.
- Explain the absorption cooling cycle.
- Explain importance of proper leveling.
- Explain the importance of venting for proper unit operation and to all applicable codes.
- Identify the sources of heat.

8-1.1 Overview of Absorption Refrigeration

8-1.1.1 History of Refrigeration

In the U.S.A., the refrigeration industry began with ice harvesting from the northern lakes in winter and storing that ice in insulated buildings to be used during summer months. Society and the normal system of commerce soon became accustomed to a supply of ice for refrigeration. This is evidenced by the fact that during the Civil War, the Mississippi River was closed to commerce, and the southland was deprived of the ice that had been barged down the river from the northern lakes. The closing of the river was a terrible blow to the cities along the gulf coast, because they could not feed the people in the cities without the supply of ice to which they had become accustomed.

Without refrigeration, millions of our people would be hungry and would not enjoy the tasty foods now taken for granted. At one time, refrigeration was a rare luxury that existed only in such places as fine restaurants and theaters. In 1940, refrigerators in the homes of common people was considered rare. Now residential refrigerators are considered necessary for wholesome and, in some cases, healthy living.

For additional information on the history and background of refrigeration, refer to *Chapter 1* of the *RV Air Conditioning* textbook.

8-1.1.2 Characteristics of Absorption Refrigeration

The cooling process for an absorption refrigerator is slower than that of a household-type refrigerator. Absorption refrigerators offer the advantage of quiet operation. These refrigerators require heat and proper venting and need to be operated level for the refrigerant to gravity flow.

Precise heat input is necessary. This type of absorption refrigeration operates via the heat applied to the boiler. It is critical for this heat to be kept within the necessary limits and properly applied. Any deviation from the specified amount of heat to the absorption system will decrease the efficiency of the cooling unit.

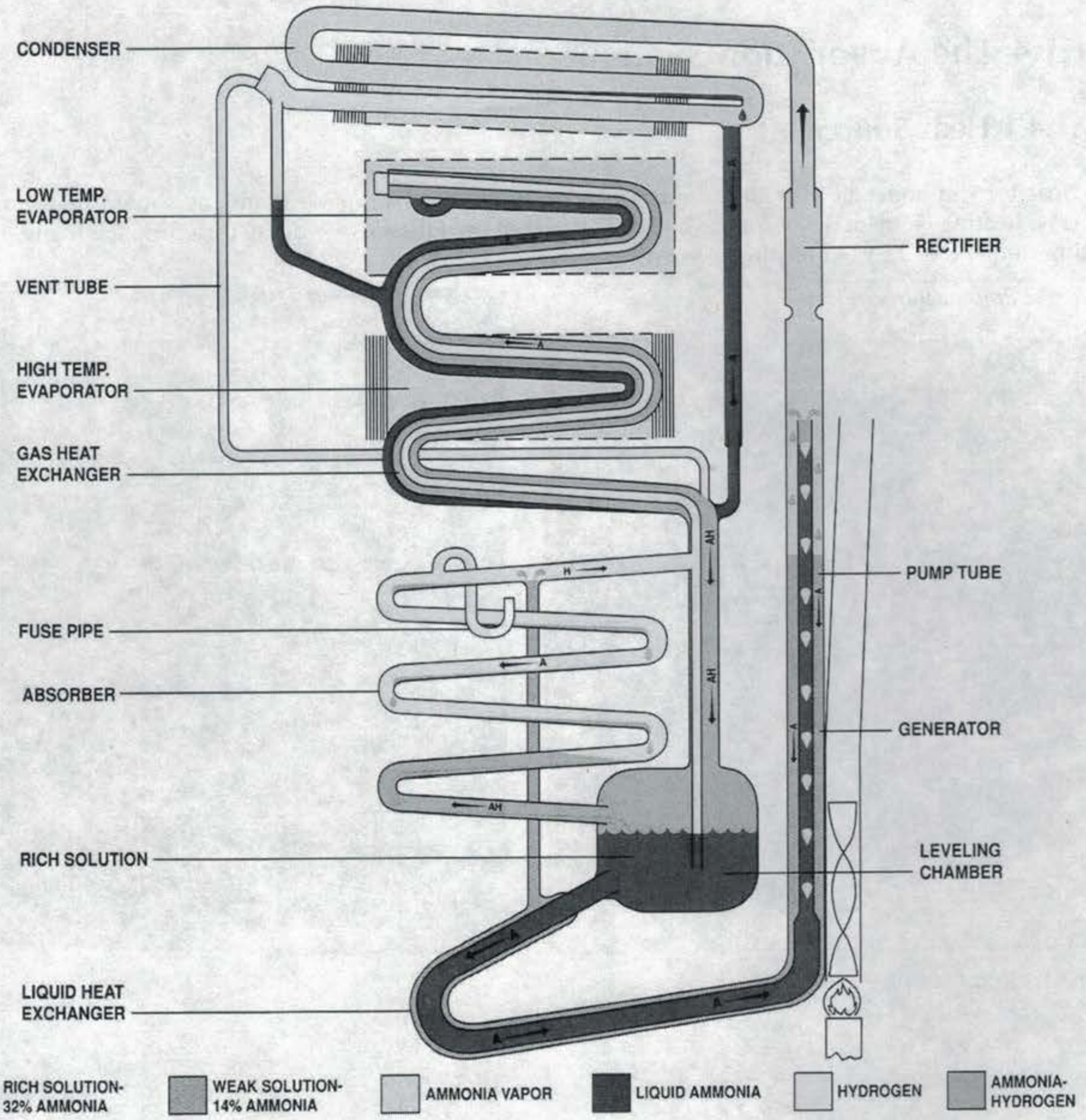
Problems can occur in refrigerators if the unit is operated off level. If the refrigerator is not level to within manufacturer specifications, the refrigerant may not flow properly, and the cooling unit may fail temporarily or permanently.

8-1.1.3 Basic Principles of Absorption Refrigeration

The continuous-absorption type of cooling unit is operated by the application of a specific amount of heat furnished by propane or electricity. No moving parts are employed. The unit consists of four main parts—the boiler, condenser, evaporator, and absorber vessel/leveling chamber (*Figure 8-1*). Ammonia, water, hydrogen, and a corrosion inhibitor (sodium chromate) are combined in the cooling unit. The sodium chromate is present to prevent the refrigerant from corroding the tubing and is not directly involved in the cooling process. The sequence of operation for an absorption refrigerator is as follows:

1. Heat is applied to the boiler to produce water vapor and ammonia vapors.
2. The vapors rise toward the water separator/rectifier.
3. At the water separator, the water vapor condenses back into a liquid. The water gravity flows through the liquid heat exchanger and enters the top of the absorber coils as a weak ammonia solution.
4. The lighter ammonia vapor continues to the condenser at the top rear of the refrigerator.
5. At the condenser, unwanted heat is rejected or removed from the ammonia vapor, changing it to ammonia liquid. It then flows by gravity to the evaporator.
6. The liquid ammonia enters the low-temperature evaporator. At this point, there will be a pressure drop due to entering the larger tube. Liquid ammonia interacts with the hydrogen gas, removing heat from the freezer compartment and causing rapid evaporation of the ammonia.
7. The ammonia and hydrogen solution then flows down to the high-temperature evaporator where heat from the refrigerator compartment is transferred to the combined vapor, cooling the refrigerator compartment.
8. The ammonia hydrogen solution then flows to the absorber vessel/leveling chamber where it flows up the absorber coils.
9. Weak ammonia solution enters the top of the absorber coils and flows downward, absorbing ammonia vapor from the ammonia hydrogen solution, allowing the hydrogen to rise through the vent tube and return to the evaporator. The heat removed from the freezer and refrigerator is rejected from the hydrogen ammonia solution through the absorber coils.
10. The strong/rich ammonia water solution is returned to the boiler where heat is being applied to maintain the continuous cycle.

Figure 8-1 The Absorber System



The **rich solution** leaves the leveling chamber and passes through the liquid heat exchanger to the pump tube. The heat source (gas or electric) causes the temperature of the solution to rise. This temperature increase causes ammonia and some water vapor to be driven out of the solution, forming vapor bubbles, which push columns of liquid up the **pump tube**. This liquid falls downward through the **generator** where the temperature is increased to approximately 360°F, causing additional ammonia vapor to be released. The remaining liquid is now a weak ammonia solution and flows through the external shell of the **liquid heat exchanger** where it transfers its residual heat to the rich solution and enters the top of the **absorber** coil at a reduced temperature.

The ammonia/water vapor passes through the **rectifier** whose reduced temperature causes any water vapor to liquefy and join the weak solution in the generator. The rich ammonia vapor enters the **condenser** and is changed to hot liquid ammonia. The liquid ammonia enters the tubular coil of the **low- and high-temperature evaporators** and wets the internal surface of the tubes. As the hydrogen passes over the wetted tube surface, the liquid ammonia evaporates into the hydrogen, creating an initial refrigeration temperature of -20 to -125°F. The hydrogen pressure at this initial stage is approximately 352 lb, and the liquid ammonia is 14 lb. As the ammonia continues to evaporate into the hydrogen, the pressure of ammonia continues to rise slowly. As the ammonia pressure rises, the evaporation temperature also rises. When eventually the hydrogen and liquid ammonia pass through the upper **gas heat exchanger** and into the high-temperature evaporator tube, the ammonia pressure has risen to 44 lb, and the hydrogen pressure has fallen to 323 lb.

This increase in ammonia pressure raises the evaporation temperature to +15°F. The weight of the hydrogen and ammonia mixture is heaver than that of pure hydrogen. Consequently, it falls through the gas heat exchanger into the top of the **leveling chamber**. From this point, it enters the bottom of the absorber coil. As this mixture travels up through the absorber, it contacts the weak solution entering the top of the absorber from the generator. As the weak solution drops through the absorber, it absorbs the ammonia from the ammonia/hydrogen mixture. The relatively pure hydrogen passes through the hydrogen circuit to the evaporator, and now the rich solution falls to the bottom of the leveling chamber where the cycle starts again.

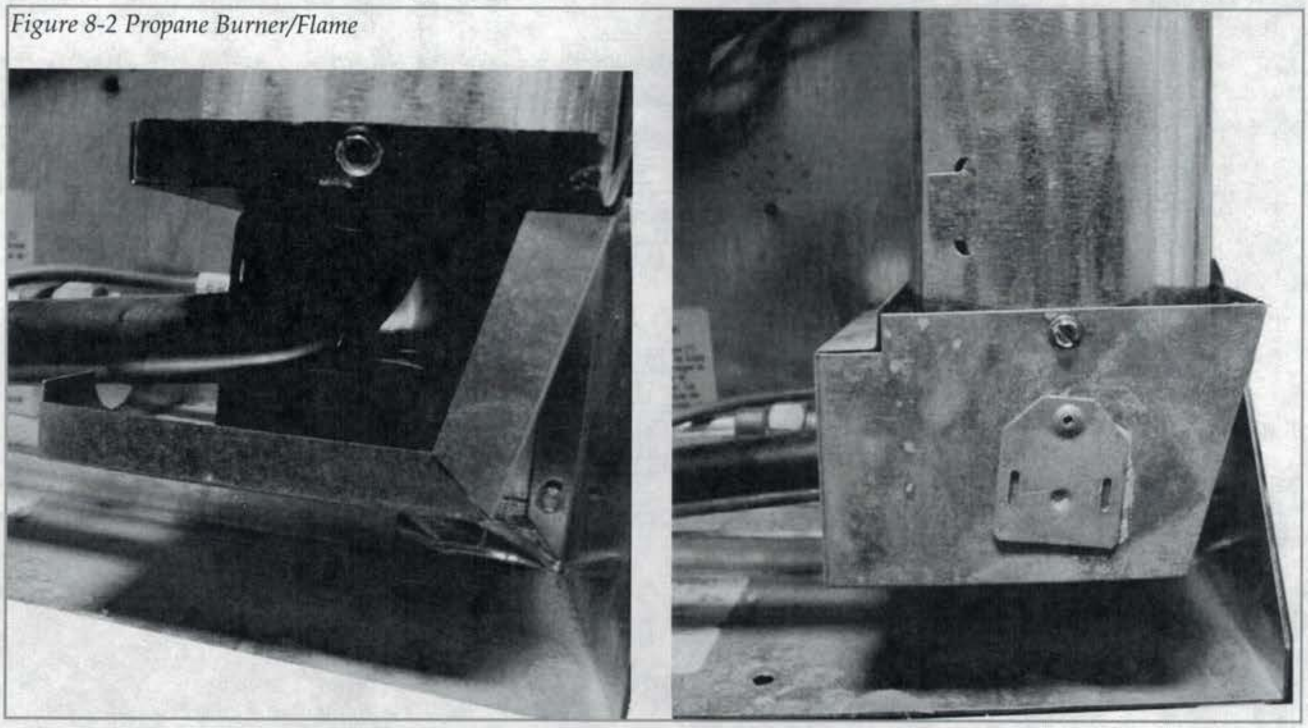
NOTE: The evaporator either protrudes into the freezer compartment or is connected to the freezer compartment. There normally will be fins attached to the evaporator in the refrigerator compartment.

8-1.1.4 The Absorption System

8-1.1.4.1 Heat Source

Heat for the boiler is provided on a two-way model by a propane flame, as shown in *Figure 8-2*, or 120 VAC heating element. Heat for the boiler is provided on a three-way model by a propane flame, 120 VAC heating element, or 12 VDC heating element.

Figure 8-2 Propane Burner/Flame



8-1.1.4.2 Boiler

The heat source raises the temperature of the ammonia/water solution, which produces both ammonia and water vapor. The rising vapors cause bubbles that flow up through the pump tube (percolation).

Figure 8-3 Boiler and Pump Tube (Two Views)

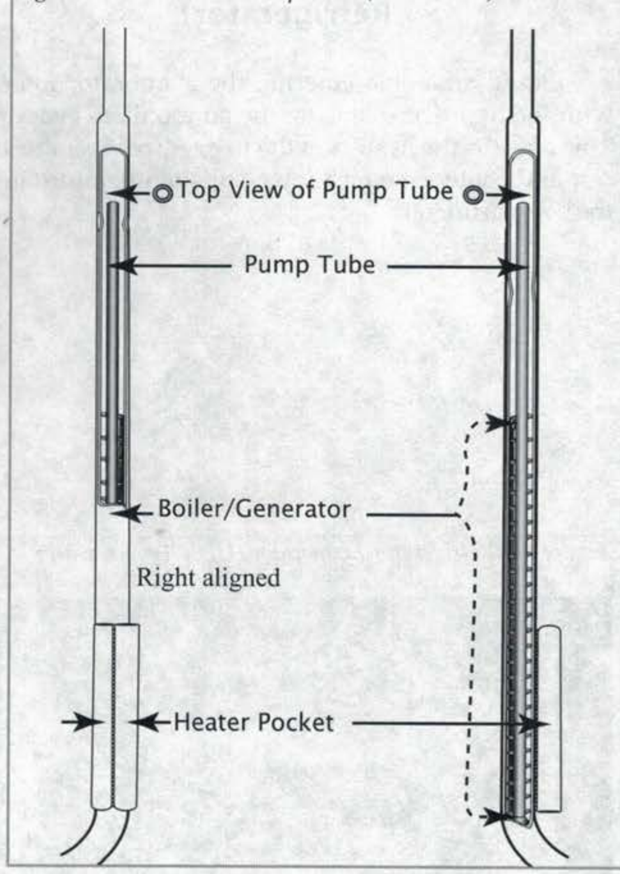
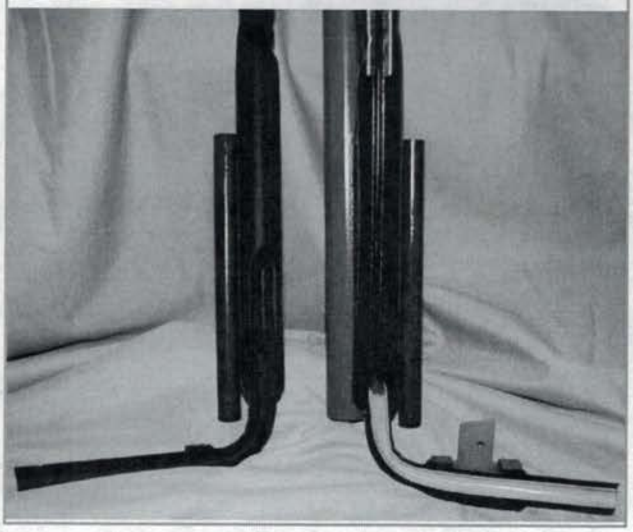


Figure 8-4 Boiler Generator Cut-away



8-1.1.4.3 Pump Tube

When the vapors percolate in the pump tube, weak ammonia liquid solution is forced out and flows down through the heat exchanger. At this point, ammonia vapor and water vapor flows upward into the water separator.

NOTE: Temperatures in the boiler area may reach approximately 360°F (180°C) or higher.

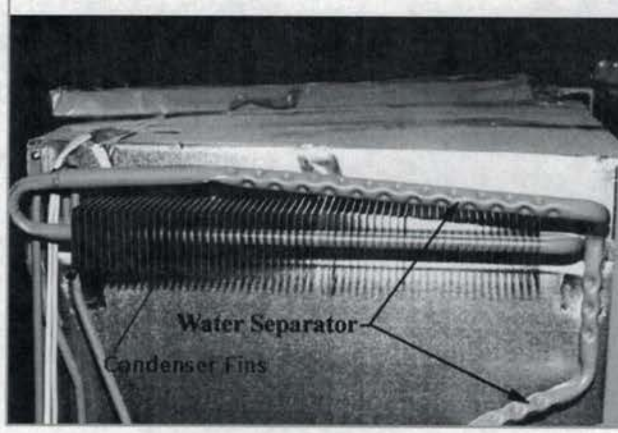
8-1.1.4.4 Water Separator (Rectifier)

The dimples of the water separator remove/condense the water vapor. The ammonia vapor continues to the condenser.

8-1.1.4.5 Condenser

The condenser assembly absorbs heat from the ammonia vapor, allowing it to change into liquid ammonia. Airflow through the condenser fins cools the condenser assembly (*Figure 8-5*).

Figure 8-5 Water Separator (Rectifier) and Condenser Fins



8-1.1.4.6 Evaporator (Freezer and Refrigerator)

Liquid ammonia entering the evaporator interacts with the hydrogen, causing the ammonia to evaporate. This absorbs the heat from the freezer/refrigerator interior and contents, which lowers the temperature inside the compartment.

Figure 8-6 Freezer Evaporator (Low-Temperature)

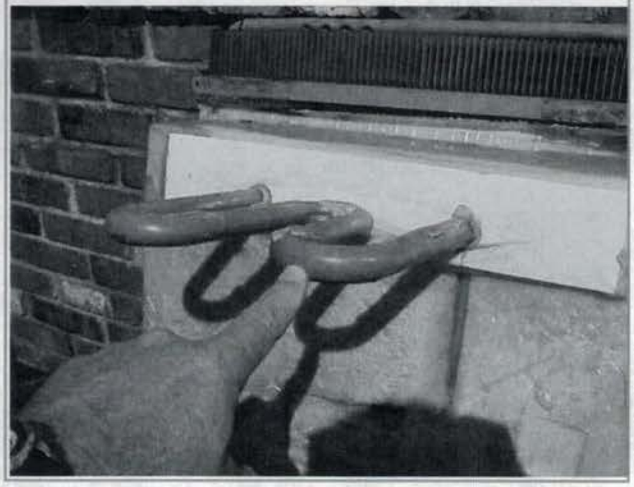
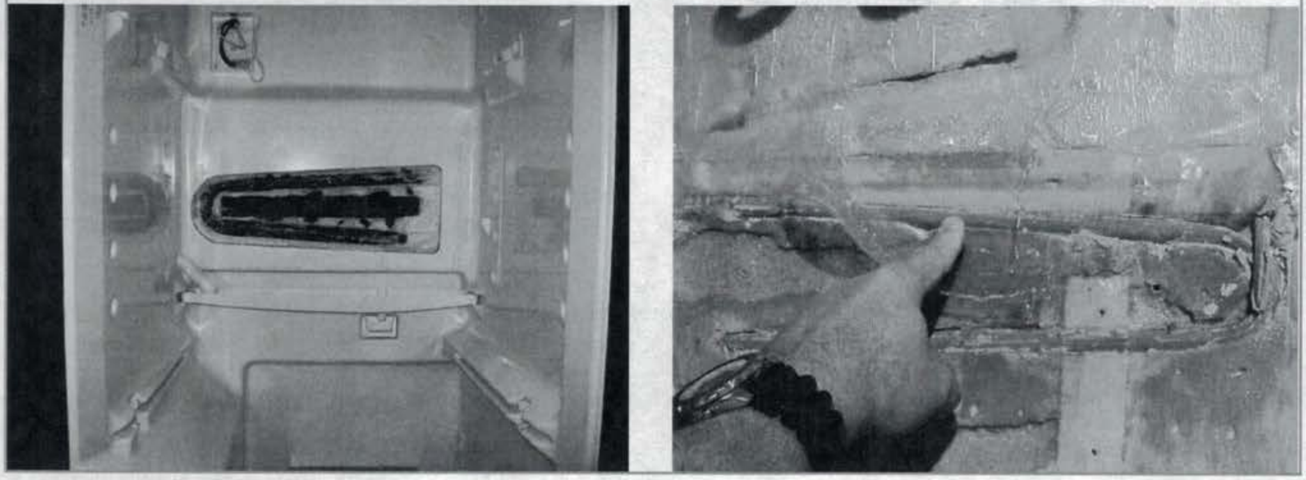


Figure 8-7 Refrigerator Evaporator (High-Temperature)

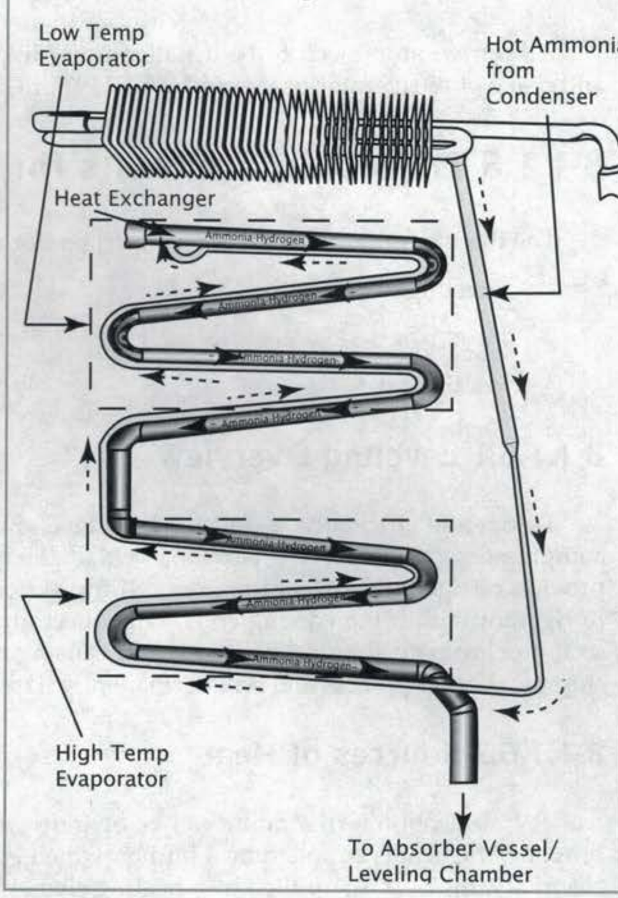


8-1.1.4.7 Gas Heat Exchanger

The gas heat exchanger transfers heat from the warm liquid ammonia mixture going on to the evaporator and the cool ammonia/hydrogen vapor coming out of the evaporator

The ammonia hydrogen solution flows from the evaporator to the top half of the absorber vessel. It then flows up the absorber coil. The bottom half of the absorber vessel is a reservoir of strong/rich ammonia water solution.

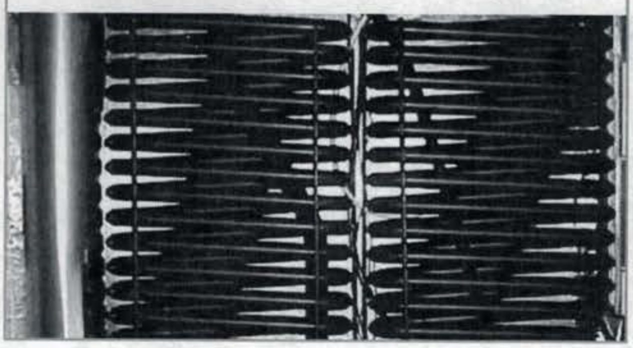
Figure 8-8 Gas Heat Exchanger



8-1.1.4.8 Absorber Coils

The ammonia hydrogen solution flows up the absorber coils while the weak ammonia water solution flows down from the liquid heat exchanger. This allows the ammonia to be absorbed by the weak ammonia water solution and frees the hydrogen to return to the upper portion of the cooling unit. The weak ammonia water solution becomes a strong/rich ammonia water solution and is stored in the lower half of the absorber vessel. The heat from the interior of the freezer and refrigerator is transferred into the air (*Figure 8-9*).

Figure 8-9 Absorber Coils



8-1.1.4.9 Liquid Heat Exchanger

In the liquid heat exchanger, heat from the weak ammonia water solution is transferred to the strong/rich ammonia water solution. The weak ammonia water solution flows from the pump tube to the top of the absorber coils, and the strong/rich ammonia water solution flows from the absorber vessel/leveling chamber to the boiler to continue the cycle.

Figure 8-10 Liquid Heat Exchanger

8-1.1.5 Installation Overview

All refrigerators need to be installed according to the specific manufacturer's instructions for the model and make of refrigerator used and *NFPA 1192* or *CSA Z240*.

8-1.1.6 Three Requirements for Proper Refrigerator Operation

The three requirements for proper refrigerator operation are:

1. Leveling
2. Heat
3. Ventilation

8-1.1.6.1 Leveling Overview

To operate efficiently, a unit must be level. Since the absorption system utilizes no mechanical pumps, compressors, or any moving parts to circulate the refrigerant within the system, proper leveling is required to provide refrigerant flow in the gravity-flow system. Without leveling within manufacturers' specifications, refrigerant within the cooling coils will collect and will become stagnant or coagulate at certain areas. The sodium chromate solution can overheat, causing crystallization and creating blockages. Crystallization will stop the cooling process and will permanently damage the cooling unit.

8-1.1.6.2 Sources of Heat

RV absorption refrigerators can be operated on either electricity or propane. When the unit operates on propane, the heat is supplied by a burner, which is fitted underneath the flue tube. When the unit operates on electricity, the heat is supplied by a heating element inserted in the heater pocket.

Some models will automatically select the available heat source for operation (120 VAC, 12 VDC, or propane) by turning the refrigerator to the ON position through the use of electronic controls.

NOTE: Beginning in the early 1980s, RV refrigerators with electronic controls require 12 VDC to operate in every mode.

8-1.1.6.3 Venting Overview

Venting is required in an absorption-type refrigerator, serving three purposes:

- To remove heat from the condenser
- To remove heat from the absorber coils and vessel/leveling chamber
- To provide combustion air and remove products of combustion

The refrigerator venting system must be able to provide a way to direct the hot air produced by the action of the cooling unit. The refrigerator extracts heat from the interior of the refrigerator cabinet and dissipates the heat out through the compartment vent system. In a proper installation, there should be as little open space as possible surrounding the sides and top of the refrigerator to achieve proper airflow. All potential dead air pockets should be blocked or baffled to ensure that heat from the cooling unit is not trapped in these spaces, reducing efficiency. In all cases, follow all ventilation instructions provided in the manufacturer's installation instructions.

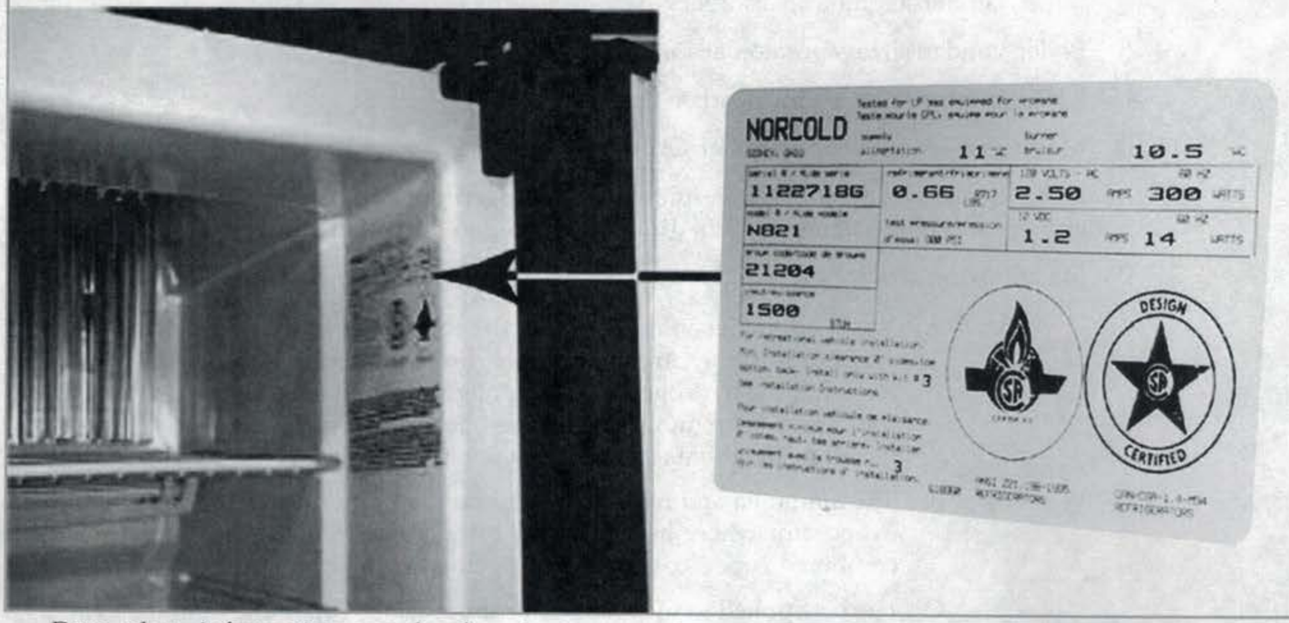


Figure 8-11 Refrigerator Information Label Location

Data plate information can be found on every refrigerator made. The service personnel need to know what information is on the data plate, its location, and how to interpret this data. Most data plates will include the unit model number, serial number, Btu rating, propane pressure, AC /DC voltage and amperage, design certification, and vent kit requirements. This information will be needed to locate a service manual and to order correct replacement parts. With this information, the technician can tell exactly what features the unit has and can make the discussion with the consumer much clearer and more informative. Refrigerator component parts may also have identification numbers readily visible for service personnel. Cooling units typically have a bar code serial number affixed to the cooling unit leveling chamber as shown in *Figure 8-12*.

Figure 8-12 Cooling Unit Bar Code Label Location

8-1 Review

1. The absorption refrigerator cooling unit consists of the following components:

   A. Boiler, condenser, motor, absorber

   B. Boiler, condenser, evaporator, absorber

   C. Boiler, motor, evaporator, absorber

   D. Motor, condenser, evaporator, absorber

2. In an absorption refrigerator water, ammonia, hydrogen gas and a neutralizing agent are combined under pressure. Which element is not directly involved in the cooling process? ______________

3. Put the following absorption refrigerator steps of operation into the proper sequence.

   _____ A. Weak ammonia solution enters the top of the absorber coils and flows downward, absorbing ammonia vapor from the ammonia hydrogen solution and allowing the hydrogen to rise through the vent tube and return to the evaporator. The heat removed from the freezer and refrigerator is rejected from the hydrogen ammonia solution through the absorber coils.

   _____ B. The ammonia and hydrogen solution then flows down to the high-temperature evaporator where heat from the refrigerator compartment is transferred to the combined vapor, cooling the refrigerator compartment.

   _____ C. Heat is applied to the boiler to produce water vapor and ammonia vapors.

   _____ D. The strong/rich ammonia water solution is returned to the boiler where heat is being applied to maintain the continuous cycle.

   _____ E. The vapors rise toward the water separator/rectifier.

   _____ F. The ammonia hydrogen solution then flows to the absorber vessel/leveling chamber where it flows up the absorber coils.

   _____ G. The lighter ammonia vapor continues to the condenser at the top rear of the refrigerator.

   _____ H. The liquid ammonia enters the low-temperature evaporator. At this point, there will be a pressure drop due to entering the larger tube. Liquid ammonia interacts with the hydrogen gas, removing heat from the freezer compartment and causing rapid evaporation of the ammonia.

   _____ I. At the condenser, unwanted heat is rejected or removed from the ammonia vapor, changing it to ammonia liquid. It then flows by gravity to the evaporator.

   _____ J. At the water separator, the water vapor condenses back into a liquid. The water gravity flows through the liquid heat exchanger and enters the top of the absorber coils as a weak ammonia solution.

4. Match the following.

_____	Condenser	A. The heat source produces ammonia and water vapor. The rising vapors cause bubbles, which flow up the pump tube
_____	Evaporator	B. Heat from weak ammonia water solution is transferred to the strong/rich ammonia water solution.
_____	Gas Heat Exchanger	C. Liquid ammonia evaporates upon interaction with the hydrogen. This absorbs the heat and lowers the refrigerator/freezer temperature.
_____	Absorber	D. Removes/condenses the water vapor. The ammonia vapor continues into the condenser.
_____	Liquid Heat Exchanger	E. Absorbs ammonia out of the ammonia/hydrogen mixture and lets the hydrogen return to the cooling unit.
_____	Water Separator/Rectifier	F. Transfers heat from warm liquid ammonia on its way to the evaporator to cool the vapor coming out of the evaporator.
_____	Boiler	G. Absorbs heat from the ammonia vapor, allowing it to change into liquid ammonia.

5. List the three requirements necessary for proper refrigeration operation.

   A.

   B.

   C.

6. List the three sources of heat for an absorption refrigerator.

   A.

   B.

   C.

7. Explain why leveling is so important for an absorption refrigerator.

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Chapter

8-2 Cooling Units

- Explain the cooling unit's composition and operation.
- Set up a cooling unit for proper testing.
- Diagnose the cooling unit.

8-2.1 Overview of Cooling Unit Composition

The cooling unit is a self-contained, hermetically sealed set of steel coils where the refrigeration process takes place. The cooling unit consists of four main parts: the boiler/generator, condenser, evaporator, and absorber.

NOTE: The cooling system coils have factory-applied paint for corrosion protection. Never try to scrape and repaint any rusted portions of the cooling system coils, as they easily rupture. Repainting will cause poor heat transfer and possible cooling unit failure.

8-2.1.1 Foam Block

The foam block insulates the evaporator section of the cooling unit.

The foam block is an internal part sealed to the refrigerator and not visible from either the interior or exterior of the unit.

Figure 8-13 Cooling Unit with Foam Block

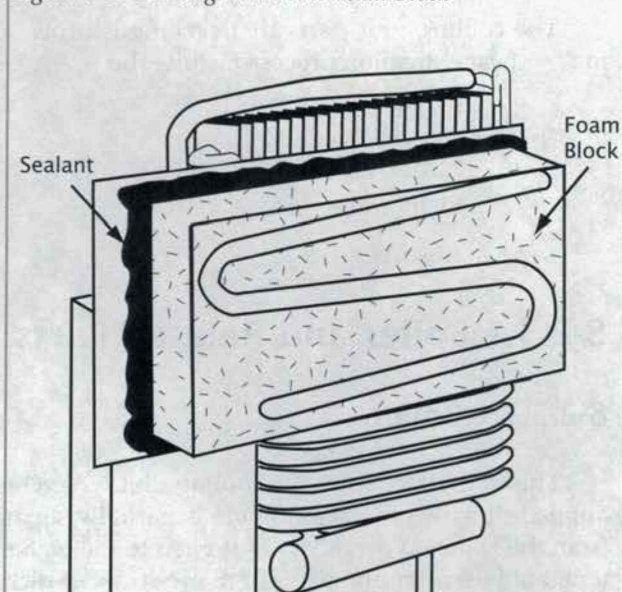
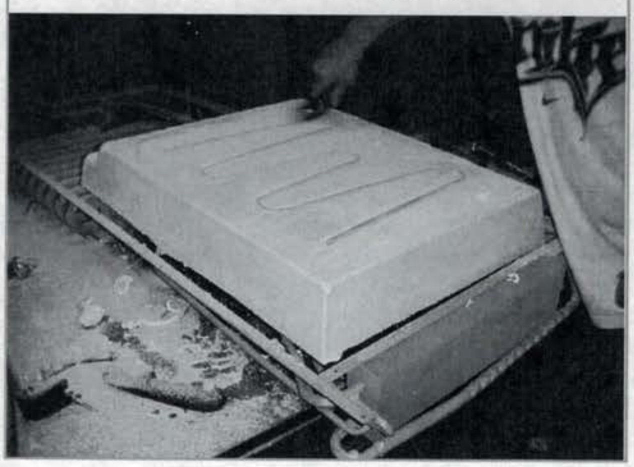


Figure 8-14 ATCO America Foam Block Trim



8-2.1.2 Pressurization of Cooling Unit

As part of the charge process, the cooling units are pressurized by the manufacturer and are not intended for any service or repair. Pressurization is required for proper operation of the cooling unit. The cooling unit must remain hermetically sealed for refrigeration to take place.

NOTE: The hydrogen has a static pressure of 250 psi and a maximum pressure of 600 psi when heated.

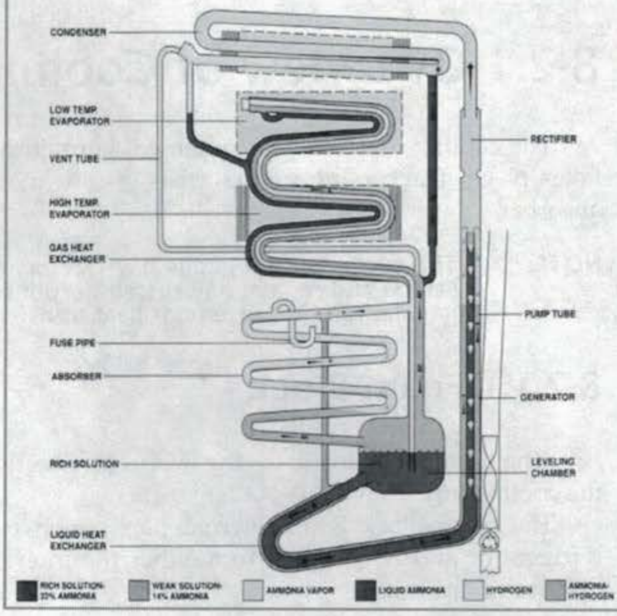
NOTE: Never try to repair a damaged cooling unit; replace it instead.

NOTE: Recognize the safety alert symbol. When this symbol is on the refrigerator or in a manual, follow the manufacturer's instruction.

8-2.2 Chemicals in the Cooling Unit

The chemicals that make up the refrigerant charge are ammonia, water, hydrogen, and sodium chromate. The ammonia and hydrogen gas are directly involved in the cooling process, the water acts as a carrier of the ammonia, and the sodium chromate (corrosion inhibitor) prevents heat, water, or ammonia from corroding the tubing.

Figure 8-15 Cooling Unit Components



8-2.3 Cooling Unit Components

The cooling unit parts that accomplish this "cooling" or heat extraction process include the:

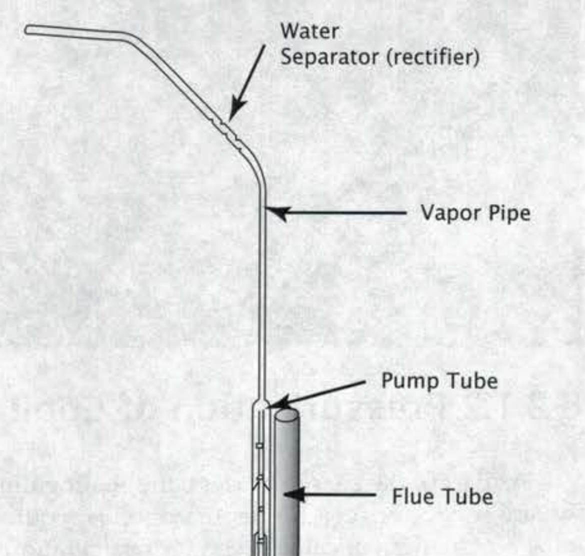
- Boiler
- Condenser
- Evaporator
- Absorber

8-2.3.1 Boiler and Related Parts

8-2.3.1.1 Boiler

This is the section of the cooling unit where heat is applied. It is where the ammonia is partially separated from the water. When heat is supplied to the boiler system, bubbles of ammonia gas are produced, which rise and carry with them quantities of weak ammonia solution through the pump tube. The boiler is composed of several tubes within each other. The outer tubes help protect against blockages from overheating. Precise heat from any one source is applied to the boiler. Heat input is one of three requirements for proper operation with absorption refrigerators. This specification is critical to maintain proper cooling properties of the cooling unit. With too little heat at the heating element or burner, the ammonia in the cooling unit will not vaporize (boil off) properly, and a lack of cooling will result. An excessive amount of heat to the cooling unit will cause the water, as well as ammonia, to evaporate, causing the cooling process to stop.

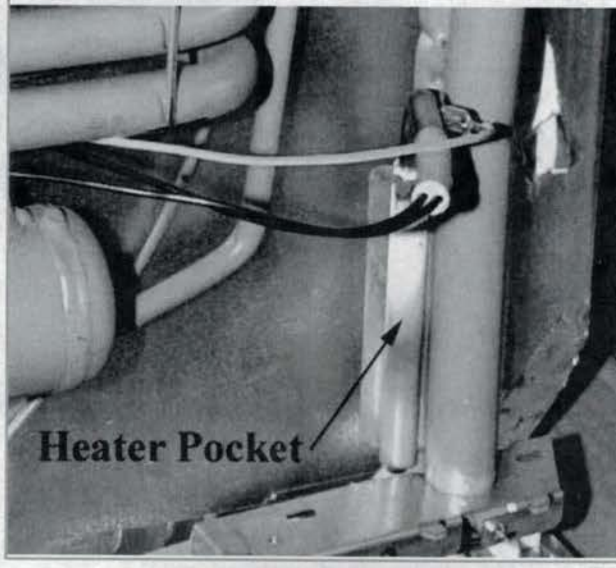
Figure 8-16 Boiler Components



NOTE: Since as little as 25 Btu (refer to glossary term *"Btu"* in the *RV Propane Systems* textbook) input can dramatically affect operation of the cooling unit, it is not recommended to substitute heating element sizes or burner orifice values. This may cause cooling unit damage or poor performance.

NOTE: The length of the replacement heating element is also critical. Although the wattage may be the same, the length, diameter, and placement of the heating element should be to original manufacturer specifications to ensure proper heat transfer, which is critical to correct boiler operation.

Figure 8-17 Heater Pocket



8-2.3.1.2 Heater Pocket/Tube

120 VAC and 12 VDC electric heating elements are installed in the pocket(s).

When the unit operates on electricity, the heat is supplied by a heating element inserted in the pocket/tube, which is welded to the boiler to transfer heat directly.

8-2.3.1.3 Flue Tube

The heat and combustion products from the propane flame are exhausted through the flue tube. The flue tube is welded to the boiler to transfer heat. The flue baffle is a spiral metal device that is hung in the flue tube assembly of the cooling unit. The baffle causes the heat supplied by the propane burner to stay at the boiler assembly for a longer period of time, forcing the heat to the outside of the flue tube. This allows the absorption system to work as efficiently on propane as other heat sources.

NOTE: The flue baffle is located at a critical point in the flue tube, and its positioning and size should always be to the manufacturer's specifications.

Figure 8-18 Flue Tube

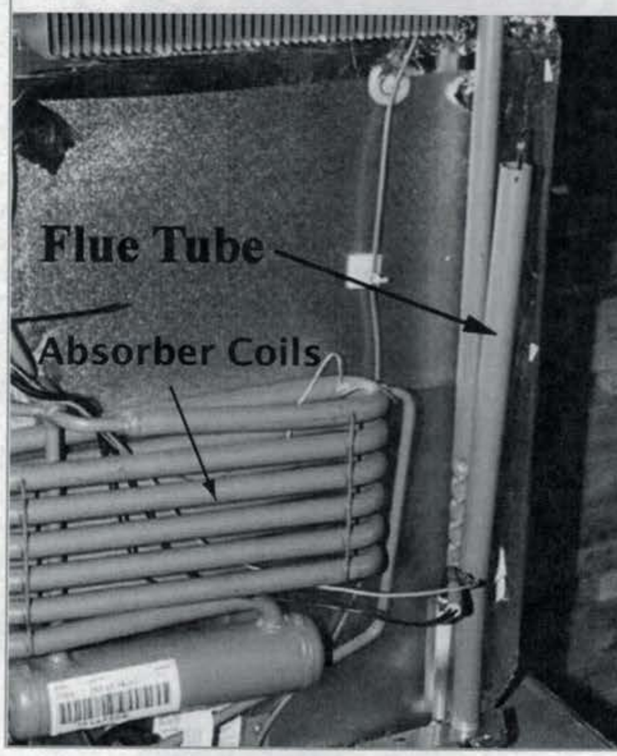
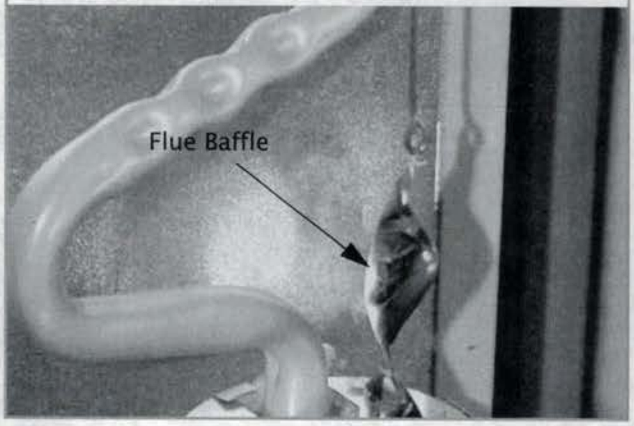


Figure 8-19 Flue Baffle



8-2.3.1.4 Pump Tube

The pump tube is an internal tube within the boiler. The ammonia vapor needed to operate the system rises to the condenser from the pump tube.

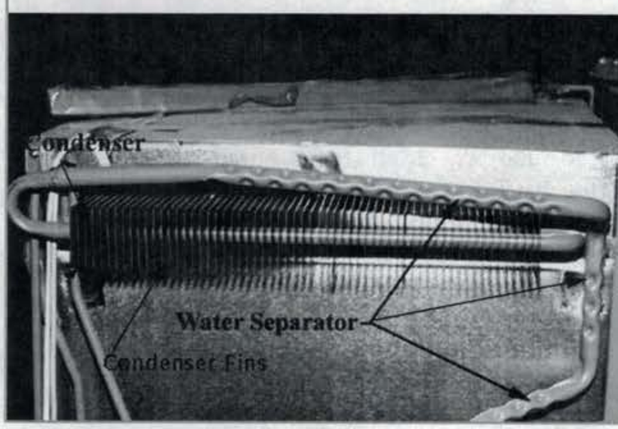
8-2.3.1.5 Water Separator/Rectifier

The water separator/rectifier removes water vapor before the ammonia vapor enters the condenser.

8-2.3.2 Condenser

The condenser, as shown in *Figure 8-20*, is the section of the cooling unit that cools the ammonia vapor into ammonia liquid. Sufficient air moving through the fins of the condenser removes heat from the ammonia vapor to cause it to condense to a strong liquid ammonia solution, which flows into the evaporator (see *"Check Ventilation" on page 8-17*).

Figure 8-20 Water Separator/Rectifier



8-2.3.3 Evaporator

The evaporator is the section of the cooling unit where cooling takes place. Liquid ammonia evaporating in a hydrogen atmosphere takes place in the evaporator. It is located inside the foam block and attached to the freezer plate and the refrigerator cooling fins. The evaporator is supplied with hydrogen and liquid ammonia. The hydrogen and ammonia pressure is lowered sufficiently as it enters the larger evaporator tube, allowing the liquid ammonia to evaporate. The evaporation of the ammonia extracts heat from the evaporator, which in turn extracts heat from the food storage space, thereby lowering the temperature inside the refrigerator. There are two sections to the evaporator: the freezer (low-temperature evaporator) and the refrigerator (high-temperature evaporator). During the refrigeration cycle, the cooling of the freezer is satisfied first. The remaining cooling takes place in the refrigerator with the aid of cooling fins.

Figure 8-21 Evaporator

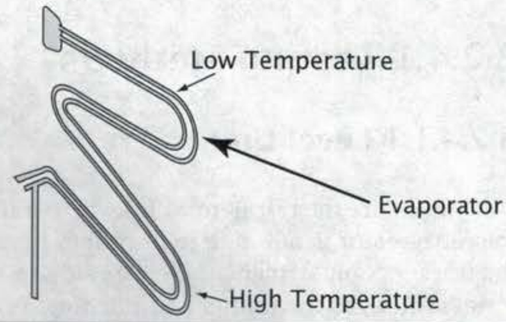
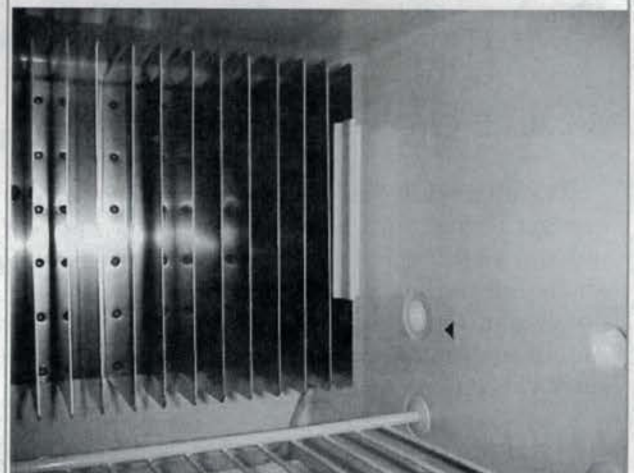


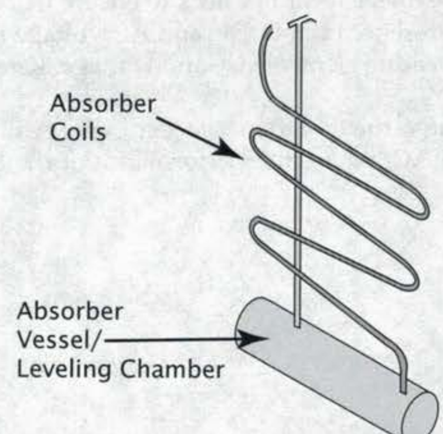
Figure 8-22 Dometic Evaporator Fins



8-2.3.4 Absorber Vessel/Leveling Chamber

The mixture of ammonia and hydrogen vapor passes from the evaporator to the absorber vessel/leveling chamber and then starts to flow up the absorber coils. Entering the upper portion of the absorber coils is a weak ammonia water solution flowing through the liquid heat exchanger. The weak ammonia solution flowing down through the absorber coils comes into contact with the mixed ammonia and hydrogen gases, readily absorbs the ammonia from the mixture, and leaves the hydrogen free to rise through the absorber coil and to return to the evaporator. The strong ammonia solution produced in the absorber coil flows down to the absorber vessel/leveling chamber and then to the boiler, thus completing the full cycle of operation.

Figure 8-23 Absorber Coils and Absorber Vessel/Leveling Chamber



NOTE: Free air circulation is necessary over the absorber and condenser. Heat must be rejected from the condenser in order to cool the ammonia vapor sufficiently for it to liquefy. Heat being rejected from the absorber is the heat that has been removed from the freezer and refrigerator. For this reason, it is best that the complete cooling unit be cleaned of dust and any foreign objects when servicing.

8-2.4 Diagnosing the Cooling Unit

8-2.4.1 Testing Methods

8-2.4.1.1 Level Unit

Make sure the refrigerator is level, per the manufacturer's specifications. Sometimes the vehicle is level but the refrigerator is not, due to improper installation. Place a level on the approximate front and center floor of the freezer compartment and check side-to-side and front-to-back levels. When the vehicle is moving, leveling is not critical, as the rolling and pitching movement of the RV will keep the solution in motion, preventing the solution from accumulating in the piping.

NOTE: In the event the following tests do not correct a customer complaint, it should be verified with the customer that the the refrigerator is level and has adequate voltage when in operation.

8-2.4.1.2 Check Ventilation

Ventilation is one of the requirements for proper cooling unit operation. The refrigerator compartment venting system must be able to provide a way to direct the hot air produced by the action of the cooling unit out and away from the refrigerator. The refrigerator extracts heat from the interior of the refrigerator cabinet and rejects the heat out through the vent system. In a proper installation, there should be as little open space as possible surrounding the sides and top of the refrigerator to ensure proper airflow. See manufacturer's specifications for venting requirements. Check the venting system to ensure that it meets the refrigerator manufacturer's specifications.

8-2.4.1.3 Check for Heat Source Operations

A proper heat source is essential for proper operation. Check for warmth at the boiler, being careful not to touch the metal surface. Check to ensure that a good flame is present. Check for proper propane pressure and for the presence of both DC and AC voltage input and heater element amperage where applicable. Check for correct heating element size and wattage. Refer to the *RV Propane Systems* textbook and *Chapter 8-5* of this textbook.

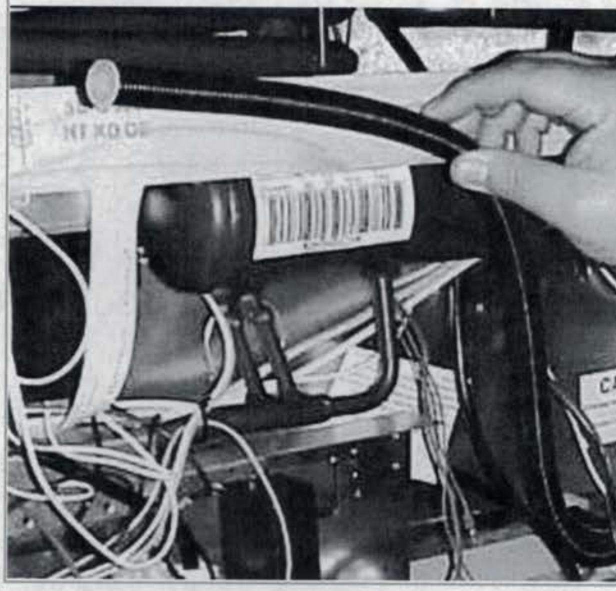
Because the tool to measure the energy of a gas flame is costly, an alternative way to test a cooling unit is on 120 VAC, where the performance of the heating element can be easily confirmed with a volt-ohmmeter (VOM).

8-2.4.1.4 Check for Air Leaks

Excess moisture or frost buildup is an indication of an air leak in the refrigerator or freezer compartment.

Carefully check door gaskets for proper seal. A damaged or worn gasket can allow enough air inside the refrigerator to overcome most of the cooling being produced. A simple test is to close the door on a dollar bill and check for even resistance. See the individual manufacturer's procedure. If no resistance is felt, the gasket is not sealing correctly. Check that the drain tube is not letting air in. See the individual manufacturer's specifications.

Figure 8-24 Condensation/Drain Tube



Holes Through the Box

Verify all openings for wires, hoses, and so forth are sealed properly. Seal any holes with silicone, putty, or the equivalent.

8-2.4.1.5 Cooling Unit Test

No equipment exists to do a quick test of refrigerator cooling. The test needs to be performed 12 to 24 hours after the refrigerator has been started up.

Cooling Unit Test

A. Place approximately one gallon of water inside the refrigerator and place a thermometer in the container of water.

B. Set the refrigerator setting to the coldest setting.

C. Next, unplug the thermistor.

D. This will bypass the thermostat control and operate for at least 12 hours.

E. Then check the temperature on the thermometer. It should be at 43°F or lower depending on test conditions. If so, the cooling unit is good. If the temperature of the water is above 43°F, replace the cooling unit.

This test should be performed using water to simulate a food load on the refrigerator. As stated by the refrigerator manufacturer, high ambient temperatures and humidity reduce the effectiveness of a cooling unit and should be considered when evaluating a cooling unit's performance.

NOTE: This test must never be performed on a cooling unit that has any signs of leaking or is subject to any recall. See *"Leaker" on page 8-19*.

8-2.4.2 Blockages

If a blockage is present, the system will be extremely hot to the touch at the boiler to the absorber vessel/leveling chamber, with little or no warmth at the absorber coils. This means there is no circulation.

A permanent blockage within the boiler pump tube can be caused by heat applied to the boiler or may occur during prolonged operation of the unit while out of level or with restricted ventilation. This type of blockage consists of crystallized sodium chromate buildup inside the boiler tube. This condition is not repairable, and the cooling unit must be replaced.

8-2.4.3 Leaker

If the unit is warm to the touch at the boiler and extremely hot at the absorber, this means a lost charge, and it is known as a *leaker*. Check for any deposits of yellow powder (sodium chromate) or liquid on the tubing, which will sometimes form around the area of a leak. This is caused by the sodium chromate crystallizing and becoming a marker for an open hole. An ammonia smell at the refrigerator could also indicate a leak. Another indication of a cooling unit that has lost its charge is a gurgling sound as it is being heated. This condition is not repairable, and the cooling unit must be replaced. Some leaks may be within the foam block and invisible to the naked eye.

8-2.4.4 Dirt or Dust on Cooling Unit

Make sure the external cooling unit surfaces are free of dirt, dust, and obstructions, as these can act as an insulator or block airflow. Obstructions could include insulation, mud dauber nests, birds nests, and so on.

8-2.5 Cooling Unit Replacement

Replacement of the cooling unit should always be done in accordance with the manufacturer's installation specifications. The following procedures should be viewed as a general set of procedures only.

8-2.5.1 Replacement Procedures

It is assumed proper troubleshooting procedures have been employed and that, indeed, the cooling unit has been deemed faulty and the correct replacement core has been procured prior to beginning these procedures.

8-2.5.1.1 Removing Faulty Cooling Unit

1. Prior to replacing any cooling unit, turn off the propane source and unplug the refrigerator AC power cord. Coil and secure the cord to the cooling unit so as not to catch on any other component inside the rear of the cabinet.
2. Light a cooktop burner to burn off the propane left in the delivery system. Turn the burner off after all propane has burned off.
3. Disconnect the copper propane tubing at the rear of the refrigerator and install a flare plug into the supply side of the delivery tubing.

NOTE: Always use a backup wrench—one to support the connection fitting and one to disconnect the flare nut.

4. Disconnect the 12 VDC power supply conductors at the rear of the refrigerator. Place electrician's tape or wire nuts over the exposed wires.
5. Disconnect any other 12 VDC conductors that may be attached to the refrigerator (auxiliary exhaust fans and so forth).
6. Remove any mounting screws or bolts securing the rear of the refrigerator to the compartment floor.
7. From inside the RV, prepare to remove the refrigerator door(s).
   a. Remove plastic trim pieces (eyebrow).
   b. Remove hinge pins and door latches.
   c. Remove door(s).

d. Gain access to front mounting screws; remove all mounting screws.

NOTE: Some mounting screws may be hidden behind plastic plugs or foil tape.

8. Look for silicone sealant at the bottom edge of refrigerator. It will be necessary to cut through the silicone sealant with a razor knife to allow easier removal of the refrigerator and to prevent damage to cabinets or paneling.
9. Push and pull the refrigerator into the living section of the RV. If resistance is met, do not force. Look for and eliminate the reason for the resistance.
10. Remove the entire refrigerator from the cabinet and from the RV interior when possible and place it on a suitable work surface outside the RV.
11. Remove all screws in the freezer compartment. Some may secure through the back wall of the freezer, and others may secure into a freezer shelf.
12. If possible, remove the freezer shelf and any trim pieces.
13. Detach the thermistor or all capillary tubes from the fins inside the food storage compartment.
14. Carefully remove thermistor or capillary tubes through the back of the refrigerator and protect them from other cooling unit components.

NOTE: Capillary tubes are quite fragile and are easily damaged or broken. Care must be taken when handling capillary tubes. If one breaks, the complete thermostat must be replaced.

15. From inside the food storage compartment, remove all screws attaching the secondary evaporator fins to the cooling unit.
    a. Single-door Dometic fins are removed from inside the refrigerator.
    b. Double-door Dometic fins will be removed with the cooling unit, with the exception of the RM100.
    c. Norcold fins remain attached to the cooling unit even though the screws are removed.
    d. If in doubt, remove all screws securing the fins and look to see if the base of the fin assembly is in front of or behind the plastic refrigerator lining. Fins in front of the liner can be removed before the cooling core is removed.
16. Place the refrigerator face down on a shop blanket. Remove all plastic trim to avoid damage.
17. Remove all cooling unit screws securing the unit to the refrigerator box.

NOTE: Some screws may be hidden under foil tape or positioned close to the large tube coming out of the foam backing. Look closely for all attaching screws.

18. Locate and disconnect the wires from the heating element(s). Label the wires appropriately. Remove all heating elements from the cooling unit heater pockets.
19. Remove any ground wires attached to the cooling unit.
20. Remove the burner cover and all mounting hardware and screws. Remove the lever lock if so equipped.
21. Remove the complete burner assembly, ignitor, and/or thermocouple if necessary.
22. Remove the printed circuit board if necessary.
23. Carefully pry and pull on the large tube in the center of the cooling unit only.
    a. Do not pry or pull on brackets or smaller sections of tubing.
    b. Use a small block of wood under the pry bar to protect the refrigerator cabinet.
    c. Once the seal is broken, the cooling unit can be fully removed by steadily pulling on the large

tube only.

d. Take care not to damage the foam in the refrigerator box.

24. Once separated from the refrigerator box, the secondary evaporator fins can be removed now if not performed in step 15 above.

25. Remove the flue cap if so equipped and remove the flue baffle, taking care not to damage the hanger wire. Clean the flue baffle.

26. Remove and clean all sealant residues from the refrigerator box. Clean all thermal transfer mastic from the secondary evaporator fins, freezer plate, and freezer shelf.

8-2.5.1.2 Installing Replacement Cooling Unit

1. Dry fit the replacement unit to ensure that the foam block fits properly. Trim the foam if necessary to obtain the optimum fit. The freezer tubes must remain level for a proper fit.

2. If the fit is correct, remove the cooling unit from the refrigerator and apply a 1/2 in. bead of transfer mastic to all exposed tubing in the foam block and all tubes that will be covered by the freezer shelf.

NOTE: Do not allow transfer mastic to contaminate the foam block. It should only be applied to the tubing.

3. Place a layer of putty tape or other sealant around the foam block opening at the rear of the refrigerator box.

4. If the cooling unit is a flush-mount device (Norcold and single-door Dometic units), gently press the cooling unit into the refrigerator box.

   a. Install one mounting screw at the top of Norcold models.

   b. Install two mounting screws at the top of Dometic models.

   c. Stand the refrigerator upright and verify the correct alignment of the freezer screw holes.

   d. Install all freezer screws and secondary evaporator fin screws.

NOTE: To align cooling unit screw holes on some Norcold models, it may be necessary to drill new mounting holes in the secondary evaporator fins. Never drill new holes into the cooling unit itself.

   e. Position the refrigerator on its face and install the remainder of the cooling unit mounting screws.

NOTE: On Norcold models, the generator/boiler tube should be parallel with the edge of the refrigerator box after securing the cooling unit.

5. If the refrigerator is a Dometic with perpendicular freezer tubes,

   a. Apply transfer mastic to the high-temperature evaporator tubes and reattach the secondary evaporator fins.

   b. Gently press the cooling unit into the refrigerator box and secure all mounting screws.

   c. Stand the refrigerator upright and install the freezer shelf and all associated hardware. Verify the level of the perpendicular low-temperature evaporator tubes by placing a four-way level on the freezer shelf.

NOTE: If the freezer compartment does not have a shelf, place the level on the freezer bottom.

6. Verify that the installation is airtight.

   a. Force fiberglass insulation between the refrigerator box and the edges of the cooling unit and seal with foil tape or duct tape to ensure an airtight installation.

NOTE: Failure to ensure an airtight seal will result in inadequate cooling.

7. Reinstall the remaining components removed or dislocated:
    a. Burner assembly
    b. Heating element(s)
    c. Printed circuit board
    d. Capillary tube/thermistor
    e. Flue baffle
    f. Flue cap
    g. Ground wire

NOTE: Seal around all components that penetrate the refrigerator box, i.e., capillary tubes/thermistor.

8. Momentarily tip the upright refrigerator 45° off vertical in all directions to ensure that all liquids are at the bottommost sections of the cooling unit prior to start-up. Allow the contents to settle for approximately 5 minutes.
9. If possible, test the refrigerator prior to reinstallation inside the RV.
10. Reinstall the refrigerator in the RV:
    a. Secure the refrigerator to its cabinet.
    b. Connect the 120 VAC power supply cord to its receptacle.
    c. Connect all 12 VDC conductors.
    d. Connect the propane tubing.

NOTE: Always use a backup wrench—one to support the connection fitting and one to tighten the flare nut.

    e. Turn on the propane supply.
    f. Immediately test the propane connection for leaks.
    g. Repair leaks before continuing.

11. Start the refrigerator on the 120 VAC electric mode for at least 6 to 8 hours (see *"Cooling Unit Test" on page 8-18*).

NOTE: If possible, allow the refrigerator to run overnight.

12. Switch the refrigerator mode to propane and test the refrigerator once again following the procedures recommended by the manufacturer. Refer to *"Cooling Unit Test" on page 8-18* for details.
13. Complete all applicable paperwork.

8-2 Review

1. Cooling system coils should be scraped and repainted as necessary to prevent rust.

   True False

2. Hydrogen gas has a static pressure of 250 psi. It has a maximum pressure of ______________ psi when heated.

   A. 400

   B. 500

   C. 600

   D. 750

3. Never try to repair a damaged cooling unit. Always replace it.

   True False

4. In an absorption refrigerator, the ______________ vaporizes in the hydrogen gas atmosphere and absorbs heat from the inside of the refrigerator.

   A. Ammonia

   B. Neutralizing Agent

   C. Water

   D. Zorbic acid

5. The function of the sodium chromate is to absorb water from the ammonia solution.

   True False

6. An excessive amount of heat in the cooling unit will cause:

   A. The water to vaporize

   B. The hydrogen gas to vaporize

   C. Both the hydrogen gas and ammonia to vaporize

   D. Both the water and ammonia to evaporate

7. When operating on electricity, the absorption refrigerator uses the electricity to provide spark to the burner for ignition of the propane.

   True False

8. The cooling unit consists of four components: the boiler, the condenser, the absorber, and the evaporator. List the five components of the boiler.

   A.

   B.

   C.

   D.

   E.

9. Match the following.

_____	Condenser	A. Where hydrogen and ammonia are separated
_____	Evaporator	B. Cools ammonia vapor into ammonia liquid
_____	Absorber Vessel	C. Where the cooling affect is produced

10. When conducting a 12 to 24 hour run test, the water temperature should be ______________ °F.
    A. 28
    B. 33
    C. 38
    D. 43
11. When the boiler is extremely hot and the absorber has very little warmth, the problem is probably:
    A. Low water level in the boiler
    B. Low hydrogen gas level
    C. Propane pressure is too high
    D. No circulation
12. When the boiler is warm to the touch and the absorber is very hot, the problem is probably a leaker, which means:
    A. Low water level in the boiler
    B. Loss of charge
    C. Propane pressure is too high
    D. No circulation

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Chapter
8-3 Installation and Venting

- Determine venting by manufacturer's specifications.
- Check the refrigerator installation for proper clearance.
- Ensure that the installation conforms to manufacturer and/or code requirements.
- Verify seals for air tightness.
- Identify energy source connections.

8-3.1 Refrigerator Installation

Each refrigerator must be installed according to its specific manufacturer's installation instructions. The following general requirements apply to most refrigerators.

8-3.1.1 Cabinet Requirements

The refrigerator must be installed in a substantial enclosure and must meet the manufacturer's leveling requirements.

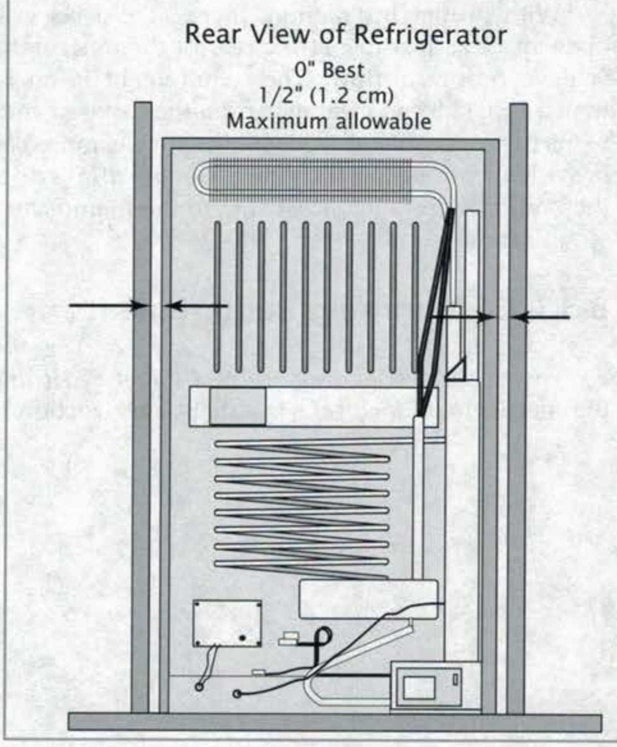
The walls of the refrigerator provide insulation needed to keep the proper cooling temperature inside the refrigerator. If the temperature surrounding the outside surface of these walls is quite warm, there will be more heat flow back into the refrigerator, with decreasing performance efficiency. Therefore, the higher temperatures surrounding the refrigerator must be isolated from the refrigerator.

8-3.1.1.1 Side Clearances

With proper installation, there should be as little open space as possible surrounding the sides of the refrigerator to achieve proper airflow. The requirement is no more than 1/2 in. (1.2 cm) clearance on either side of the refrigerator. This minimum clearance can be provided by built-in panels (baffles) or insulation.

NOTE: Any baffles or insulation must be properly sized, firmly attached, and in no way interfering with proper airflow.

Figure 8-25 Minimum Side Clearances

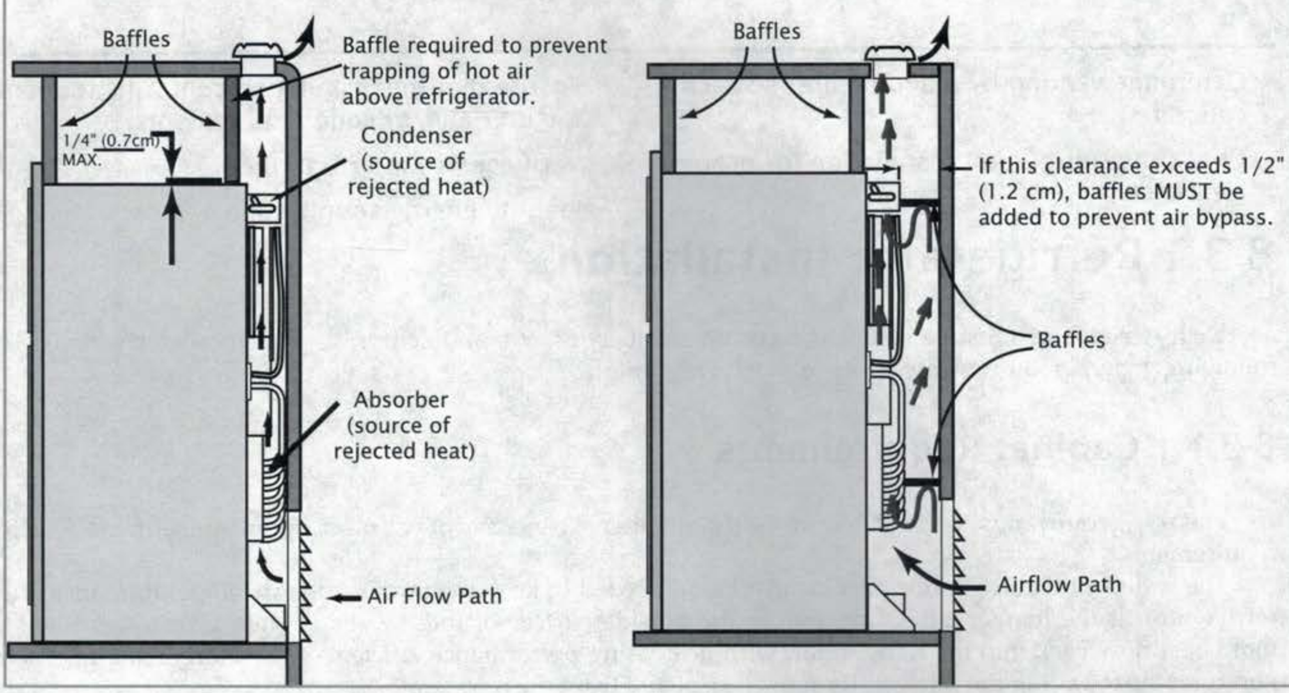


8-3.1.1.2 Top Clearances

With proper installation, there should be as little open space as possible on the top of the refrigerator to achieve proper airflow. The requirement is no more than an 1/4 in. (0.7 cm) clearance on top of the refrigerator. This minimum clearance can be provided by built-in panels (baffles) or insulation.

NOTE: Any baffles or insulation must be properly sized, firmly attached, and in no way interfering with proper airflow. The installation of the refrigerator must not block the exhaust vent.

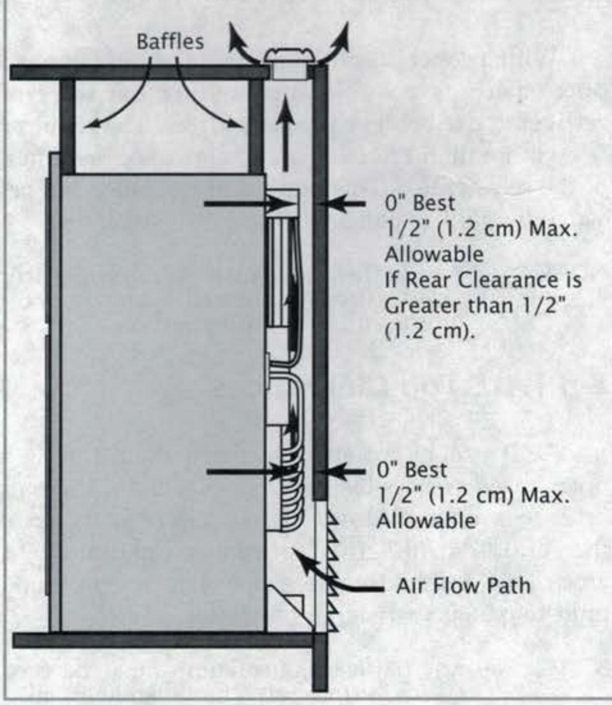
Figure 8-26 Baffle Positions



8-3.1.1.3 Rear Clearances

With proper installation, there should be as little open space as possible at the rear of the refrigerator to achieve proper airflow. The requirement is no more than a 1 in. (2.5 cm) clearance from the exposed components to the coach wall. This minimum clearance can be provided by built-in panels (baffles). If baffles are used, they must be installed according to the manufacturer's specifications.

Figure 8-27 Rear Clearances



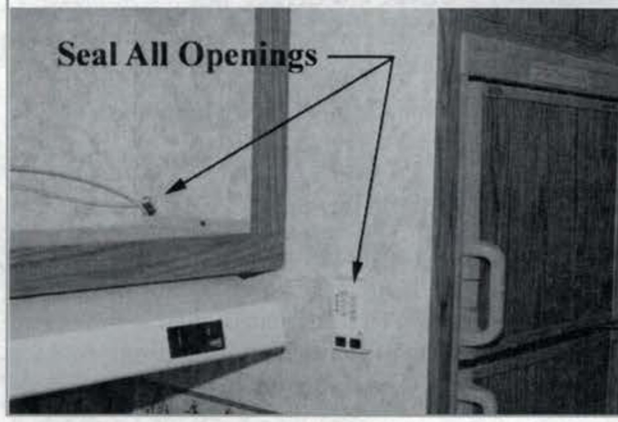
8-3.1.1.4 Mounting Requirements

Fasten the refrigerator to the cabinet according to the specific manufacturer's installation instructions.

8-3.1.1.5 Sealing to Inside of Coach

When installing the refrigerator in the enclosure, all areas within the recess in which the refrigerator is installed must be sealed. The *NFPA 1192* and *CSA Z240* require that the refrigerator be installed so as to provide complete separation of the combustion air and the interior of the recreational vehicle. This regulation requires all seams and joints in the enclosure to be sealed. Make sure that there is a complete seal between the front frame of the refrigerator and the top, sides, and bottom of the enclosure. A length of sealing strip is applied to the rear surface of the front frame for this purpose. Also apply a sealing strip to the foremost floor of the enclosure, and apply a second sealing strip to the bottom of the trim strip on the front base.

Figure 8-28 Sealing to Inside of Coach



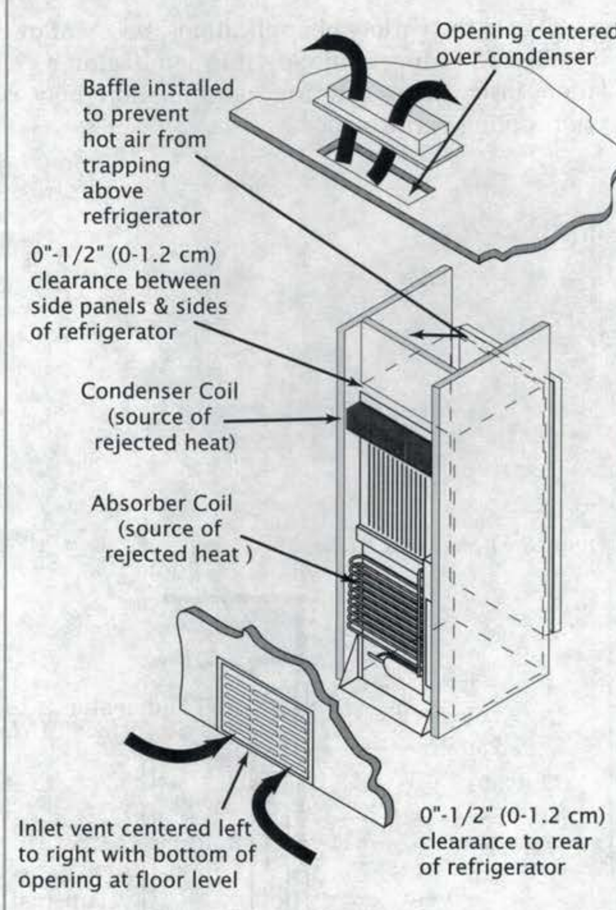
8-3.1.2 Venting Requirements

8-3.1.2.1 Airflow

The more heat given up to the air, the better the cooling performance, provided the heat is carried away as fast as it is produced. To accomplish this heat removal, a draft is created when the cooler intake air is heated, becomes lighter, and rises up through the roof jack opening. The rising air starts a "draft," which pumps more cool air in through the intake vent. The greater the temperature difference between the rejected heat and the intake air, the stronger the draft (more accurately called the *thermo-siphon effect*).

Each refrigerator must have ventilation provided as specified in the specific manufacturer's installation manual. The following general items are addressed in most installation instructions.

Figure 8-29 Optimum Ventilation Installation



8-3.1.2.2 Proper Vent Sizes

Ventilation is one of the three requirements for proper cooling unit operation. The coach vent system must be able to provide a way to direct the hot air produced by the action of the cooling unit out away from the installation of the refrigerator. The refrigerator extracts heat (cooling) from the interior of the refrigerator cabinet and dissipates the heat out through the vent system. The vent area must be free of dead air pockets surrounding the sides and top of the refrigerator to achieve proper airflow. Some refrigerator installations and refrigerators installed in a slideout room utilize a double sidewall vent system. The incoming air is drawn through the lower vent and the heat is dissipated through the upper vent. Other refrigerator installations use a lower vent and roof vent to meet the same venting requirements. Some refrigerator installations require a fan for increased airflow. The size and placement of each of these vents is critical, so it is important to refer to the specific vent requirements outlined in the manufacturer's installation manual when diagnosing vent systems.

8-3.1.2.3 Lower Vent

The lower vent provides three functions:

- Fresh air intake for combustion
- Fresh air intake for ventilation
- Provides an access for service

The lower vent must be installed with the bottom edge of the vent opening at or below the refrigerator floor level and must be sealed to the interior of the coach. This is to allow any heavier-than-air fuel gases to flow out from the compartment.

8-3.1.2.4 Upper Side Vent

Due to the variety of applications, this vent must be installed according to the specific manufacturer's installation instructions. Improper installation may cause poor cooling performance.

Figure 8-30 Vent

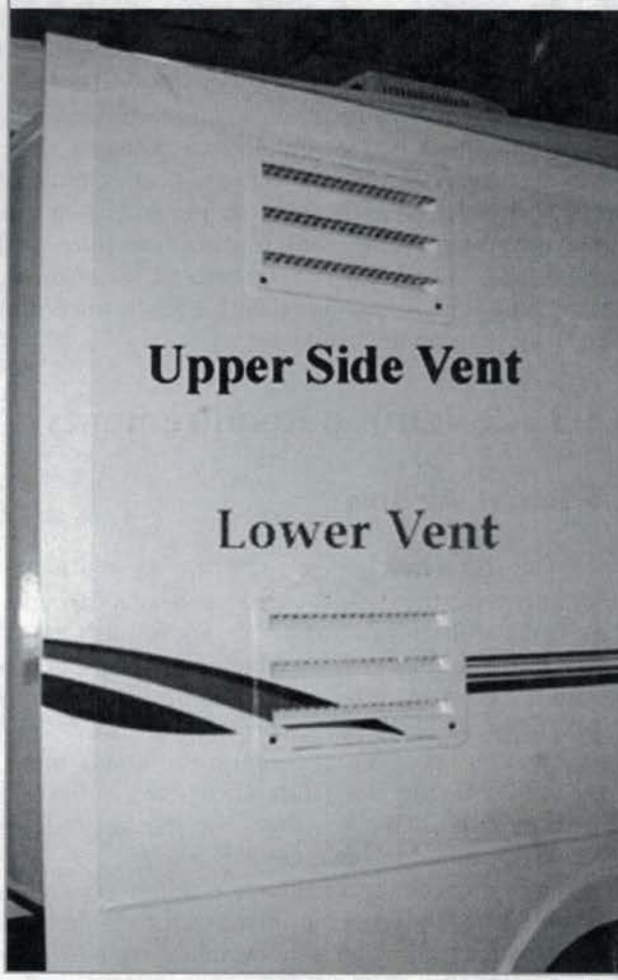
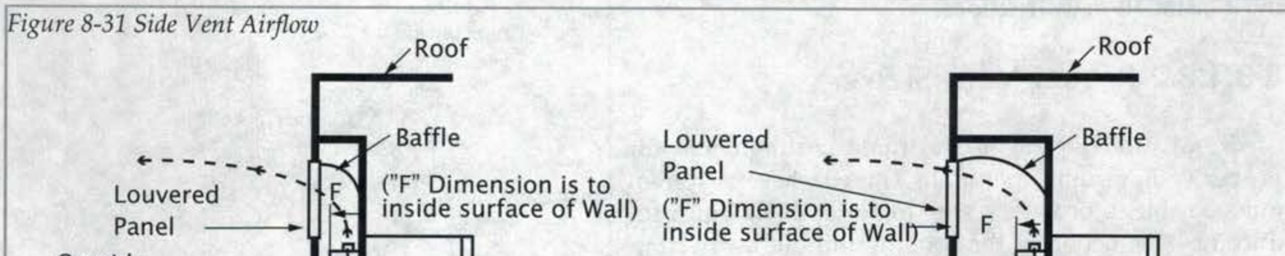


Figure 8-31 Side Vent Airflow



Side Vent Application Illustration

When dimension "F" exceeds recommended installation applications, it is necessary to add "Baffles" as shown above.

8-3.1.2.5 Roof Vent

The roof vent must be sized and installed according to manufacturer's installation specifications.

Figure 8-32 shows a roof vent installed directly over the condenser. *Figure 8-33* shows an offset roof vent installation.

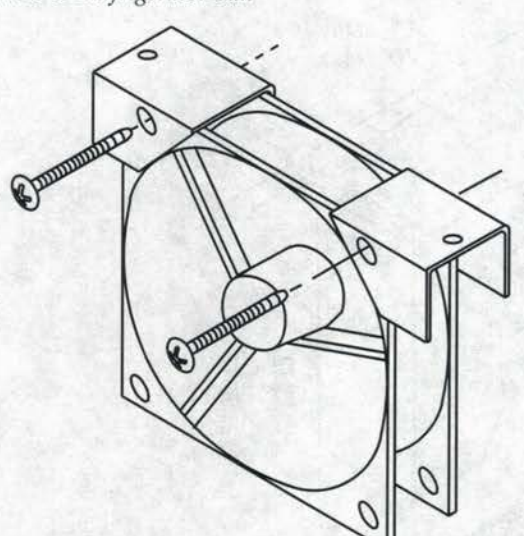
If the roof opening is more inboard than the rear of the refrigerator, this opening position is permitted, provided a baffle is provided between the inboard edge of the roof opening and the back edge of the refrigerator cabinet. The tilt angle must not exceed 45°.

8-3.1.2.6 Other Methods of Air Circulation

Other means of air circulation for some models of refrigerators include through-the-floor ventilation and the use of fans.

Many RV refrigerators have fans installed to assist the required air movement across the refrigerator condenser to ensure optimum performance. The location of the fans and size are specifically designed for the installation application and are not interchangeable. Check the OEM installation guide for correct application before replacing any fan.

Figure 8-34 Refrigerator Fan



The following diagrams illustrate common fan placement configurations.

Figure 8-32 Open Space

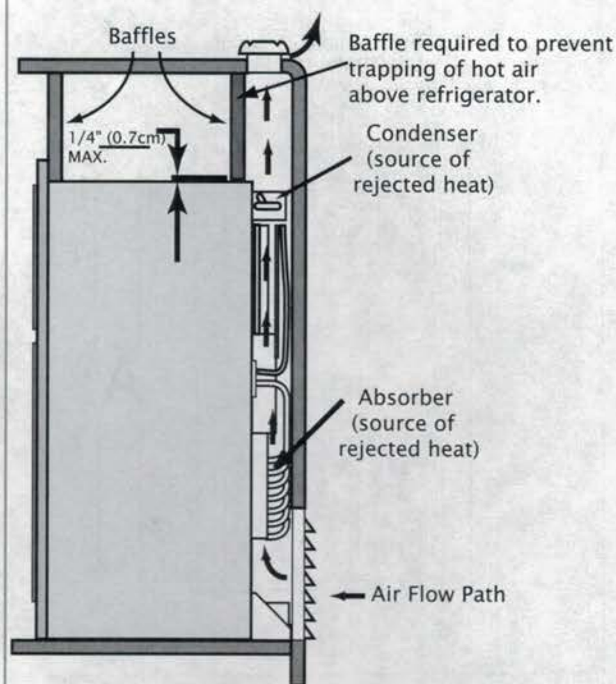


Figure 8-33 Roof Vent

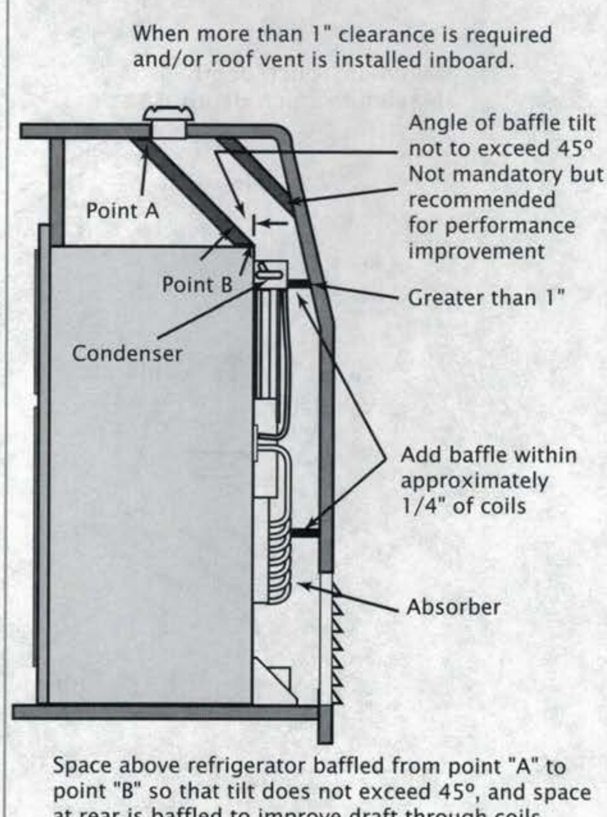


Figure 8-35 Top Mount Installation

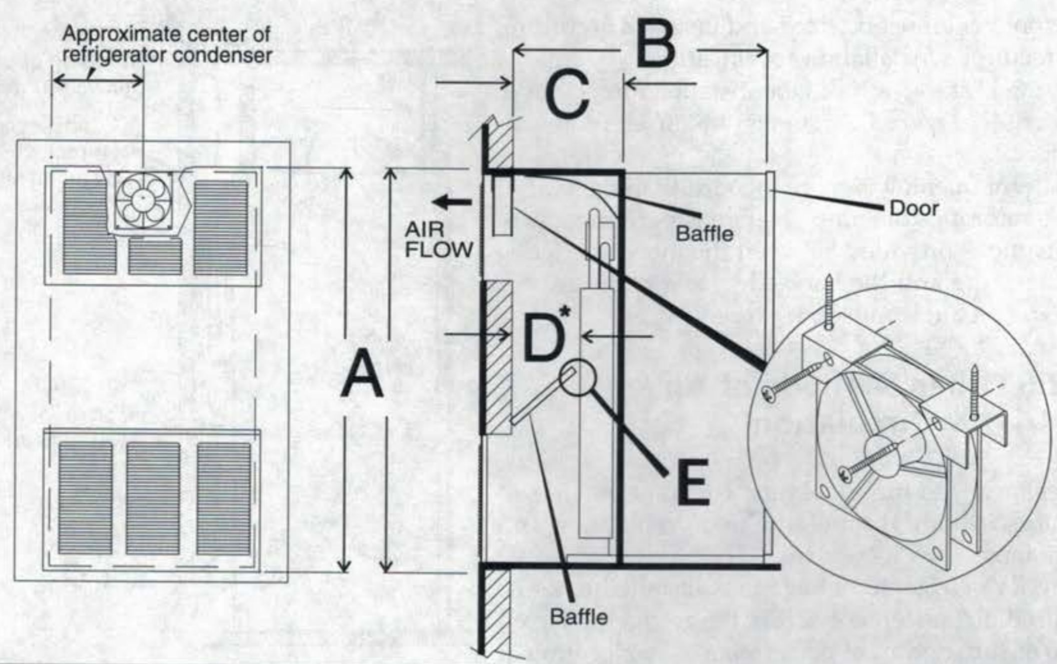


Figure 8-36 Below-Floor Mount Installation

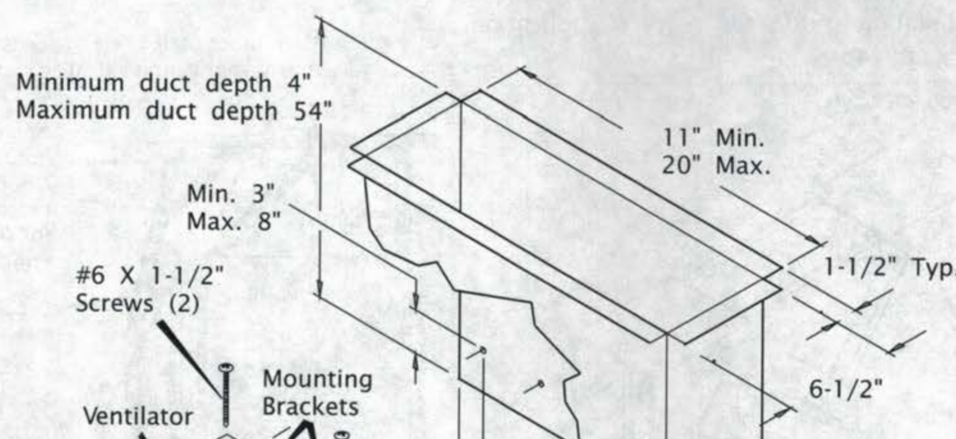
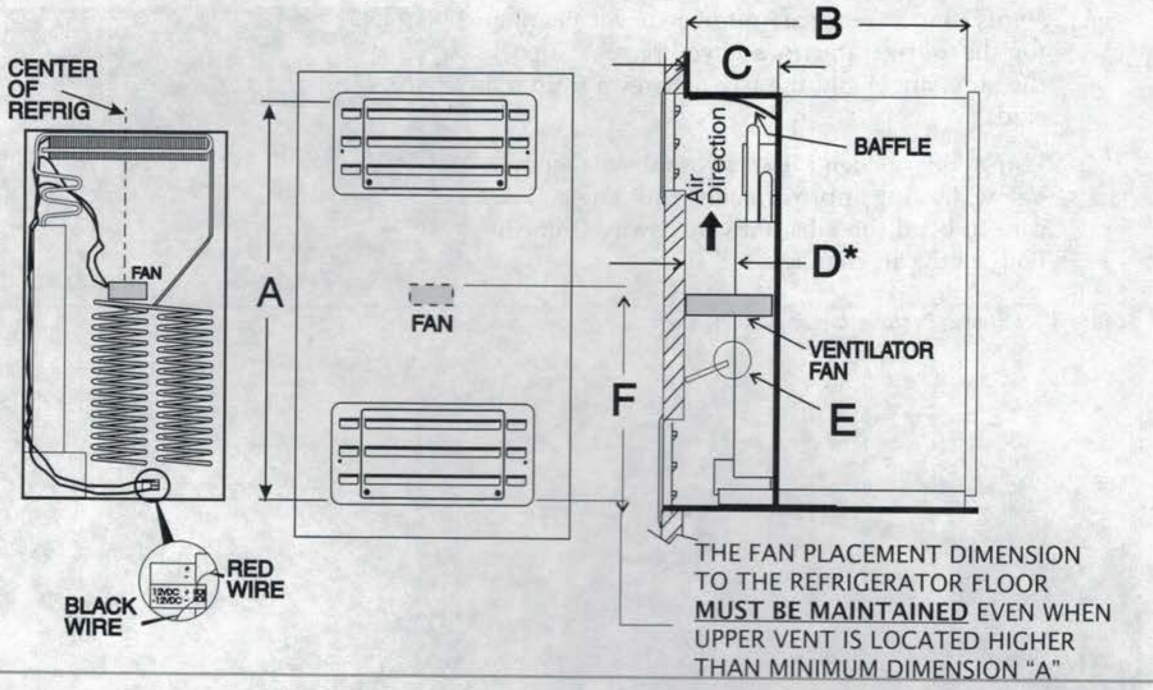


Figure 8-37 Center Mount Installation



8-3.1.2.7 Vent Channel Installation

Some refrigerators have a vent channel installation application that helps ensure proper airflow and increases operational efficiency. The following illustrates proper vent channel installation for Dometic refrigerators. Always refer to the OEM installation guide before installing any vent channel kit.

Installation of Air Channel

- Measuring tape
- A pair of gloves
- A pair of pliers
- Sheet metal shears
- Phillips screwdriver, #2
- Marking pen
- Battery-powered drill with clutch or torque adjustment
- 5/16 in. hex nut driver bit, magnetic
- 6 in. extension for nut driver bit (recommended)
- Self-drilling screws (quantity six) supplied with air channel
- Wood screws, #8 × 3/4 in. (quantity three)

NOTE: Sheet metal edges may be sharp. Wearing gloves is recommended.

INSTALLATION PROCEDURE

Figure 8-38 Step 1, Installation of Air Channel

1. Verify the correct part number of air channel for the refrigerator (see cover page). Unpack the air channel and the bag of screws from the skid.
2. Using pliers, bend the two tabs as shown below, leaving approximately a 10° angle. Take care to bend the tabs outward, away from the body of the air channel.

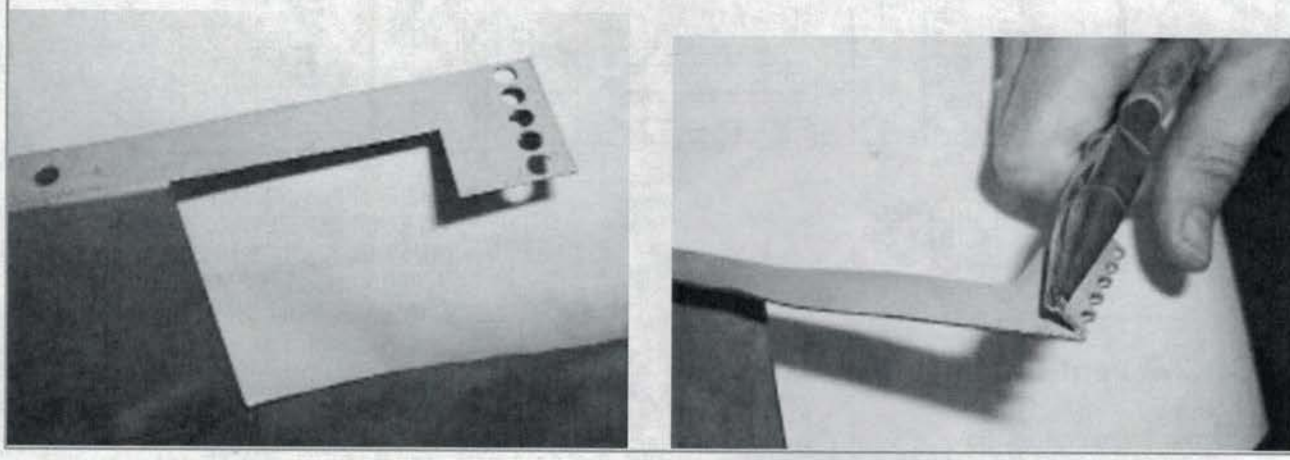


Figure 8-39 Step 2, Installation of Air Channel

3. Hand-bend the two long, perforated bends as shown below to a 90° angle.

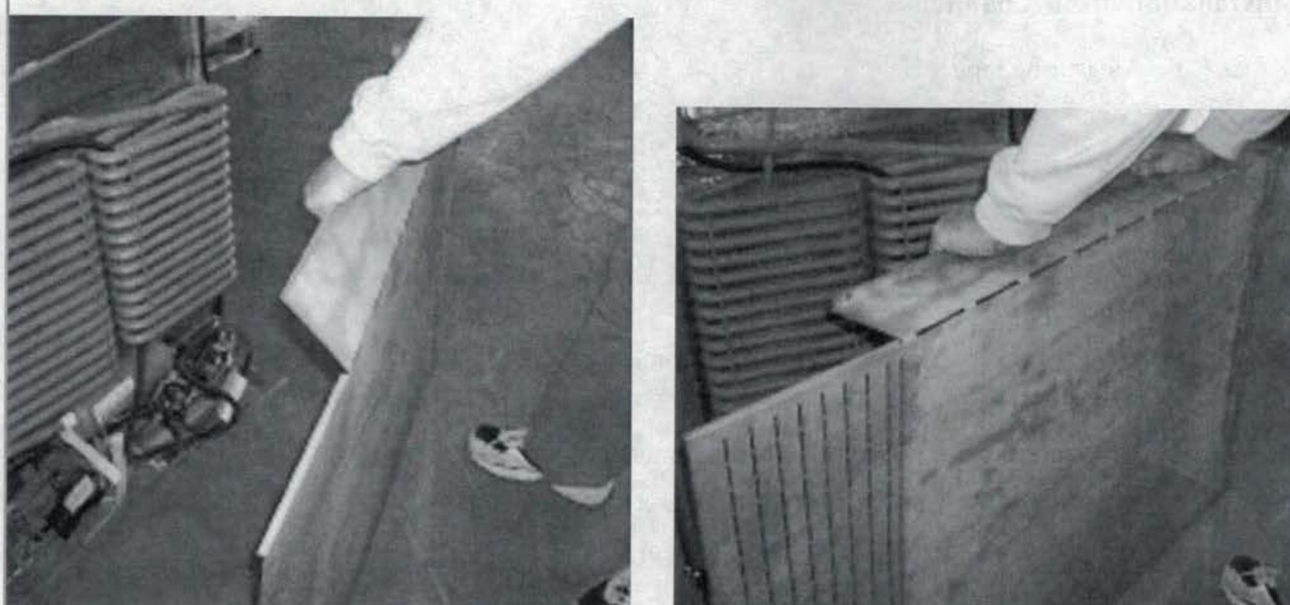


Figure 8-40 Step 3, Installation of Air Channel

4. On the rear of the refrigerator, inspect the top of the cooling unit mounting rail on each side. If there is not a gap of at least 1/8 in. between the rail and the refrigerator as shown, loosen the screw until there is a 1/8 in. gap. The screw(s) will be retightened later.

5. Hang the air channel on the back of the refrigerator by sliding the bent tabs down into the gaps behind the cooling unit mounting rails shown in step 4.

Figure 8-41 Step 4, Installation of Air Channel

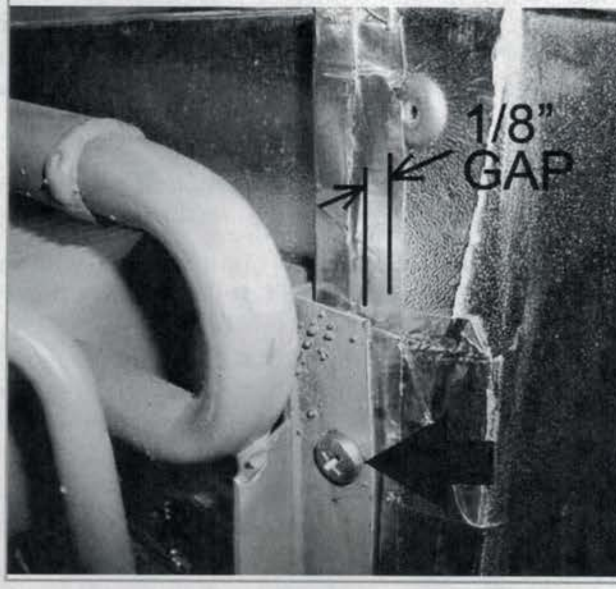
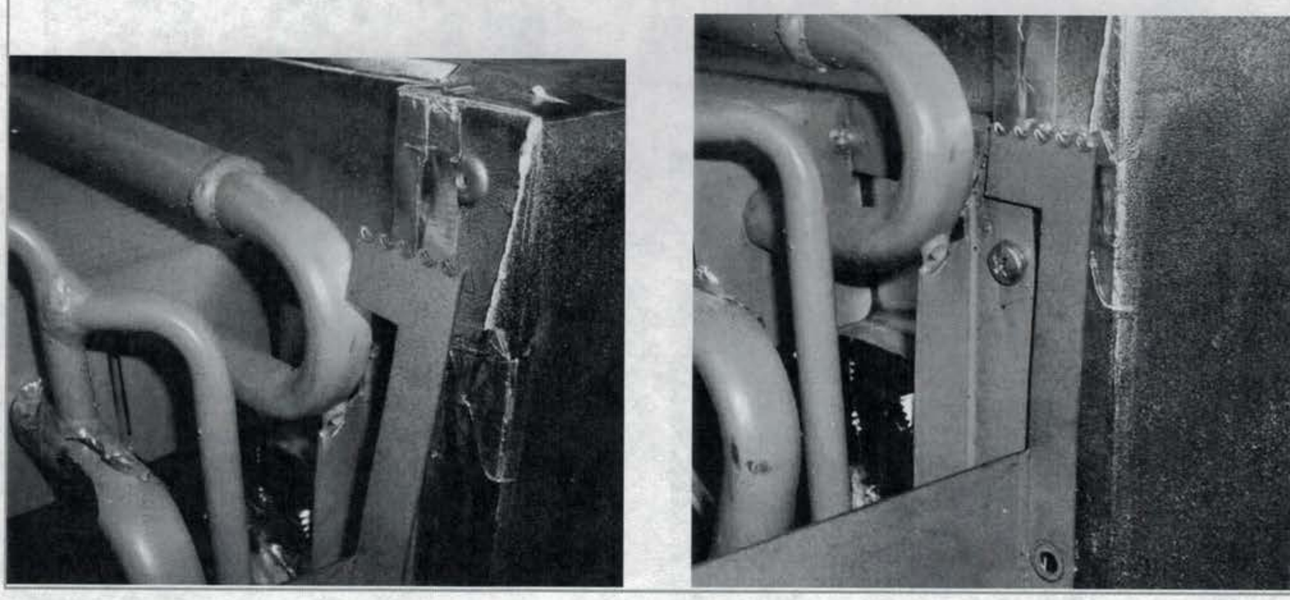


Figure 8-42 Step 5, Installation of Air Channel



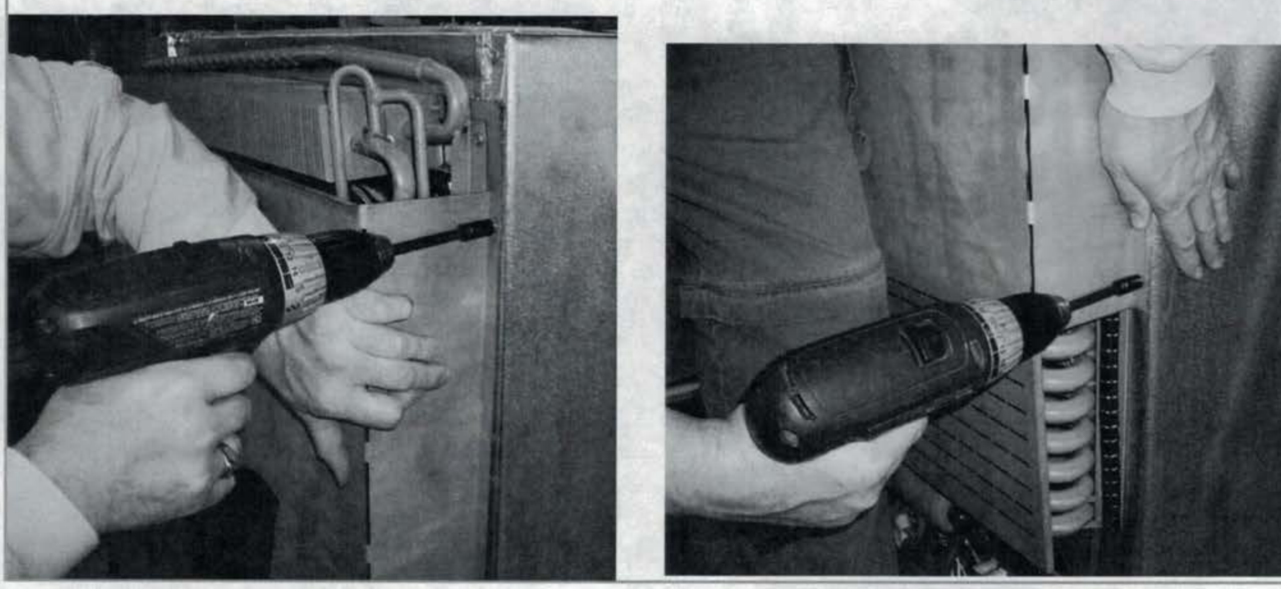
6. The air channel will now hang in position. Check that the side mounting flanges of the air channel remain within the overall width of the refrigerator so as not to interfere with placing the refrigerator into the recess. Adjust if necessary before proceeding to the next step.

   If the cooling unit mounting screw(s) were loosened in step 4, tighten them now.

7. Using the drill and nut driver bit (with extension), install six self-drilling screws (three per side) in the holes provided in the air channel mounting flanges. Make sure the flange aligns parallel with the cooling unit vertical frame and is at least 1/8 in. from the corner of the refrigerator. Use a low torque setting and be careful not to overtighten the screws.

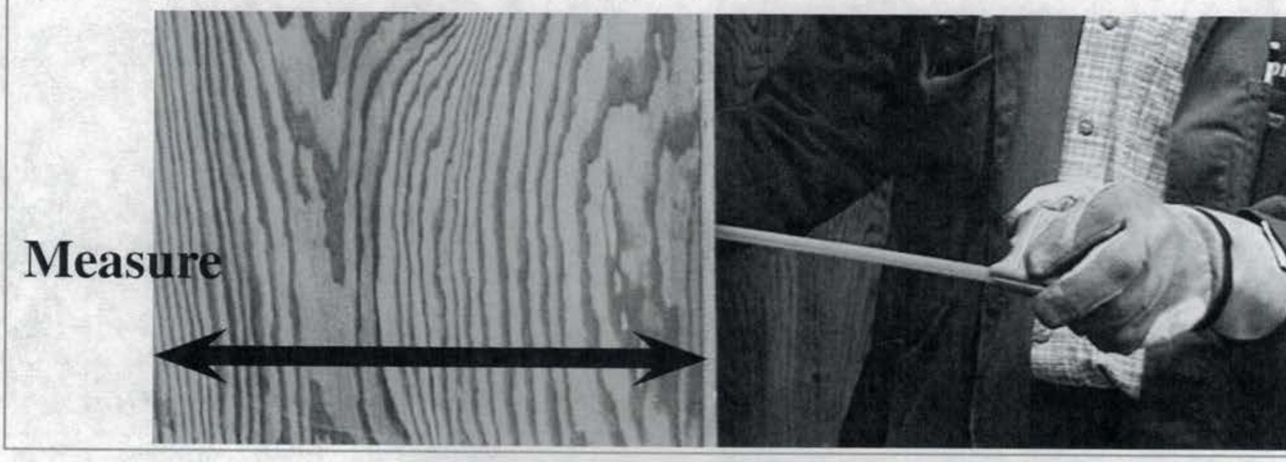
Figure 8-43 Step 6, Installation of Air Channel

Figure 8-44 Step 7, Installation of Air Channel



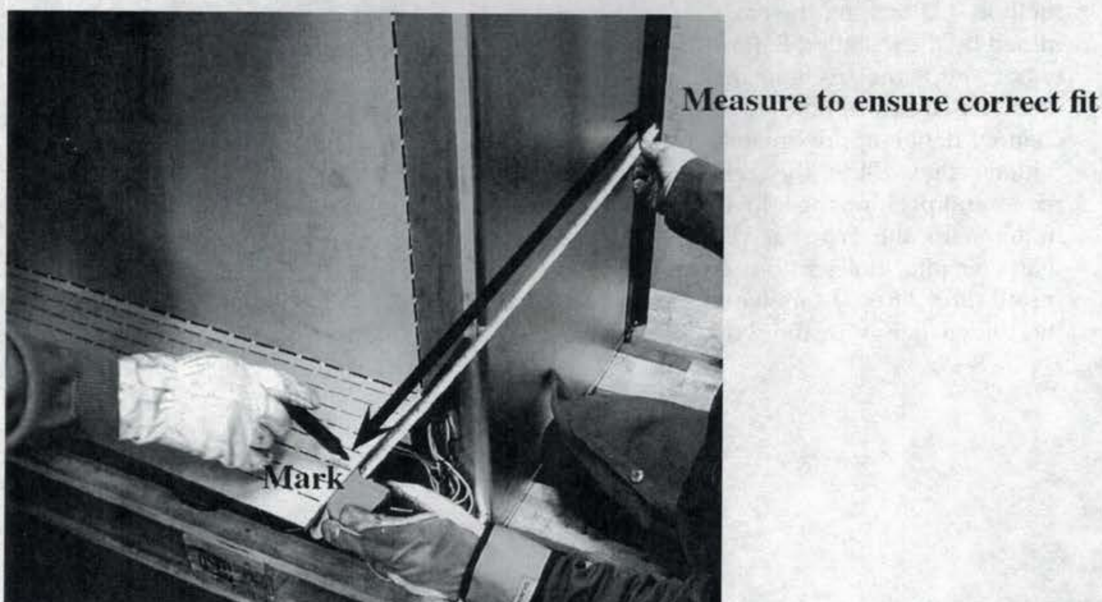
8. Installation of the air channel onto the refrigerator is now complete. Next, measure the depth of the recess in which the refrigerator will be installed. Make a note of the measurement.

Figure 8-45 Step 8, Installation of Air Channel



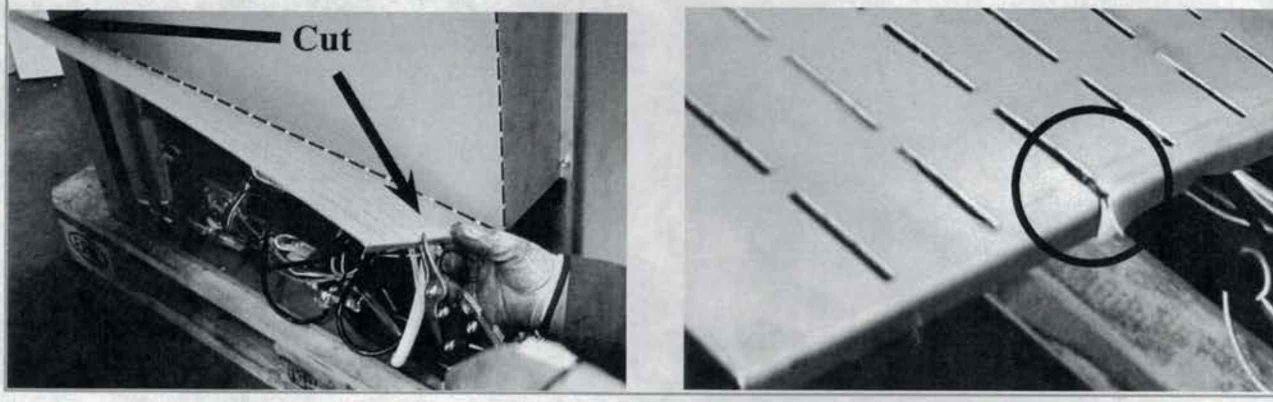
9. Hand-bend the lower flange of the air channel up 90°. Place a mark on each side of the bent flange as shown at the distance measured in step 8.

Figure 8-46 Step 9, Installation of Air Channel



10. Select the row of perforated slots at or just less than the measured distance of the marks made in the previous step. Using sheet metal shears, make a small cut (1/2 in.) on each side at this row of slots.

Figure 8-47 Step 10, Installation of Air Channel



11. Fold the flange up and over (180°).

12. To complete the installation of the air channel, a wooden crossbar (minimum 1 × 1 in.) at least as long as the width of the air channel flange must be attached as shown inside the recess. The method of attaching the crossbar is to be determined by the installer. Before sliding the refrigerator into the recess, drill three 3/16 in. diameter clearance holes through the folded air channel flange approximately 1/2 in. from the folded edge. Slide the refrigerator into the recess and position the folded air channel flange underneath the crossbar. Drill three 3/32 in. diameter pilot holes into the wooden crossbar. Install three #8 × 3/4 in. wood screws to secure the folded flange to the wooden crossbar. See *Figure 8-49*.

Figure 8-48 Step 11, Installation of Air Channel

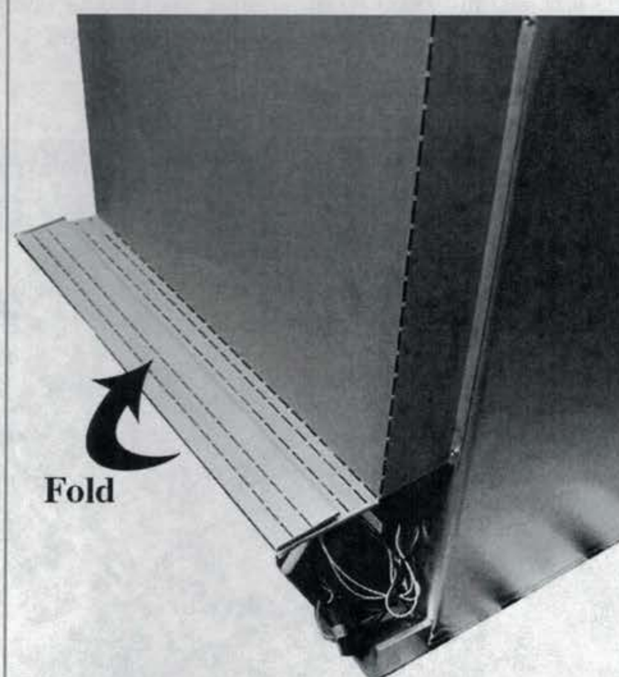
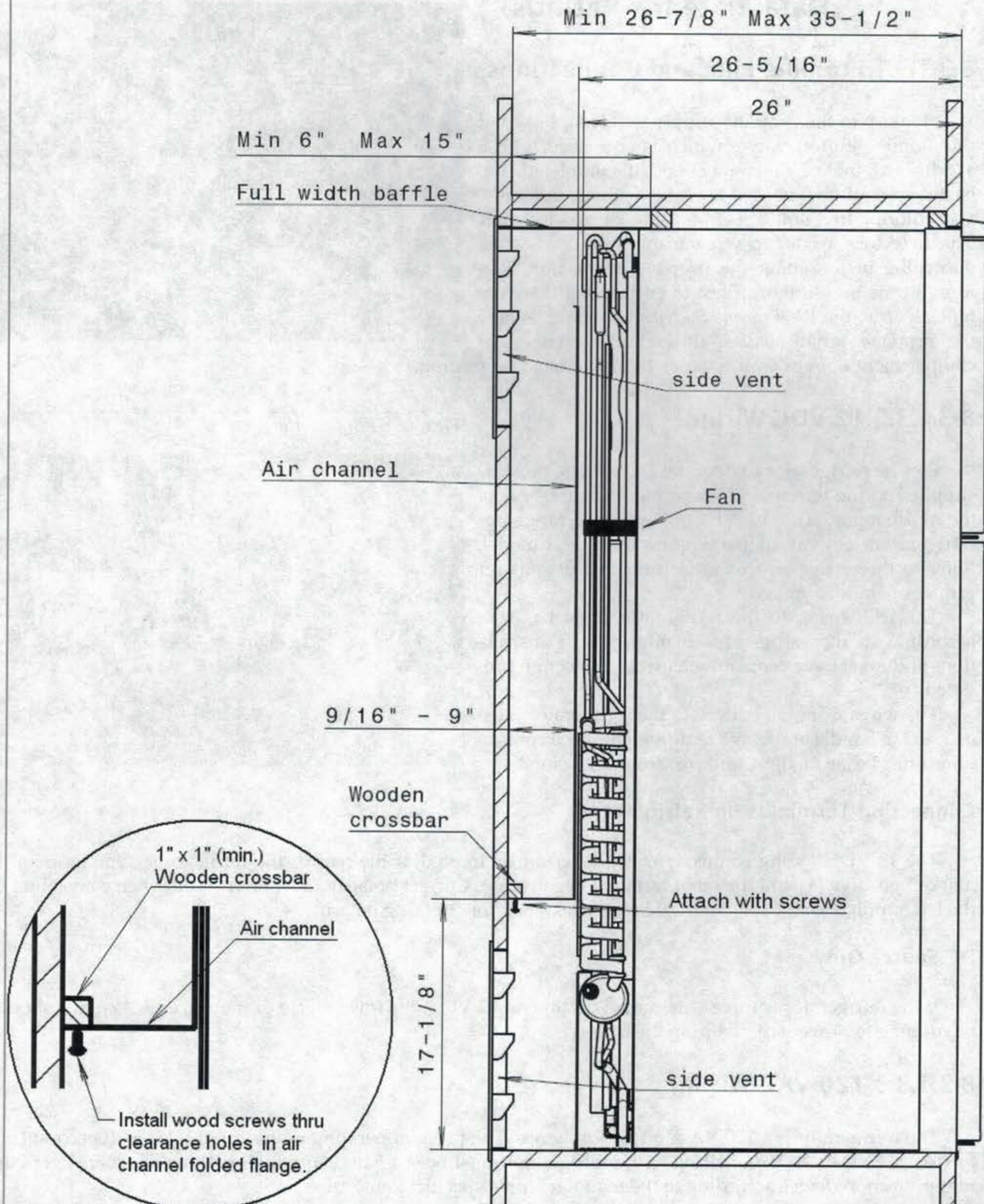


Figure 8-49 Step 12, Installation of Air Channel

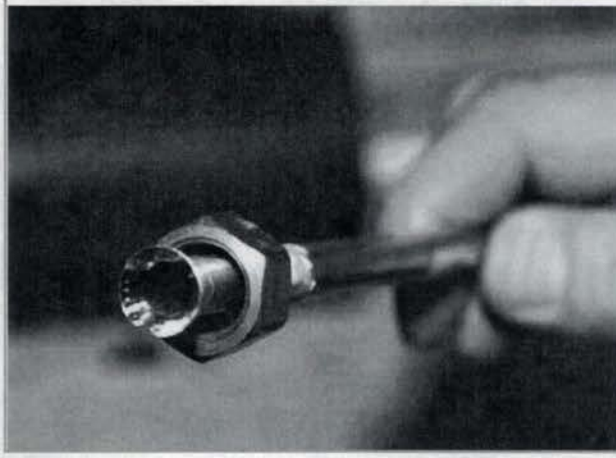


8-3.1.3 Energy Sources (Refer to Data Plate for Ratings)

8-3.1.3.1 Propane Line and Connections

Hookup to the propane supply is accomplished at the manual shutoff valve, which is equipped with a 3/8 in. SAE male flare connection. All completed connections should be checked for leaks with an ammonia- and chlorine-free liquid leak detector or an electronic leak detector. A backup wrench must be used when tightening or loosening the propane connection. Perform a time pressure drop test to ensure that there are no leaks (see the *RV Propane Systems* textbook). Where the propane tubing passes through the refrigerator compartment floor or wall, a vapor-tight seal must be ensured.

Figure 8-50 Copper Flare



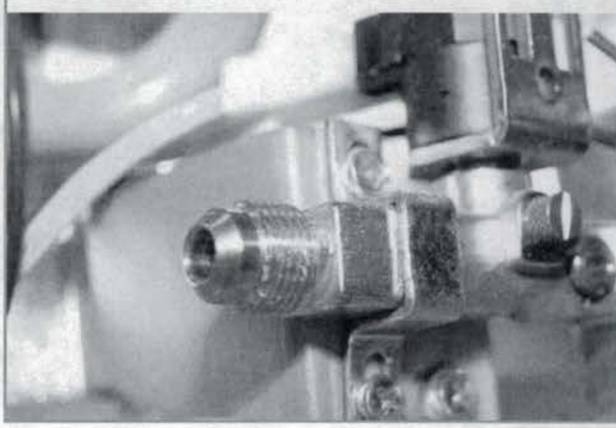
8-3.1.3.2 12 VDC Wiring

For the refrigerator to operate, DC voltage must be supplied to the terminal block or blocks at the rear of the refrigerator. The 12 VDC operational range for refrigerators can vary depending on make and model. Refer to the refrigerator manufacturer instructions for proper operational range.

The DC wiring to the refrigerator must be sized according to the refrigerator manufacturer's instructions and must have proper overcurrent protection provided.

The wires from the battery to the refrigerator must be sized to handle amperage requirements. The connections must be clean, tight, and free from corrosion.

Figure 8-51 Brass Fitting



Connecting Terminals on Refrigerator

The 12 VDC wiring connections are at terminals located at the rear of the refrigerator. One terminal is marked positive (+) and the other terminal negative (–). Correct polarity must be ensured when connecting to the DC supply. See the *RV Electrical Systems* textbook for checking polarity.

DC Source Only

If the refrigerator is three-way model cooling on 12 VDC, the tow vehicle or motorized RV engine should be running to prevent discharging the battery.

8-3.1.3.3 120 VAC Wiring

The refrigerator is a 120 VAC, 60-Hz appliance. The proper operating range is 120 VAC ± 10 percent (108 to 132 VAC). All 120 VAC wiring to the refrigerator must be sized and equipped with an adequate over-current protection device according to the manufacturer's specifications.

8-3 Review

1. ________________ requires that the refrigerator be installed in such a manner as to provide complete separation of the combustion system and the interior atmosphere of the RV.

   A. *NFPA 1192/CSA Z240*

   B. Manufacturer's installation instructions

   C. *NEC 501C/UL 14-5*

   D. *UL 14-5/NFPA 1192*

2. Some refrigerators use a double sidewall vent system. This means incoming air is drawn in through the ________________ vent and heat is dissipated through the ________________ vent.

3. An opening toward the outside at floor level in the refrigerator compartment must be provided for ventilation of heavier-than-air fuel gases.

   True False

4. A draft (natural or fan-generated) is required for proper airflow.

   True False

5. The proper electrical voltage operating range for a 120 VAC, 60 Hz refrigerator is:

   A. 108 to 132 VAC

   B. 108 to 121 VAC

   C. 102 to 138 VAC

   D. 102 to 121 VAC

6. The proper electrical voltage operating range for a 12 VDC refrigerator depends on the make and model.

   True False

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Chapter

8-4 Refrigerator Control Components

- Recognize component parts found in manual and automatic refrigerators.
- Identify and explain the function of component parts.
- Identify component parts within the system.
- Explain how propane flows through the main and bypass portion of the thermostat on manual refrigerators.

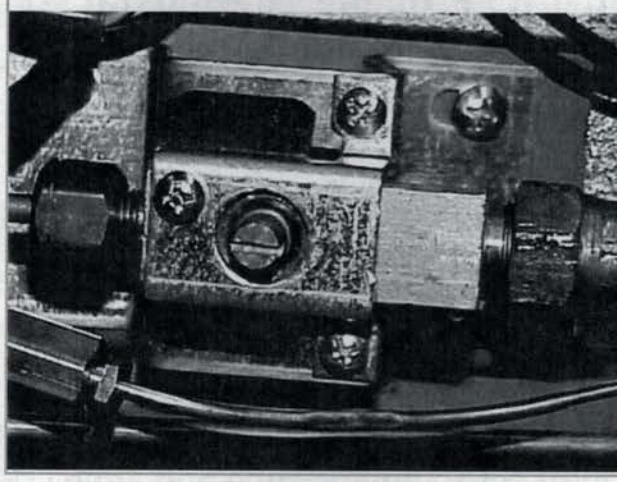
8-4.1 Components

8-4.1.1 Propane Connection (All Models)

Connection to the propane supply line is accomplished at the manual propane shutoff valve, which is furnished with a 3/8 in. SAE male flare connection. A backup wrench must be used when tightening or loosening the propane connection (see *Figure 8-51*), and a pressure drop test must be performed anytime the propane system is opened (see the *RV Propane Systems* textbook).

8-4.1.2 Manual Propane Shutoff Valve (Some Manual and Automatic Models)

Figure 8-52 Manual Shutoff Valve



The manual propane shutoff valve, as shown in *Figure 8-52*, is where the incoming propane supply is attached. Propane flows from the propane line to the shutoff valve and to the connection fitting. The valve must be turned to ON before any propane operation can occur. Depending on the model, this type of manual gas valve can be shut off from the front or rear.

Sometimes, in conjunction with the selector switch on manual models, this valve is directly coupled to the selector switch by means of a steel clip. When the selector switch is turned to the electric mode, the cutoff valve is automatically closed. When this same switch is turned to the propane mode, the electric circuit is also automatically interrupted.

8-4.1.3 Propane Regulator

The propane regulator of the RV's propane system supplies proper pressure to the refrigerator solenoid or manual gas valve. The refrigerator does not have its own separate regulator as do some other appliances.

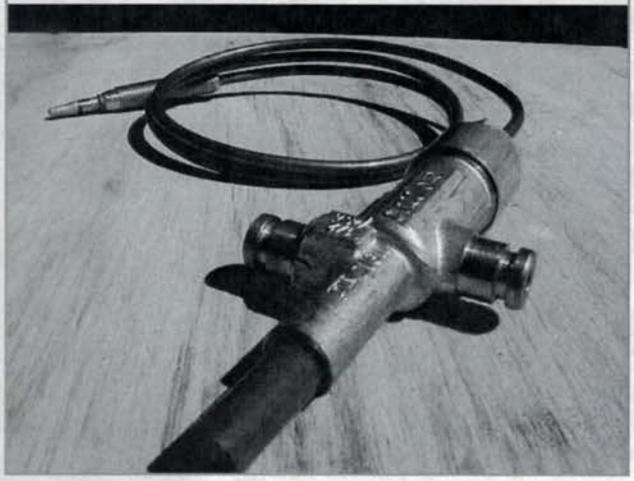
8-4.1.4 Safety Valve (Manual Models)

8-4.1.4.1 Description and Operation

The safety valve, or flame failure safety device, as shown in *Figure 8-53*, consists of a brass alloy valve housing and cap, an electromagnet, and a thermocouple.

The thermocouple is used to energize the electromagnet in the safety valve. The purpose of this device is to ensure that the flow of propane is shut off in the event that the flame is lost at the burner. If this occurs, the thermocouple cools, the electromagnet loses its magnetic field, and the valve closes, shutting off the propane flow.

Figure 8-53 Safety Valve and T-Couple



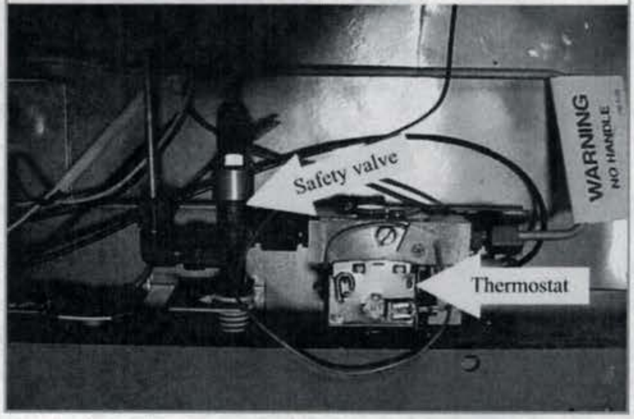
The thermocouple generates approximately 14 to 30 mV when heat is applied to the tip. (Check the manufacturer's specifications for exact values.) The voltage is used to energize the electromagnet to hold the safety valve open.

8-4.1.5 Propane Thermostat (Manual Models)

When the thermostat is working properly, a manometer, attached to test port, will read refrigerator pressure of 11 in. WC nominal when the thermostat is calling for cooling. When the thermostat is satisfied, the propane pressure will be reduced, and the burner will go to low flame. Pressure at low flame will be 3 to 5 in. WC or per manufacturer's specifications.

NOTE: A U-tube manometer is recommended for measuring the lower pressure readings. See the *RV Propane Systems* textbook.

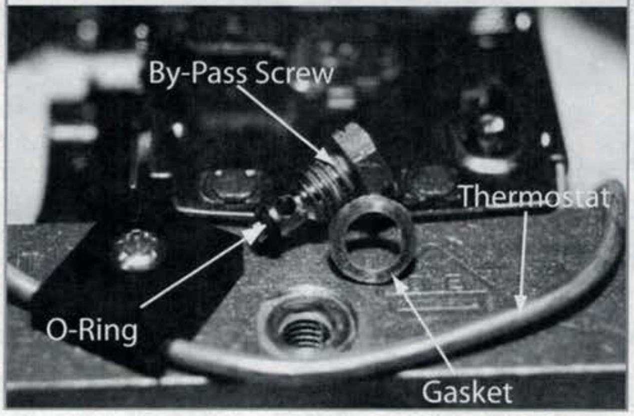
Figure 8-54 Dometic Manual Thermostat and Safety Valve



8-4.1.5.1 Capillary Tube and Bellows

The capillary tube has refrigerant inside that expands and contracts due to temperature change. The end of the capillary tube is attached to the high-temperature cooling fins located inside the food storage compartment. Expansion and contraction of refrigerant in the capillary tube moves the bellows, which controls propane flow through the thermostat.

Figure 8-55 Bypass Screw



8-4.1.5.2 Bypass Screw (Manual Models)

When the thermostat is satisfied, the propane is diverted to flow through the bypass screw orifice, which regulates the size of the low flame. The bypass screw assembly consists of a bypass screw, gasket, and O-ring.

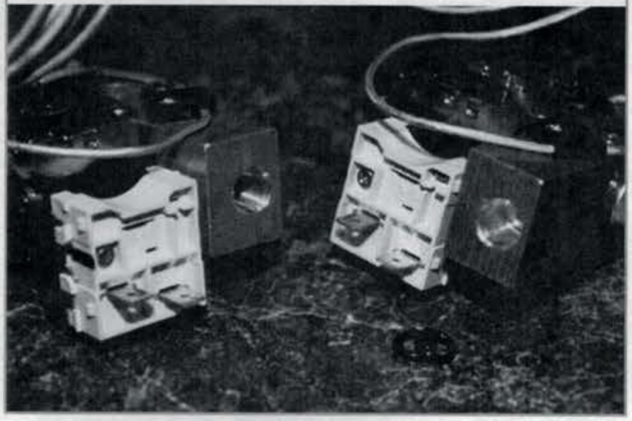
8-4.1.5.3 Thermostat Inlet and Outlet Fittings

Two types of inlet and outlet fittings are available:

1. Threaded
2. O-ring seal type

Whenever the system is separated, the O-rings must be replaced.

Figure 8-56 Inlet and Outlet Fitting



8-4.1.6 Propane Pressure Test Port (All Models)

All refrigerator models have a test port for measuring propane pressure flowing to the orifice.

For the refrigerator to cool efficiently on propane, the pressure should be set at 11 in. WC nominal at the propane system regulator.

The pressure test port fitting, as shown in *Figure 8-57*, is a screw hex fitting with 1/8 in. NPT threads.

Figure 8-58 New Style Solenoid Gas Valve

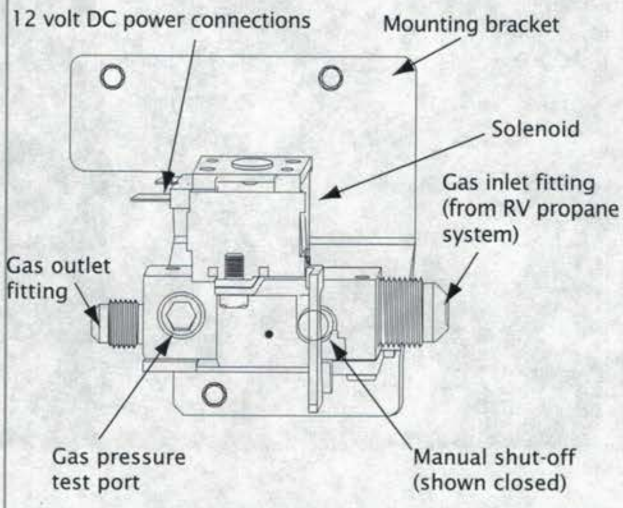
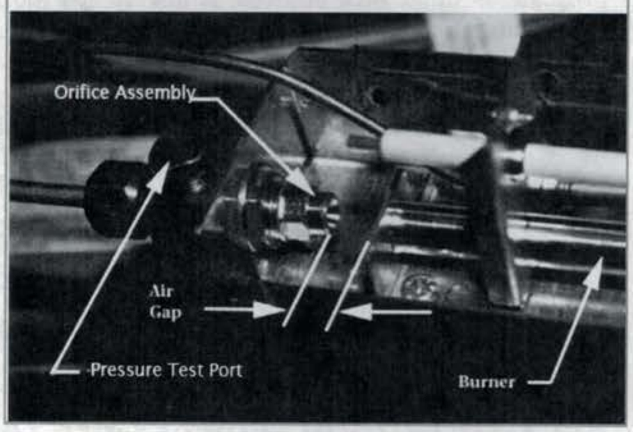


Figure 8-57 Burner Assembly



8-4.1.7 Orifice Assembly (All Models)

The orifice assembly is a small fitting that is mounted on the propane line just prior to the burner (see *Figure 8-57*). This device has a very small opening (the orifice) to regulate propane flow to the burner. The following are types of orifice assemblies:

1. Ceramic insert/brass fitting
2. Drilled brass fitting
3. Stainless steel insert/brass fitting
4. Laser-drilled ruby insert/brass fitting

The orifice is cleaned by using an alcohol-based solvent and allowing it to air dry. Do not use a pin or needle. This will distort or shatter the orifice. Do not use compressed air from a compressor to dry the orifice. Use of low-pressure, clean, canned compressed air (like used to clean a computer) is acceptable.

8-4.1.8 Burner (All Models)

Figure 8-59 Burners

The burner's function, when it is supplied the correct amount of air and propane, is to apply the correct amount of heat to the boiler.

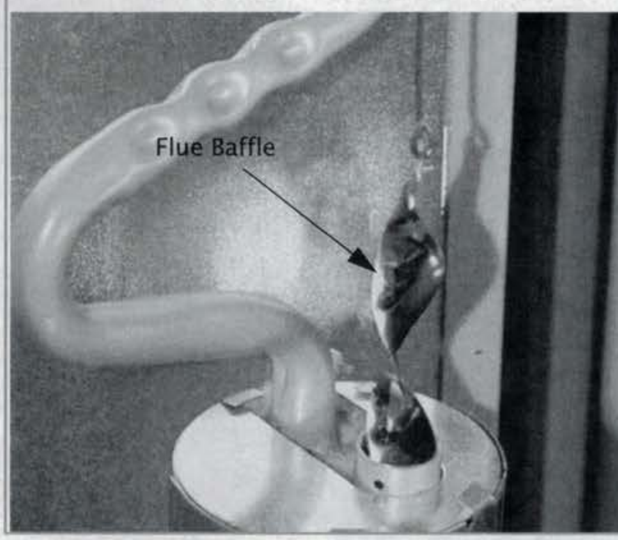
The burner is located so the flame is directly under the flue tube.

The burner should be cleaned periodically to maintain the proper cooling capabilities of the refrigerator. Clean the burner following manufacturer's recommendations.

The burner is provided the necessary air mixture through the presence of the primary air gap or hole.

8-4.1.9 Flue Baffle

Figure 8-60 Flue Baffle



The flue baffle is designed to concentrate the heat supplied by the propane burner at the boiler. This allows the absorption system to work as efficiently on propane as other heat sources. It also keeps the heat from going directly up the flue tube. This forces heat to the outside of the flue tube (see *Figure 8-60*) for better transfer to the boiler.

The flue baffle is hung in the flue tube assembly of the cooling unit. If the flue baffle is distorted at the end from heat, it must be replaced. The flue baffle length and distance from the top of the burner must be to manufacturer's specifications.

The flue baffle does require periodic cleaning with a wire brush. If badly pitted or corroded, it should be replaced.

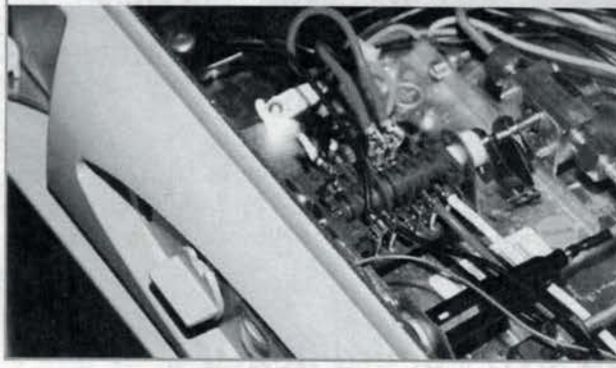
8-4.1.10 120 VAC Power Cord (All Models)

The refrigerator is equipped with a three-prong grounded plug for protection against shock hazards and should be plugged directly into a properly grounded three-prong receptacle located in the sealed refrigerator compartment. Do not cut or remove the grounding prong from this plug. The power cord should be routed to avoid direct contact with the burner cover, flue cover, or manual propane shutoff valve knob.

8-4.1.11 Selector Switch (Manual Models)

The selector switch allows only one energy source to be active at a time (propane, 120 VAC, or 12 VDC). On some models, the selector switch also controls the manual propane shutoff valve.

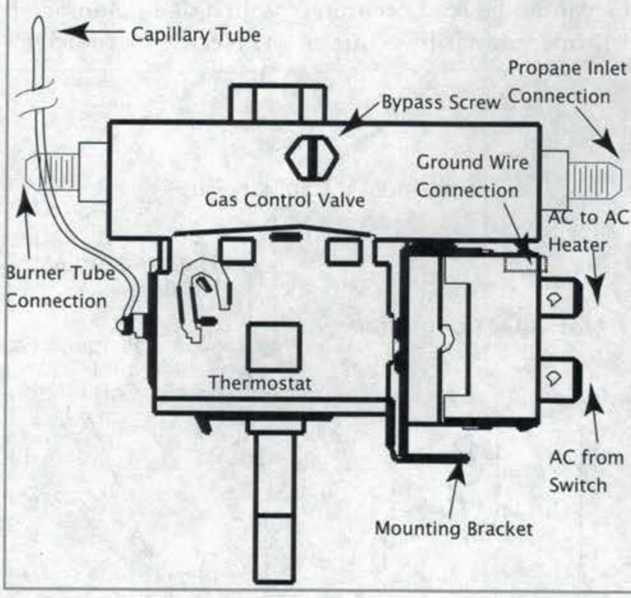
Figure 8-61 Selector Switch

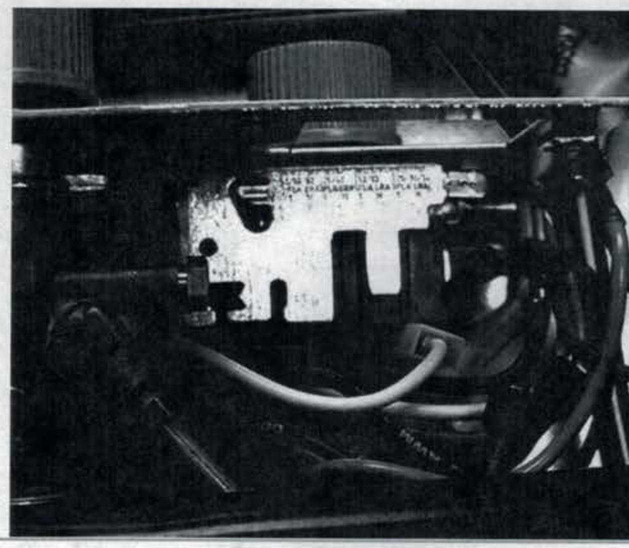


8-4.1.12 Electric Thermostat (Manual Models)

The electric thermostat acts as a switch to control refrigerator temperature by opening and closing contacts to the heating element. The capillary tube has refrigerant inside that expands and contracts due to temperature change. The end of the capillary tube is attached to the high-temperature evaporator fins. Expansion and contraction of refrigerant in the capillary tube moves the bellows, which opens and closes the contacts to the heating element.

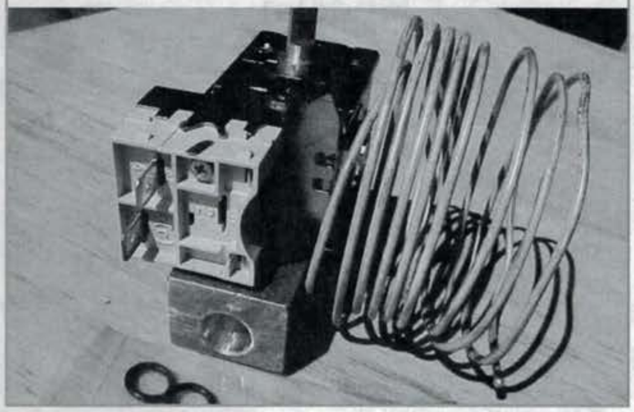
Figure 8-62 Thermostat





8-4.1.13 Combination Propane/Electric Thermostat (Manual Models)

Figure 8-63 Refrigerator Combination Thermostat

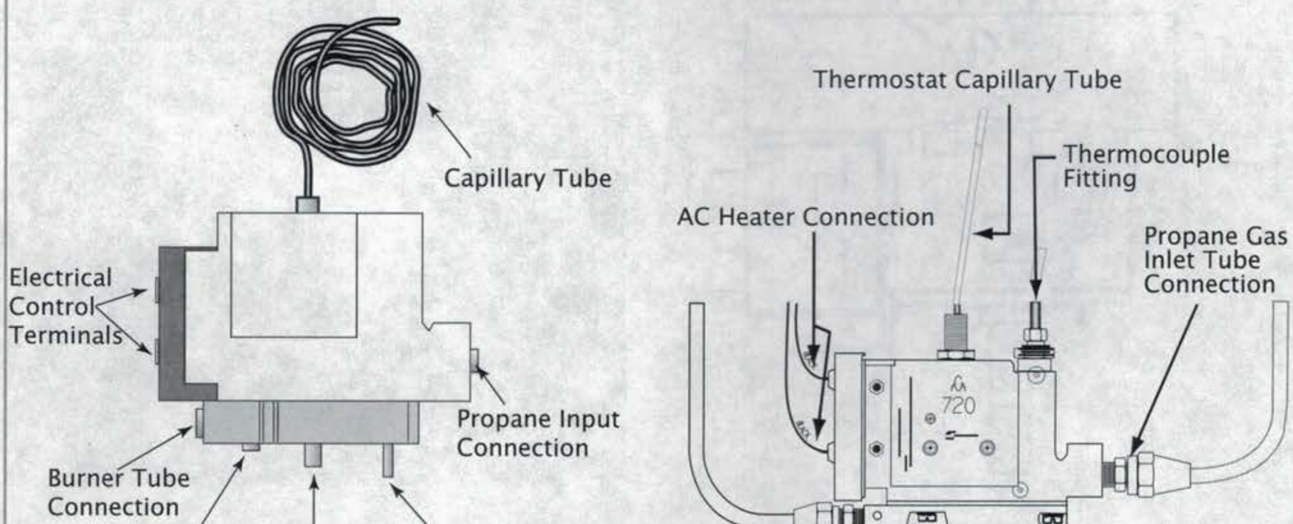


This thermostat, as shown in *Figure 8-62*, regulates both the propane operation and the electric operation. One capillary tube and bellows operate both gas and electric functions.

8-4.1.14 Sourdillon Propane/Electric Thermostat (Manual Models)

This thermostat combines a selector switch, safety valve, and thermostat. On some models, the pressure test port is part of this valve. In propane operation, as the temperature is satisfied, the pressure drops off slowly. With this type of thermostat, the bypass pressure cannot be read accurately with a dial manometer; a U-tube manometer must be used. The thermostat's electric operation is the same as any electric thermostat.

Figure 8-64 Sourdillon Propane/Electric Thermostat



8-4.1.15 Heating Elements (All Models)

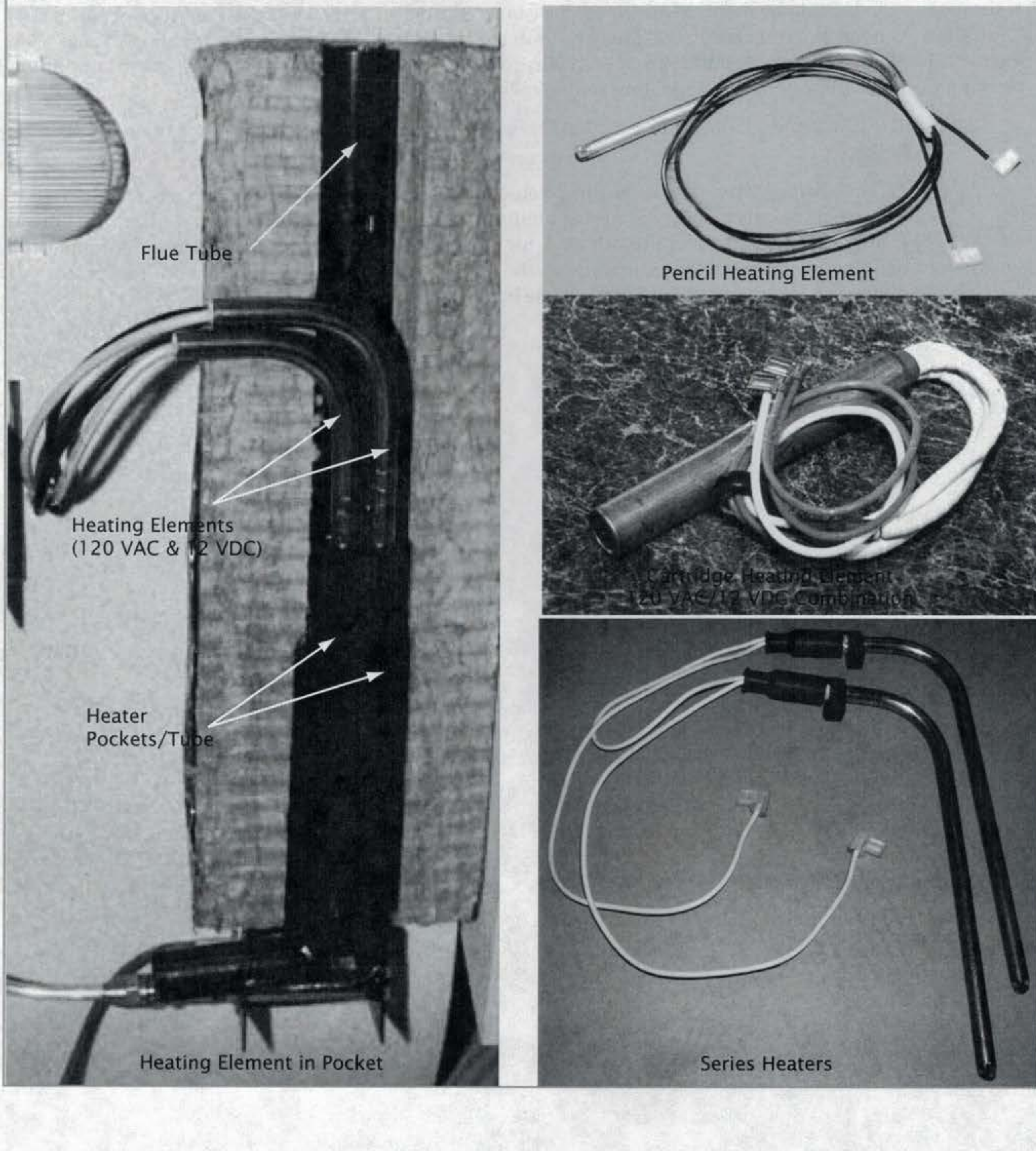
The heating element applies a specific amount of heat to the boiler when it is supplied with the correct voltage. There are two types of heating elements:

1. Cartridge-type (older type). These are usually 5/8 in. diameter or larger, available in 120 VAC, 12 VDC, or 120 VAC/12 VDC combination. See *Figure 8-67*.
2. Pencil-type. Available in 120 VAC or 12 VDC versions. See *Figure 8-65*.

The heating element heats up very quickly and must be a snug fit in the heater pocket/tube on the cooling unit, as shown in *Figure 8-65*, to prevent failure. A multimeter can be used to check voltage, amperage, and resistance of the heating element. Measure the resistance through the element between its two wires. Using Ohm's law, convert the resistance measurement to determine if it matches the wattage rating of that heating element. Then measure for continuity from each wire to the casing of the heating element. Any continuity indicates a shorted heating element, mandating replacement.

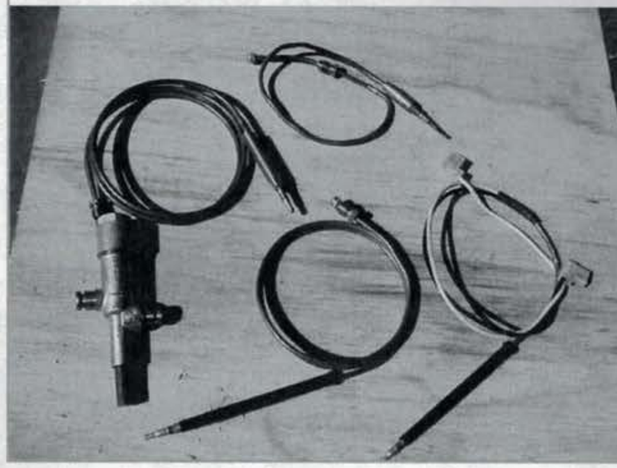
- *120 VAC heating element.* The 120 VAC heating element generates a specific amount of heat to the boiler.
- *12 VDC heating element.* This heating element does not have the capability to cool the refrigerator from an initial start, but it has the capability to maintain the temperature for a short duration. This element is very inefficient and uses a high amount of amperage. This element is primarily for maintaining refrigerator temperature while driving or towing the RV, when a constant 12 VDC power source is present from the vehicle battery/charging system.

Figure 8-65 Heating Elements



8-4.1.16 Thermocouple (Manual and Some Automatic Models)

Figure 8-66 Various Thermocouples



The thermocouple is used to energize the electromagnet in the safety valve. The purpose of this device is to ensure that the flow of propane is shut off in the event that the flame is lost at the burner. If this occurs, the thermocouple cools, the electromagnet loses its magnetic field, and the valve closes.

The thermocouple generates approximately 14 to 30 mV when heat is applied to the tip. Check the manufacturer's specifications for exact values. The voltage is used to energize the electromagnet to hold the safety valve open.

The safety valve shuts off the supply of propane to the burner assembly if the flame goes out for any reason. The thermocouple is a component connected to the safety valve, extending above the burner assembly so the tip is in the path of the flame when the refrigerator is operating in propane mode. The thermocouple senses the heat of the flame to hold the safety valve open. If there is no flame, the safety valve closes. This will prevent propane from accumulating at the burner.

If the tip of the thermocouple has decomposed from flame impurities, it must be replaced. Ensure that the thermocouple connection at the safety valve is tight and clean. A loose or dirty connection will cause flame shutdown. Clean and tighten the thermocouple and ensure it is engulfed in the flame.

Figure 8-67 Piezo Ignitor and Panel Face

8-4.1.16.1 Ignitor Sources

Piezo Ignitor

The piezo ignitor is a self-contained assembly that generates a high-voltage spark to ignite the propane. When the button is pushed, a spring-loaded striker creates a spark. If there is no resistance when pressing the button, the piezo ignitor is defective and must be replaced. If the piezo snaps or has resistance when the button is pushed, but there is no spark, the problem lies in the electrode or the electrode wire.

Figure 8-68 Piezo Ignitor

Glow Coil (Manual Models)

The glow coil is another type of ignition device used in older units. These are powered by two D-cell batteries and are activated only when pushing the button for ignition.

Zip Tube Ignitor (Manual Models)

This is another type of ignitor consisting of an aluminum tube with perforated holes to light the burner. Propane is only allowed through it by depressing the safety switch. These are only present on very old (>30 years) units.

Flint Ignitor (Manual Models)

This ignitor uses a flint and knurled wheel that, when twisted the correct way, generates a spark at the burner. This ignitor is found only on older units.

Ignitor Probe or Electrode (Manual and Automatic Models)

The electrode is a metal probe, enclosed in a ceramic insulator. Its function is to send sparks to the burner to ignite the propane. See manufacturer's specifications for spark gap. It is located just above the burner and is connected to the high-voltage cable. The spark is generated by the electrical charge produced by the ignitor when the high voltage "bridges" the air gap between the electrode and the burner.

Figure 8-72 Ignitor Probe/Sensor Probe

Figure 8-69 Refrigerator Glow Coil Ignitor

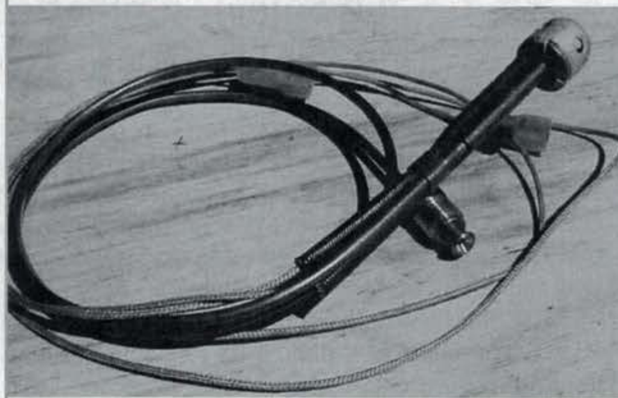


Figure 8-70 Zip Tube and Burner Assembly

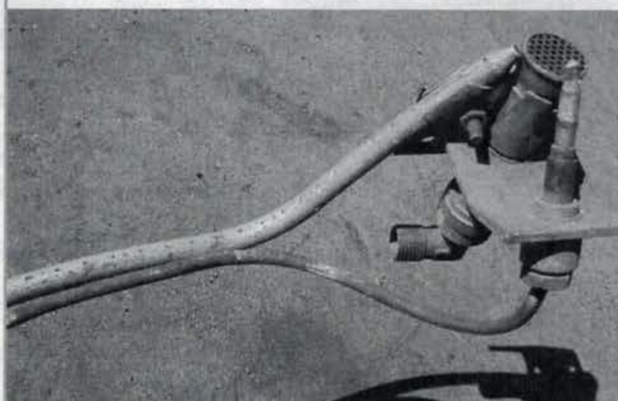
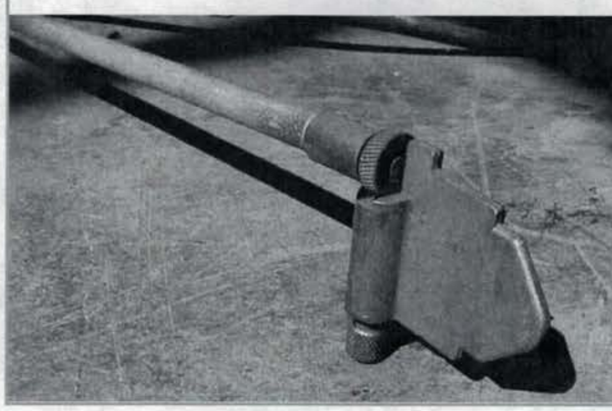


Figure 8-71 Flint Ignitor

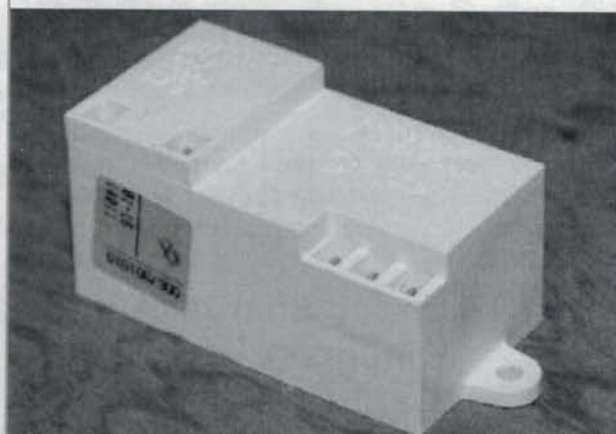


Reignitor/Relighter

The reignitor/relighter, used on certain model refrigerators, operates on 12V current. On propane operation, the reignitor senses the flame. When there is no flame at the burner, the circuit is open, and the reignitor begins sparking to ignite the propane. As soon as the flame is lit, the circuit is completed (millivolts are present), and the reignitor stops sparking. The millivolts are monitored by the reignitor and if for any reason the flame goes out, the reignitor begins sparking until the burner is lit. The reignitor requires a 12 VDC power source and has a high-voltage output.

Figure 8-73 Reignitor Installed

Figure 8-74 Reignitor



Ignition Module (Automatic Models)

The ignition module ignites and monitors the flame and powers the solenoid gas valve. The ignition module is used only during propane operation. It supplies power to the ignition electrode to ignite the burner. It senses the flame through the sense electrode and supplies 12 VDC to operate the solenoid gas valve. When the burner ignites and remains lit, the ignition module turns off the spark. If the burner does not ignite, or ignites and goes out when the sparking stops, the ignition module will close the solenoid gas valve (thereby turning off the propane supply to the burner) and illuminate the check light at the eyebrow (control panel).

Figure 8-75 Ignition Module

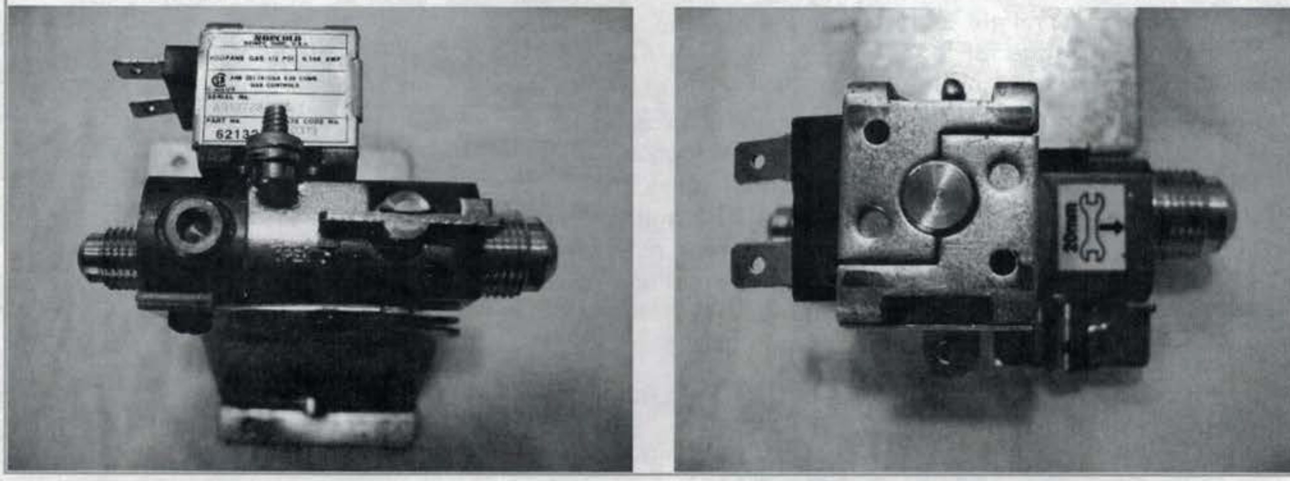
Sensor Probe (Manual and Automatic Models)

The sensor probe completes the circuit through the flame to ground to tell the reigniter or ignition module that a flame is present. In some applications, the electrode and sensor will be separate components but in others are a combined unit.

8-4.1.17 Solenoid Gas Valve (Automatic Models)

The solenoid gas valve assembly is a safety valve as well as a propane flow valve. The solenoid gas valve controls the flow of propane by use of 12 VDC.

Figure 8-76 Solenoid Valve, Side View (Left) and Top View (Right)

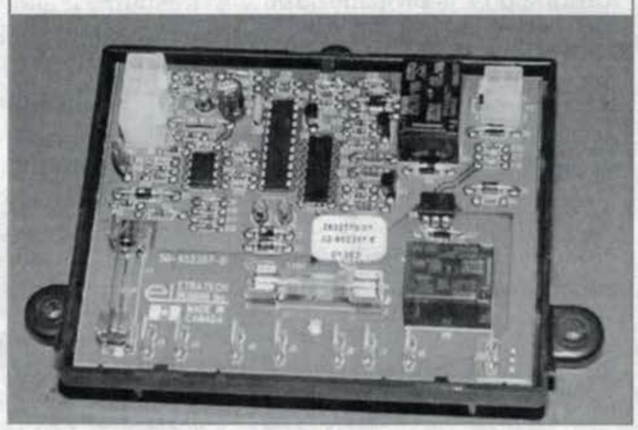


8-4.1.18 12 VDC Relay (Manual and Automatic Models)

The 12 VDC relay is a component controlling the circuit to the 12 VDC heating element. Containing a set of normally open contacts, the relay will complete the circuit (by closing contacts) to the heating element when proper voltage is established at the relay. When the 12 VDC relay is selected, the main circuit board sends voltage to the relay, and an internal coil is energized that closes the contacts to enable 12 VDC heating to operate.

8-4.1.19 Circuit Boards (Automatic Models)

Figure 8-77 Circuit Board



Circuit boards control the operation of the refrigerator. They can control the mode of operation, ignition, and cooling.

Circuit board testers are available for some circuit board diagnostics. Some models have self-test features.

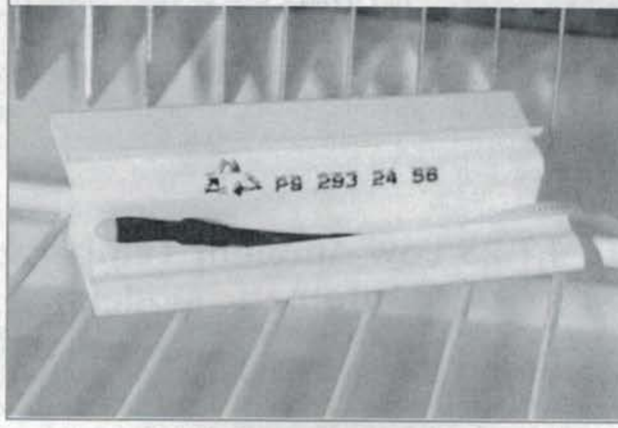
8-4.1.20 Connecting Lead, Ribbon Cables, Wire Harnesses (Automatic Models)

These cables and harnesses distribute the DC current to different components of the refrigerator. The use of proper connectors eliminates corrosion problems at the connectors.

8-4.1.21 Thermistors

The thermistor senses the interior temperature of the refrigerator and tells the control system when to turn on and off. Temperature affects the resistance of the thermistor; as temperature increases, resistance decreases, and vice versa. Depending on the refrigerator manufacturer, the thermistor may be reading air or metal temperature at the high-temperature cooling fins.

Figure 8-78 Thermistors



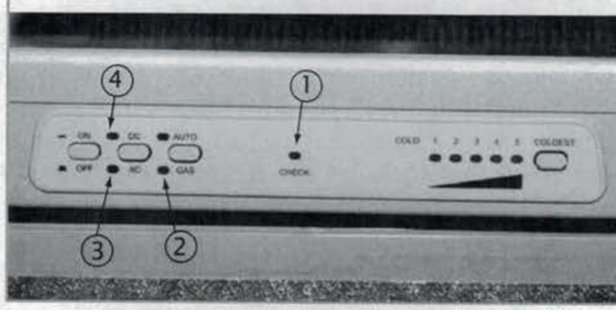
8-4.1.22 Eyebrow and Center Controls (Automatic Models)

These controls are used to select the mode of operation. When set to AUTO, the control will select AC as long as AC is supplied. If AC is lost for some reason, it will automatically select PROPANE. It also displays the mode of operation, determines the operating temperature (if not manually selected), and indicates when a trial for ignition has failed. On three-way models, when DC is selected, it will override the automatic mode. On some models, selection of propane mode will also override the automatic mode.

Several indicator lights, as shown in *Figure 8-79*, are present, depending on the refrigerator model.

1. Failure to light or stay lit on propane lamp (check light)
2. Propane light
3. AC light
4. DC light
5. Flashing ignition lamp (not shown)

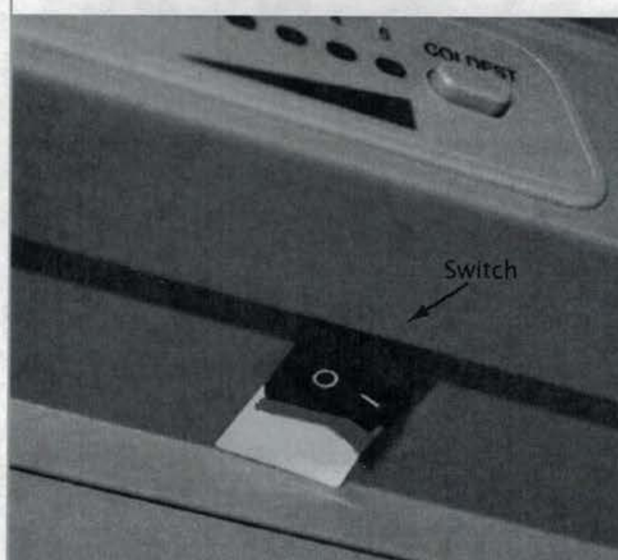
Figure 8-79 Eyebrow Control



8-4.1.23 High Humidity Switch and Heater (Automatic Models)

Turning on the high humidity switch will keep the surface between the door openings dry during high-humidity conditions. The switch should be left in the OFF position unless condensation is observed in this area. When the refrigerator is not in use, the high humidity switch must be in the OFF position. If the switch remains in the ON position, a continuous amp draw may occur, and the battery may run down.

Figure 8-80 High Humidity Switch



8-4.1.24 Door Switch for Interior Light (Some Manual and Automatic Models)

The interior door switch turns on the light when the door is opened. When the switch arm is depressed, the interior light should be off. When the refrigerator door is open, the switch is closed, and the interior light should be on. A defective door switch can actually be the cause of insufficient cooling, since the bulb is a heat source when on.

8-4.1.25 Low Ambient Temperature Switch (LAT) (Some Manual and Automatic Models)

Some RV absorption refrigerators are equipped with a feature that allows for trouble-free operation in low ambient temperatures below 50°F (10°C) for extended periods of time. Simply turn on the low ambient temperature switch located beneath the top decoration panel that houses the control panel. Once the outdoor temperature is above 50°F (10°C), the low ambient temperature switch should be turned off.

8-4.1.26 Interior Light Assembly (Some Manual and Automatic Models)

Interior lights provide illumination to the refrigerator section. Smaller refrigerators may not be equipped with interior lights. Lights are 12 VDC circuits. The wiring for interior lights may be incorporated in a harness assembly that includes the thermistor. Always check with the refrigerator manufacturer and/or owner's manual.

Figure 8-81 Interior Light Assembly

8-4 Review

1. A backup wrench must be used anytime a propane connection is loosened or tightened.

   True   False

2. The propane system regulator at the container provides the propane pressure for the refrigerator. The refrigerator does not have its own propane regulator.

   True   False

3. The propane safety valve on a refrigerator is designed to ensure that propane pressure does not exceed safe limits.

   True   False

4. A capillary tube has refrigerant inside it that expands and contracts due to temperature.

   True   False

5. For a refrigerator to work properly on propane, the propane pressure should be:

   A. 12 in. WC

   B. 11 in. WC

   C. 10 in. WC

   D. 9 in. WC

6. Match the following.

_____	Flue baffle	A.	Refrigerator internal temperature sensor
_____	Selector switch	B.	Completes the circuit with flame to ground to tell the board that a flame is present
_____	Electric thermostat	C.	A device that generates a high-voltage spark to ignite propane
_____	Sourdillon thermostat	D.	Device used to energize the electromagnet in the safety valve
_____	Thermocouple	E.	Powered by two D-cell batteries and activated by pushing the button for ignition
_____	Piezo ignitor	F.	Combines selector switch, safety valve, and thermostat
_____	Glow coil	G.	Designed to concentrate the heat supplied by the propane burner at the boiler
_____	Sensor probe	H.	Allows only one energy source at a time to be used
_____	Solenoid valve	I.	A safety valve as well as a propane flow valve
_____	Thermistor	J.	Acts as switch to control refrigerator temperature by opening and closing contacts to the heating element

7. Some circuit boards have self-test features.

   True   False

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Chapter 8-5 Sequence of Operation and Troubleshooting

- Explain sequence of operation of an automatic refrigerator (two-way, three-way).
- Diagnose the cooling unit.
- Use proper test equipment to isolate faults.
- Ensure that all electrical and propane requirements have been met.
- Demonstrate the proper procedure for cleaning the orifice, burner, and flue tube.
- Identify and repair electrical faults.
- Demonstrate the appropriate action to take if the thermostat is defective.
- Identify and repair propane system faults.
- Diagnose probable causes of main board failure.
- Diagnose circuit boards (upper and lower).

The power options for automatic refrigerators are propane, 120 VAC, and 12 VDC for three-way models, and propane and 120 VAC for two-way models. The sequence and priority selection of the power source will vary from model to model.

8-5.1 Sequence of Operation of Dometic Systems

8-5.1.1 120 VAC Operation (First Priority)

Since 120 VAC is usually the most common energy source for operation of the refrigerator, the control system is designed to select this mode whenever it is available (except when the *propane only* mode is manually selected).

8-5.1.2 12 VDC Operation (Second Priority)

The 12 VDC operation is available only as an optional mode. On AMES (automatic/manual energy selector), the 12 VDC is manually selected. On the AES (automatic energy selector), the 12 VDC is the second priority but available only if proper DC voltage is present as per manufacturer's requirements.

8-5.1.3 Propane Operation (Last Priority)

When there is no electrical power available (120 VAC or 12 VDC), or if the propane mode is selected manually, the control system will switch to propane operation. The following sequence takes place:

1. A high-voltage spark is generated above the burner.
2. Power is sent to a solenoid, which opens the solenoid gas valve, allowing propane to flow to the burner. The spark ignites the propane, and a flame is established at the burner.
3. A thermocouple mounted above the burner monitors the flame continuously. If the flame should fail for any reason, the high-voltage spark will start immediately and attempt to relight the flame. After an ignition attempt period, if flame is not sensed, the unit will illuminate the check light, shut off the solenoid gas valve, and shut off the ignition.

NOTE: Most propane appliances used in recreational vehicles are vented to the outside of the vehicle. When parked close to a gasoline pump, it is possible that gasoline fumes could enter this type of appliance and ignite from the burner flame, causing a fire or an explosion. For personal safety, it is required by local, state, and federal laws that all propane appliances that are vented to the outside must be shut off when refueling. This means putting the selector switch in the OFF position.

NOTE: Some older refrigerators are equipped with a propane delay mode. This would prevent the refrigerator from operating on propane for a specific period of time (check the manufacturer's specifications). This was a safety feature intended to prevent possible fires during refueling.

8-5.2 Sequence of Operation of Norcold Systems

The control system on automatic mode will select among 120 VAC, propane, and 12 VDC, or each mode can be manually selected.

8-5.2.1 120 VAC Operation (First Priority)

Since 120 VAC is usually the most common energy source for operation of the refrigerator, the control system is designed to select this mode whenever the controls are set to AUTO or AC manual mode. In the AC manual mode, if 120 VAC power is not available, the controls will set a fault code. If 120 VAC power becomes available, AC operation will resume automatically.

8-5.2.2 Propane Operation (Second Priority)

When there is no 120 VAC electrical power available or the controls are set to propane manual mode, the controls will select propane operation. The following sequence takes place:

1. A high-voltage spark is generated above the burner.
2. The controls send power to the solenoid gas valve, allowing propane to flow to the burner. The spark ignites the propane, and a flame will be present at the burner.
3. A sensor electrode mounted above the burner tube monitors the flame continuously. If the flame should fail for any reason, the high-voltage spark will start immediately and attempt to relight the flame. After a 30 second ignition attempt period, if flame is not sensed, the unit will illuminate the no-flame indicator, shut off the solenoid gas valve, shut off the ignition, and lock out propane operation.

NOTE: Most propane appliances used in recreation vehicles are vented to the outside of the vehicle. When parked close to a gasoline pump, it is possible that gasoline fumes could enter this type of appliance and ignite from the burner flame, causing a fire or an explosion. For personal safety, it is required by local, state, and federal laws that all propane appliances that are vented to the outside must be shut off when refueling. This means putting the selector switch in the OFF position.

8-5.2.3 12 VDC Operation (Third Priority)

The 12 VDC operation is found on three-way refrigerators. When the controls are set to AUTO and 120 VAC and propane are not available, the controls select 12 VDC operation. When the controls are set to DC manual mode, the only operation available is 12 VDC.

NOTE: Technicians should always use the service manuals for the specific product models and brands they are working on. The following procedures are offered as samples only and are not all inclusive of possible problems or procedures.

8-5.3 Troubleshooting Cooling Failures

8-5.3.1 Possible Cooling Unit Faults

8-5.3.1.1 Blockage

One of the possible faults with a cooling unit is a blockage. This can happen when the unit is operated off-level or if too much heat has been applied to the boiler area. To the touch, this unit will be extremely hot at the boiler, with little warmth at the absorber. In other words, there is no circulation.

8-5.3.1.2 Venting

1. Check for airflow restrictions.

   Clean out the refrigerator intake and exhaust vents. Bird nests, leaves, twigs, and other debris can lodge there, choking the unit's efficiency and presenting a fire hazard. Screens should not be used on lower vents. The lower vent area should not be used as storage.
2. Check for properly sized vents.
3. Check for air movement over absorber and condenser. Check for dirt, dust, and debris.
   - No air pockets above the refrigerator.
   - All potential dead air pockets should be blocked or baffled to ensure that heat from the cooling unit is not trapped in these spaces, thus reducing efficiency.
   - Maximum 1 in. from the back wall
   - Sidewall clearances: 0 to 1/2 in. maximum
   - Top clearance: 0 to 1/4 in. maximum
   - With proper installation, there should be as little open space as possible surrounding the sides and top of the refrigerator to achieve smooth airflow out of the upper vent.

NOTE: Check with manufacturer's installation documentation for proper venting specifications.

8-5.3.1.3 Leaker

A "leaker" is a cooling unit that has lost its charge. If the unit is warm to the touch at the boiler and extremely hot at the absorber vessel/leveling chamber, this may indicate a lost charge. In this condition, the ammonia may still be boiling but has no hydrogen for evaporation. Check for any deposits of yellow powder or liquid on the tubing, which will sometimes form around the area of a leak caused by the sodium chromate crystallizing and becoming a marker for an open hole. An ammonia smell at the refrigerator could also indicate a leak.

8-5.3.1.4 Running out of Level

When in operation, make sure the unit is as level as possible. The closer to level the unit is, the more efficiently it will cool. Continuous off-level operation will eventually block the circulation of the refrigerant and damage the cooling unit.

8-5.3.1.5 Cooling Unit Test

No equipment exists to do a quick test of refrigerator cooling. The test needs to be conducted 12 to 24 hours after the refrigerator has been started up.

1. Place approximately one gallon of water inside the refrigerator.
2. Place a thermometer in the container of water.
3. Set the refrigerator setting to the coldest setting.
4. Next, unplug the thermistor. This will bypass the thermostat.
5. Allow the unit to operate for at least 12 hours.
6. Then check the temperature on the thermometer. It should be at 43°F (6°C) or lower, depending on test conditions.
7. If so, the cooling unit is good.
8. If the temperature of the water is above 43°, replace the cooling unit.

This test should be performed using water to simulate a food load on the refrigerator. As stated by the refrigerator manufacturer, high ambient temperatures and humidity reduce the effectiveness of a cooling unit and should be considered when evaluating a cooling unit's performance.

NOTE: This test must never be performed on a cooling unit that shows any signs of leaking or is subject to any recall. See *"Leaker" on page 8-19.*

8-5.3.2 Possible Energy Source Faults

8-5.3.2.1 12 VDC

Check with Voltmeter/VOM

Check the 12 VDC input at the refrigerator. The refrigerator must have 12 VDC power to operate in any mode. If no 12 VDC is present, diagnose and repair fault(s). Remove the wire connections from the 12 VDC terminal block. Remove cover from circuit board. Check condition of fuse on the circuit board.

NOTE: If a fuse is open, do not replace it until the cause has been determined. An open fuse indicates a short or faulty component. It is possible to have a faulty fuse that has not blown but is open. Faulty fuse holders can be a cause.

Reconnect the 12 VDC input wires. Check for 12 VDC at the 3 A fuse on the circuit board. If 12 VDC is not present, replace the circuit board.

NOTE: Clean direct current (DC) is mandatory for high-tech circuits to operate as designed. An RMS meter may be required. Refer to specific manufacturer's recommendations.

8-5.3.2.2 120 VAC

Check with Voltmeter/VOM.

If the refrigerator is not functioning on 120 VAC, check the 120 VAC input to the refrigerator at the AC terminals where the power cord connects to the refrigerator. The required voltage is 120 VAC ± 10 percent (108 to 132V). If no 120 VAC is present, diagnose and repair the fault.

Disconnect the 120 VAC cord from the receptacle, and remove the circuit board cover. Check the condition of the AC fuse.

NOTE: If a fuse is open, do not replace it until the cause has been determined. An open fuse indicates a short or faulty component. It is possible to have a faulty fuse that has not blown but is open. Faulty fuse holders can be a cause.

If no 120 VAC is present at the fuse, verify the condition of the heating element(s) (see *"Heating Elements" on page 8-63*). If the heating elements check okay, replace the circuit board.

8-5.3.2.3 Propane Pressure

Check with the Manometer

Check for proper propane pressure (11 in. WC nominal) at the refrigerator test port using a calibrated manometer.

8-5.3.3 Heat Sources

8-5.3.3.1 Heating Elements

Measure for proper resistance between the leads (refer to manufacturer's specifications for specific model information). It is vital that the correct element be used.

Check for continuity between each lead and the element case. Continuity between either lead and the case indicates a short, and the element must be replaced.

A second test for verifying heater element operation is to use an ammeter or amprobe, as shown in *Figure 8-82*.

Figure 8-82 Clamp-On Ammeter/Multimeter

8-5.3.3.2 Propane Flame Faults

A. Visually ensure that a proper flame is present. Check for crisp blue flame, and listen for slight roar. There must be no yellow tipping present. Orange streaks in the flame indicate dust and are not considered to be a problem.

B. Check the propane system operating pressure to the refrigerator at the pressure test port with a calibrated manometer.

8-5.3.3.3 Flue Tube and Spiral Baffle

If the refrigerator cools on electric but not on propane, check the flue tube and spiral baffle.

A. Ensure that the flue tube is not blocked.

B. Ensure proper baffle length and position above the burner.

C. Ensure that the baffle and flue tube are clean.

8-5.4 Possible System Faults

8-5.4.1 Thermostats

A. Propane thermostat stuck on bypass:

1. Check flame condition and verify propane pressure.

B. Electric thermostat stuck open:

1. Verify voltage to refrigerator and through the thermostat. Verify voltage to heating element.
2. An optional test would be to use an ammeter or amprobe to verify amperage draw at the heating element.

8-5.4.2 Selector Switches

Check for continuity through the switch with a VOM. Consult the refrigerator manufacturer's instructions on switch operation.

8-5.4.3 Fuses

Remove the fuse(s) and check for continuity.

8-5.4.4 Blocked Flue Tube

Periodically inspect and clean the flue tube.

A. Remove the burner assembly and orifice.

B. Remove and clean the spiral baffle.

C. Cover the open end of the gas supply line.

D. Cover the open end of the supply valve.

E. Clean flue tube with the correct diameter brush.

F. Reassemble.

G. Test for propane leaks.

8-5.4.5 Defective Circuit Boards

Use the manufacturer's recommended test procedures to verify the operational sequence of the circuit board.

8-5.4.6 Defective Eyebrow Controls

Use the manufacturer's recommended test procedures to verify the operational sequence of the eyebrow board.

8-5.4.7 Cooling Unit

A. Check heat pattern of the cooling unit per manufacturer's specifications after running for a minimum of 12 to 24 hours.

B. Run with the 120 VAC heating element, bypassing the controls. Consult the manufacturer's recommendations before using this test.

C. Check cooling unit surfaces for dust and debris restricting heat transfer and airflow.

8-5.4.8 Venting

A. Check venting for obstructions.

B. Verify the size and location of vents per manufacturer's specifications.

C. Verify the side, rear, top, and baffle clearances per manufacturer's specifications.

D. Verify, using customer input, the operating temperatures/conditions when the failure occurred.

8-5.4.9 Thermostats

8-5.4.9.1 Propane Refrigerator

A. Not responding to the need for cooling.

If the thermostat loses its refrigerant charge in the capillary tube, it will become inoperative.

- Turn propane off at the rear of the refrigerator. Connect a manometer to the pressure test port.
- Turn propane on at the rear of the refrigerator. Light the refrigerator burner.
- Turn thermostat to coldest setting and observe pressure. Pressure should be nominal 11 in. WC.
- If pressure is at low flame pressure as per manufacturer's specifications (3.5 to 5 in. WC), then the thermostat is defective and must be replaced.

B. Capillary tube or thermistor not placed or secured properly.

- Ensure that the capillary tube is properly attached to the evaporator. Verify the location of thermistors or capillary tubes per manufacturer's specifications. Verify that thermistors and capillary tubes are undamaged.

C. Stuck on bypass.

The bypass screw reduces the pressure and volume of propane to the burner.

- To check, shut off propane supply at the back of the refrigerator.
- Connect manometer to the pressure test port.
- Turn on the propane and light the burner.
- Verify that the refrigerator is set to cooling mode.
- Pressure reading should be 11 in. WC; if substantially less, continue.
- Turn refrigerator to OFF position and remove the bypass screw from the top of the thermostat.
- Use a bypass screw that does not have the small O-ring at the bottom. Reinstall this bypass screw into the thermostat.

- Turn on the refrigerator and light the burner.
- If the manometer now reads 11 in. WC, the thermostat is defective and must be replaced.

8-5.4.9.2 Electric Thermostat on Manual Refrigerator

Ensure that the capillary tube is undamaged and properly attached to the cooling fins per manufacturer's specifications.

8-5.4.10 Propane Flame

A. Dirt or spider webs in the orifice. Remove, clean with alcohol and air dry.

B. Dirt or spider webs in burner. Remove, clean with solvent or soft wire brush.

C. Dirty filter (if so equipped). Replace filter or thermostat if low propane pressure at the pressure test port indicates a dirty or obstructed filter.

D. Dirty flue tube or flue baffle out of position or incorrect position above the burner.

Check that the flue tube, which houses the spiral baffle, is clean and free from obstruction.

Check that the flue baffle is located as per manufacturer's specifications.

Check that the flue baffle is in good condition and clean.

E. Low propane system operating pressure.

The correct propane system operating pressure is 11 in. WC nominal.

8-5.4.11 Heating Elements

A. Check resistance.

The heating element should be checked for proper resistance per manufacturer specifications.

B. Check amp draw.

The heating element should be checked for proper amperage per manufacturer's specifications.

C. Check for fit in pocket/well.

A loose heating element in the pocket/well will not provide proper heat transfer.

D. Ensure wattage rating as per manufacturer's specifications.

8-5.4.12 Door Gaskets or Holes in Cabinet

A. Door gasket inspection.

Carefully check door gaskets for proper seal. A damaged or worn gasket can allow enough air inside the refrigerator to overcome most of the cooling being produced. A simple test is to close the door on a dollar bill and check for even resistance around the entire seal. See the individual manufacturer's procedure. If no resistance is felt, the gasket is not sealing correctly.

B. The door out of alignment could cause distortion of the door gasket and a resulting air leak. To adjust the door, on some models of refrigerators, the refrigerator will have to be partially removed to gain access to adjustment points. Adjust the door per manufacturer's specifications.

C. Holes in cabinet allowing air in. Verify that all openings for wires, hoses, and so on are sealed properly. Seal any holes with silicone, putty, or equivalent.

D. Check that the drain tube is not letting air in. See the individual manufacturer's specifications.

8-5.4.13 Out-of-Level Operation

A. Level the refrigerator and conduct a run test for a minimum of 12 hours. If refrigerator cools, continue to B.

B. Question the customer about leveling habits while the refrigerator is operating.

1. At campgrounds, how long before the RV is leveled?
2. How long is the RV left off level at any given time?
3. When stopping at restaurants or sightseeing, does the coach remain level?

C. Verify that when the coach is level, the refrigerator remains comfortably level.

8-5.4.14 Thermistor

A. Check for proper resistance.

- Disconnect the thermistor from the circuit board.
- Disconnect the thermistor sensor from the cooling fins.
- Connect the ohmmeter leads to both leads of the thermistor.
- Place the thermistor sensor in a glass of ice water, allow it to cool for 10 minutes, and take a resistance reading.
- Verify that both resistance readings are within manufacturer's specifications.

B. Check for proper position on the cooling fins per manufacturer specifications.

8-5.4.15 Customer Loading

An overloaded refrigerator and/or blocked shelves can affect refrigeration. Proper refrigeration requires free air circulation within the food storage compartment. Restricted air circulation within this compartment will cause higher compartment temperatures. It is essential that the shelves not be covered with paper or large storage containers, because this inhibits free air circulation.

8-5.4.16 Interior Light On

A. Check the door switch.

The door switch is a normally closed (NC) switch. When the switch arm is depressed, the interior light should be off.

A. When the refrigerator door is open, the switch is closed (interior light should be on).

- With the refrigerator door open, verify that the light is on.
- Depress the door light switch and verify that the light goes out.

B. Check that the switch assembly is properly aligned.

- Close the door and verify switch alignment with the door.
- If alignment is needed, adjust the door hinge/bracket.

C. Verify that light is shutting off when door is closed.

- Disconnect one of the door light wires at the rear of the refrigerator or circuit board.
- Connect an ammeter in series with the disconnected wire and verify that there is no amp draw with door closed. If there is still an amp draw, then the light is not shutting off. Realign or replace the door switch.
- On some models, there may not be a light switch. On models with a low ambient temperature (LAT) switch, verify that the switch is in the off position.

NOTE: On some models that incorporate a reed switch, there will be no visible light switch.

8-5.5 Failure to Light on Propane

8-5.5.1 Dirt in Burner, Orifice

A. Visually inspect the burner and orifice. Determine if cleaning and service is necessary.

- Disassemble the burner and orifice.
- Clean the burner orifice with alcohol, and air dry.
- Clean the burner with alcohol and/or soft wire brush as needed.
- Reassemble.

B. Inspect flue tube for rust, soot, or obstructions. Clean as necessary.

C. Ensure that no dirt gets in the orifice when cleaning the burner.

8-5.5.2 No or Insufficient Propane Pressure

A. Check the propane system operating pressure to the refrigerator with a manometer as outlined in the *RV Propane Systems* textbook. Adjust the propane system operating pressure at the propane system regulator as required, replace the propane system regulator as necessary.

B. Check the propane pressure at the pressure test port as outlined in *Chapter 8-4*. A large difference in pressure between the propane system operating pressure and the pressure at the test port will indicate a plugged filter or other blockage in the refrigerator propane components.

- If equipped with a filter, replace it.

8-5.5.3 Ignition Failure

A. Check for 12 VDC between positive and negative leads at the rear of the refrigerator. If not present, correct the source.

B. Check for broken, chaffed, or scraped wires.

C. Check ignitor for:

- Proper gap
- Cracked or damaged ceramic

- Alignment with burner head

8-5.5.4 Selector Switch Not Functioning Properly

The selector switch should be checked for continuity.

8-5.5.5 Wire Harnesses and Connections

Check for scrapes, cuts, and bad connections. Check for corrosion on the contacts of the ignition module. Always use a contact cleaner and preservative. At a minimum, clean the contacts with a soft eraser.

8-5.5.6 Thermocouples

- Clean and inspect the thermocouple. Remove any carbon buildup.
- Position thermocouple in center of flame.
- Test for correct millivolt output, according to manufacturer's specifications, during operation.

8-5.6 Failure to Operate on 120 VAC or 12 VDC

8-5.6.1 Selector Switch

Check for continuity between all terminals.

8-5.6.2 Power Supplies

Check voltage of sources. 120 VAC should be present at the refrigerator receptacle, and 12 VDC should be present at the refrigerator terminal block. Correct as necessary.

8-5.6.3 Thermostat

Check for continuity.

8-5.6.4 12 VDC Relay

The 12 VDC relay is a component controlling the circuit to the 12 VDC heating element. Containing a set of normally open contacts, the relay will complete the circuit (by closing contacts) to the heating element when proper voltage is established at the relay. When 12 VDC is selected, the main circuit board sends voltage to the relay, and an internal coil is energized that closes the contacts to enable 12 VDC heating to operate.

A. Measure for the correct DC voltage at the input connections to the relay

B. Measure the for coil resistance/continuity. See the *RV Electrical Systems* textbook or manufacturer's service manual.

C. Measure for the correct amp draw at the 12 VDC heating element.

8-5.6.5 Circuit Board

Verify operation of the circuit board using the correct test equipment and procedures.

8-5.6.6 Wire Harnesses and Connections

Check for scrapes, cuts, and bad connections. Check for corrosion on the contacts of the ignition module. Clean the contacts with a soft eraser.

8-5.7 Overcooling

Overcooling can occur when a thermostat is inoperative, a thermistor/capillary tube is improperly placed or defective, or board failure occurs.

8-5.7.1 Thermostats

8-5.7.1.1 Propane

A. Verify operation of the propane thermostat.

- Turn the propane off at the rear of the refrigerator. Connect a manometer to the pressure test port.
- Turn the propane on at the rear of the refrigerator. Light the refrigerator burner.
- Turn the thermostat to the coldest setting and observe the pressure. Pressure should be nominal 11 in. WC.
- Turn the thermostat to the warmest setting and observe the pressure. Pressure should be reduced to 3.5 to 5 in. WC. If the pressure remains higher than 5 in. WC, replace the bypass screw per manufacturer's specifications. If the pressure remains at nominal 11 in. WC, replace the thermostat.

B. Verify the capillary tube or thermistor is properly secured.

8-5.7.1.2 Electric

A. Verify thermostat operation.

- Disconnect wire connections at the thermostat.
- Test for continuity at the thermostat terminals with the thermostat on the coldest setting.
- Test for continuity at the thermostat terminals with the thermostat on the warmest setting
- If the thermostat has continuity on the warmest setting, replace the thermostat.

B. Verify that the capillary tube or thermistor is properly secured.

8-5.7.2 Thermistor

A. Check for proper resistance.

If the thermistor is defective, the refrigerator will overcool or not cool on both propane and electric. To check, remove the cover from the lower circuit board. Disconnect the thermistor harness from the two-pin terminal. Place the thermistor in a glass of ice water, approximately 33 to 35°F (0.5 to 2°C).

Wait 2 to 3 minutes. Using a properly calibrated ohmmeter, place a probe on each terminal point. The normal failure mode for this type of device is to have a very high resistance. Refer to manufacturer's specifications.

8-5.7.3 Board Failure

Always refer to the manufacturer's diagnostic procedures.

Figure 8-83 Norcold Flow Chart

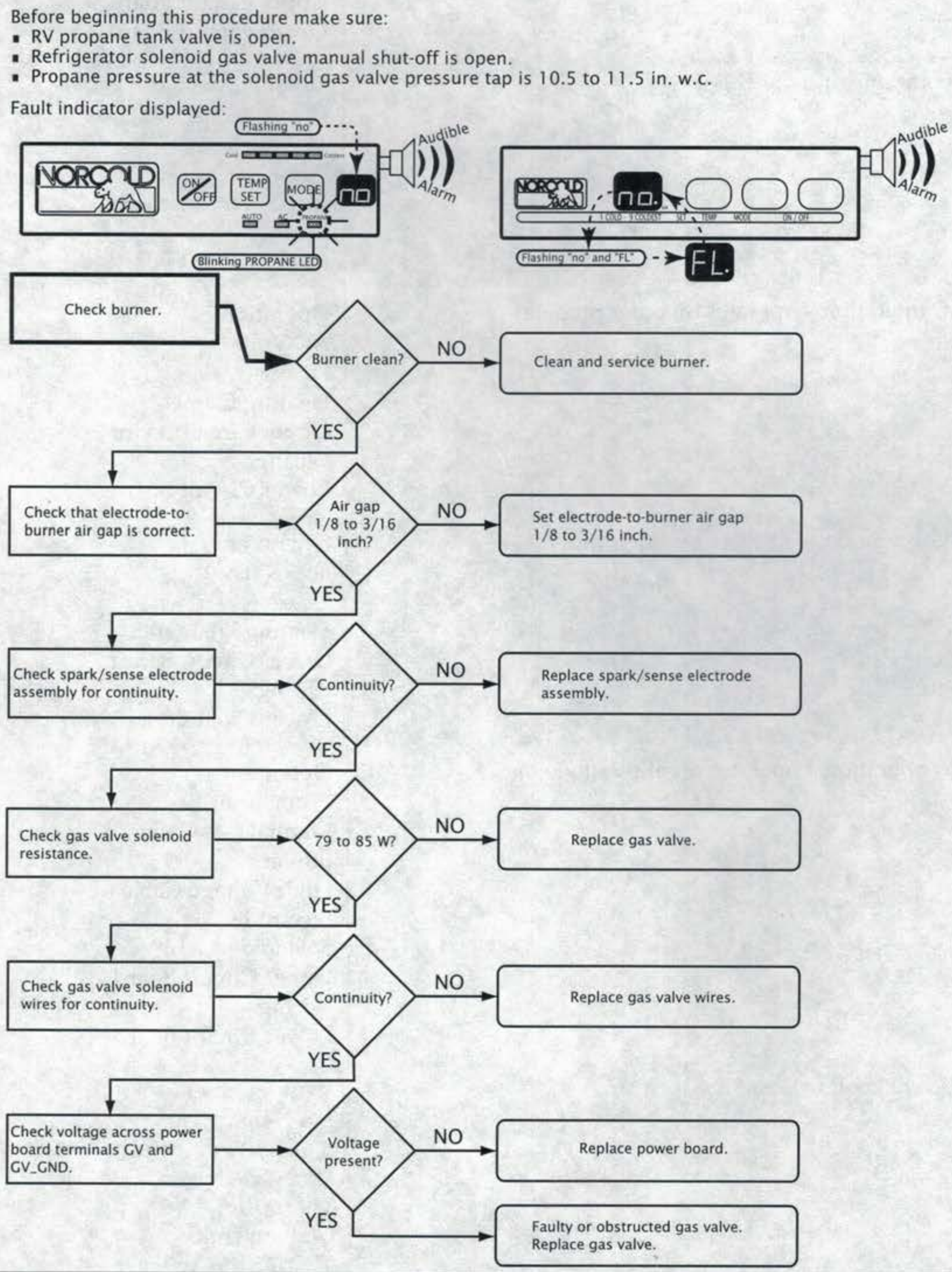

Table 8-1 Dometic Troubleshooting Chart

Symptom	Cause
1. No operation – no panel lights	Operation DC Volts Fuse Wiring Upper Circuit Board Lower Circuit Board
2. No operation – has panel lights	Operation DC Volts Thermistor Fuses Upper Circuit board Wiring Lower Circuit Board
3. No AC operation – operates on other mode(s)	Operation AC Volts Fuse Heating Element Upper Circuit Board Wiring Lower Circuit Board
4. No DC operation – operates on other mode(s)	Operation DC Volts Fuse Heating Element Upper Circuit Board Wiring Lower Circuit Board
5. No gas operation – operates on other mode(s)	Operation Propane Manual Gas Valve Igniter High Voltage Cable Electrode Solenoid Upper Circuit Board Wiring Lower Circuit Board
6. Insufficient cooling on all mode(s)	Ventilation Leveling Ambient Temperature Air Leaks Thermistor Cooling Unit Thermistor Adjuster

Table 8-1 Dometic Troubleshooting Chart

Symptom	Cause
7. Insufficient cooling on AC—cools properly on other mode(s)	AC Volts Heating Element Lower Circuit Board
8. Insufficient cooling on DC—cools properly on other mode(s)	DC Volts Heating Element Wiring Lower Circuit Board
9. Insufficient cooling on gas—cools properly on other mode(s)	Propane Orifice Flue Baffle Flue Tube Flue Cap (if equipped) Burner Lower Circuit Board
10. Freezes	Thermistor Thermistor Adjuster Lower Circuit Board Upper Circuit Board
11. Changes preset mode	Operation DC Volts Wiring Upper Circuit Board Lower Circuit Board
12. Check light on	DC Volts Wiring Propane Manual Gas Valve Solenoid Orifice Burner Lower Circuit Board Thermocouple
13. Interior light on when door is closed	Wiring Door Switch Door Position
14. Rapid formation of frost	Food Storage Interior Liner to Frame High Humidity Air Leaks

Table 8-1 Dometic Troubleshooting Chart

Symptom	Cause
15. Water on frame	Interior Liner to Frame High Humidity Air Leaks Climate Control Heater

8-5 Review

1. 12 VDC is usually the most common operation mode of the refrigerator.

   True False

2. The reason for the propane delay mode is to avoid a propane flame during refueling.

   True False

3. The automatic energy source selection sequence for the AES system refrigerator is:

   A. 120 VAC, 12 VDC, propane

   B. 120 VAC, propane, 12 VDC

   C. 12 VDC, propane, 120 VAC

   D. Propane, 120 VAC, 12 VDC

4. The Norcold system refrigerator allows the customer to select the desired energy source selection sequence.

   True False

5. Match the following.

_____	Blockage	A. Situation in which the boiler is warm to the touch and the absorber is very hot
_____	Leaker	B. Situation in which the boiler is very hot to the touch and the absorber has little warmth

6. On refrigerators equipped with an interior light, the light switch is open when the door is closed, and the switch is closed when the door is open.

   True False

7. If the thermistor is defective, the refrigerator will overcool or not cool on both propane and electric operation.

   True False

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Chapter

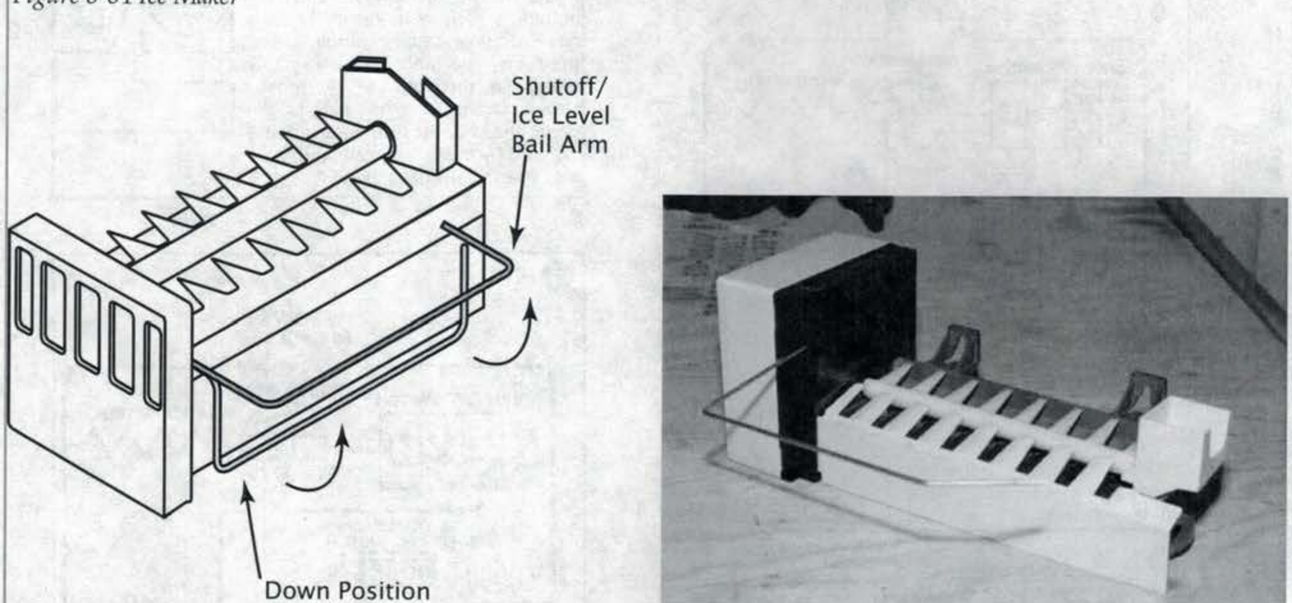
8-6 Ice Makers

- Explain operation and components of a Dometic ice maker.
- Explain the operation and components of a Norcold Ice maker.
- Troubleshoot Ice Makers.

8-6.1 Dometic Ice Makers

The refrigerator has to be connected to 120 VAC and must be allowed to precool properly before the ice maker can operate. The water valve supplying the refrigerator must be turned on, and the ice shutoff/level bail arm must be in the fully down position. When the ice maker thermostat senses the preset temperature for ejection of the ice cubes, the fingers will start to rotate, dumping any ice cubes and filling the mold with water. When the storage container is full of ice, the ice level bail arm cannot return to the down position. This will stop further production of ice until the container is emptied and the bail arm is returned to the down position.

Figure 8-84 Ice Maker



NOTE: If the ice maker was cleaned and drained, no ice cubes will be dumped into the storage container during the first cycle. The first few cycles may have small cubes due to air trapped in the water lines. The first container of ice cubes should be dumped if the water system has been winterized or not used for several weeks.

8-6.1.1 Sequence of Operations

While the operation of the ice maker is fairly simple, an understanding of its cycle is necessary for the service technician to diagnose specific problems. The following electrical schematics will show a typical cycle and the positions of various components during the cycle. These are the mold and its contents, the ejector, the shutoff arm, and the storage bin.

Figure 8-85 Electrical Schematics 1–5

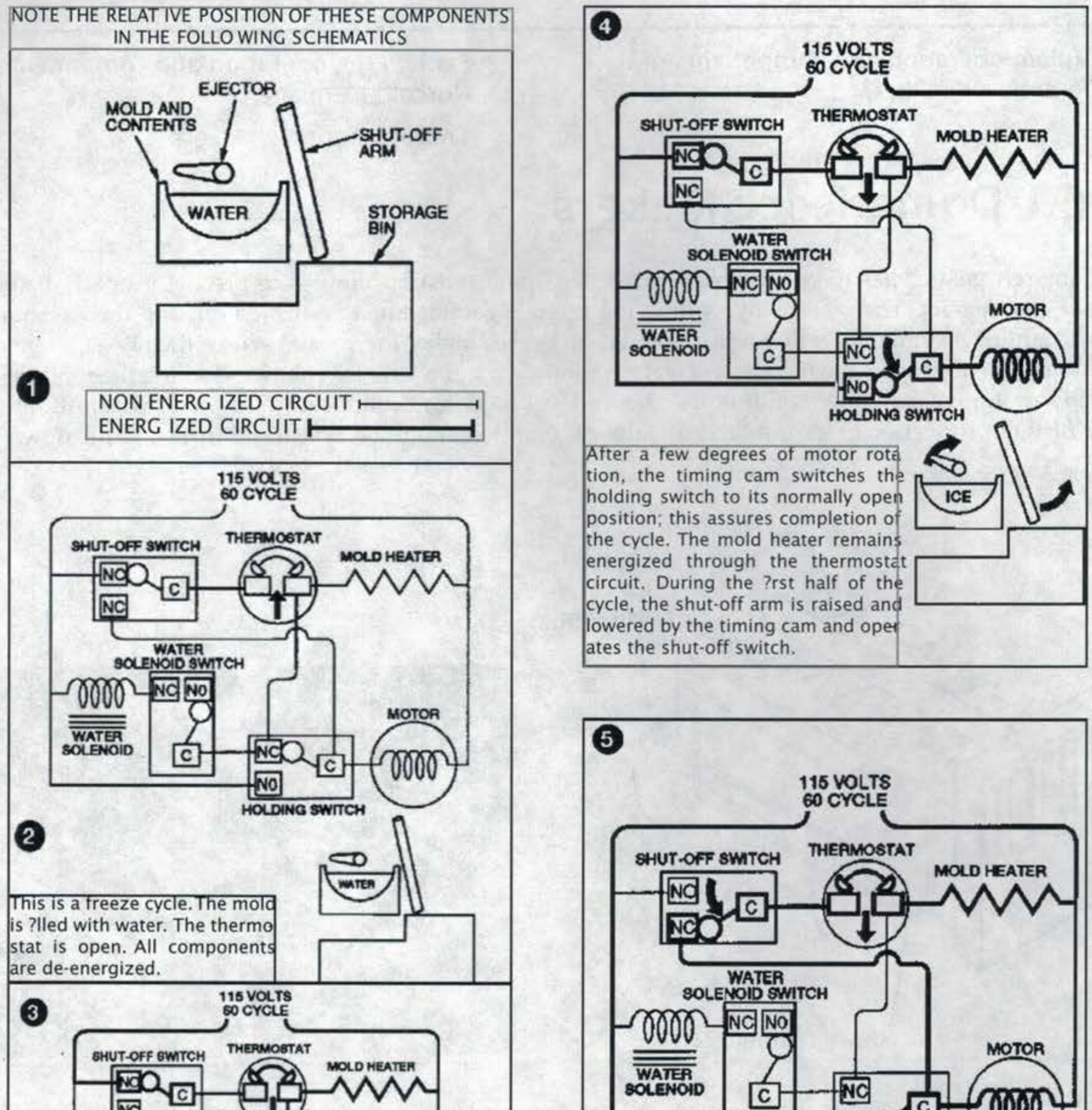
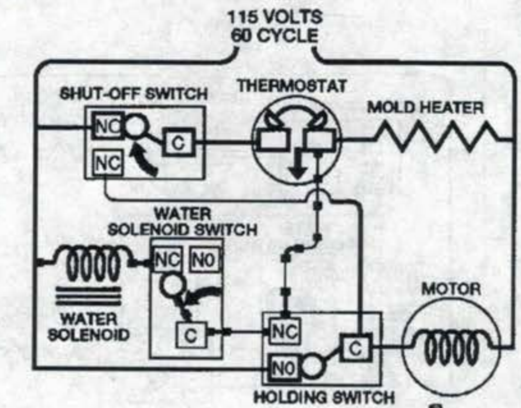
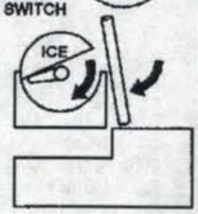


Figure 8-86 Electrical Schematics 6–9

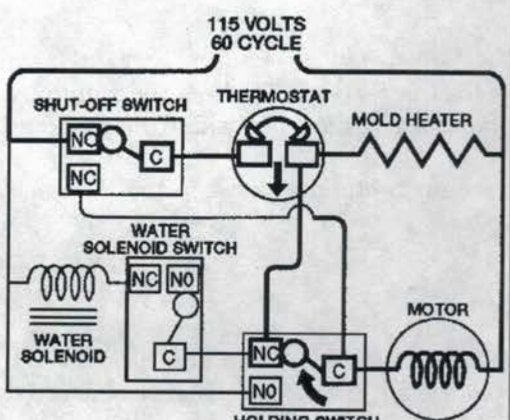
6

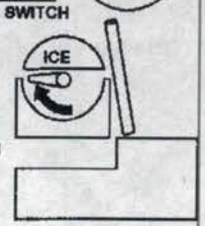




Near the completion of the ?rst revolution, the timing cam closes the water valve switch. However since the thermostat is still closed the mold heater circuit is energized. Current will not pass through the water valve solenoid and its switch. (Electrical current follows the path of least resistance.)

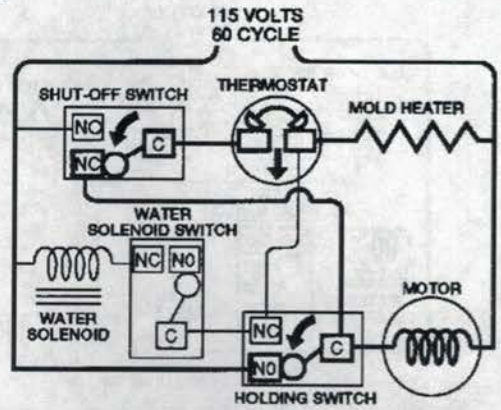
7

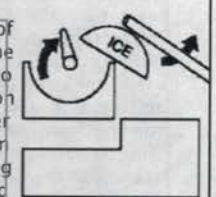




At the end of the ?rst revolution the timing cam opens the holding switch. However, since the thermostat is still closed a second revolution begins.

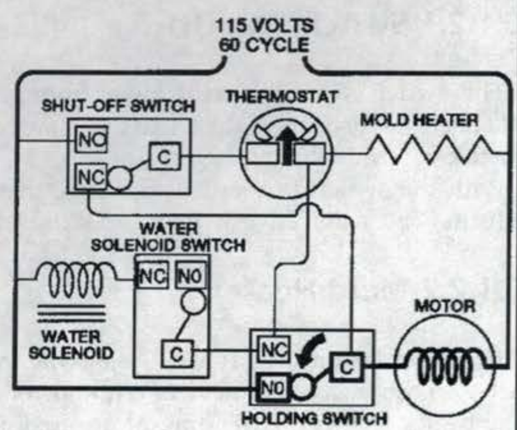
8





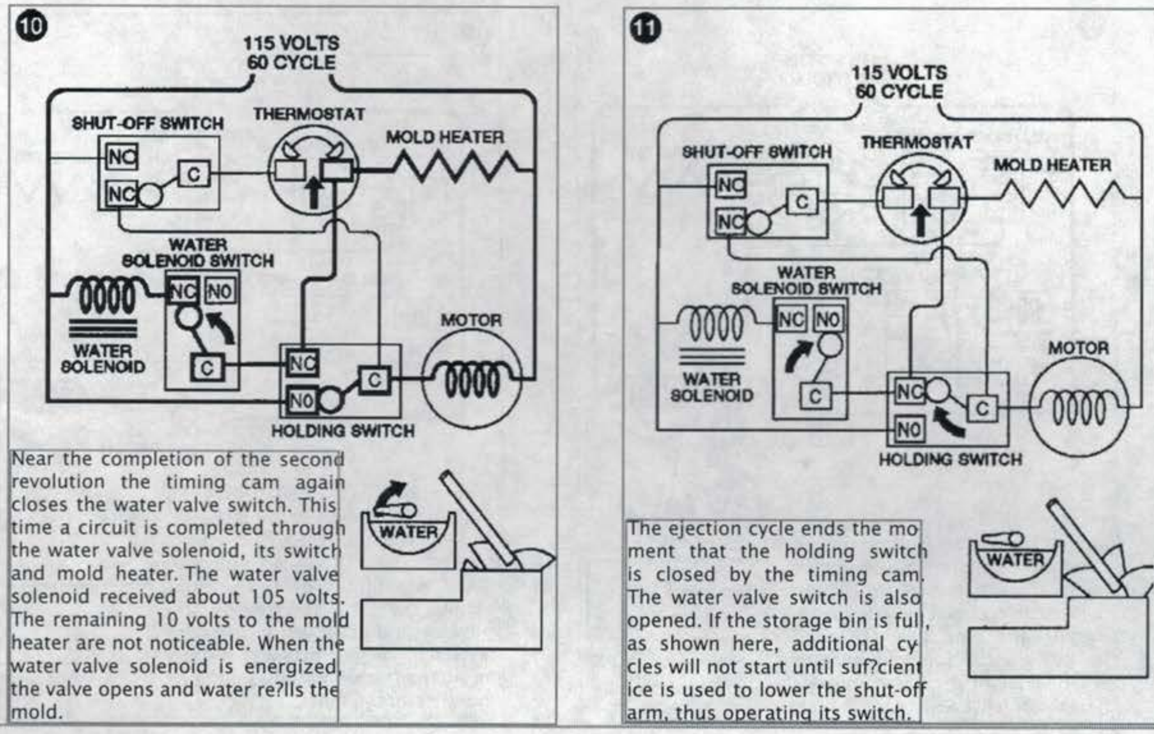
Once again after a few degrees of rotation the timing cam closes the holding switch providing a circuit to the motor that will assure completion of this revolution. The mold heater remains energized. The shut-off arm will raise and lower again operating its switch. The ice that was ejected during the ?rst revolution is dumped into the storage bin.

9



Some time during the second revolution the mold heater resets the thermostat. at this time, the mold heater is de-energized. If the storage bin is full, the shut-off arm will remain in a raised position.

Figure 8-87 Electrical Schematics 10–11



8-6.1.2 Components

8-6.1.2.1 Switch, On/Off

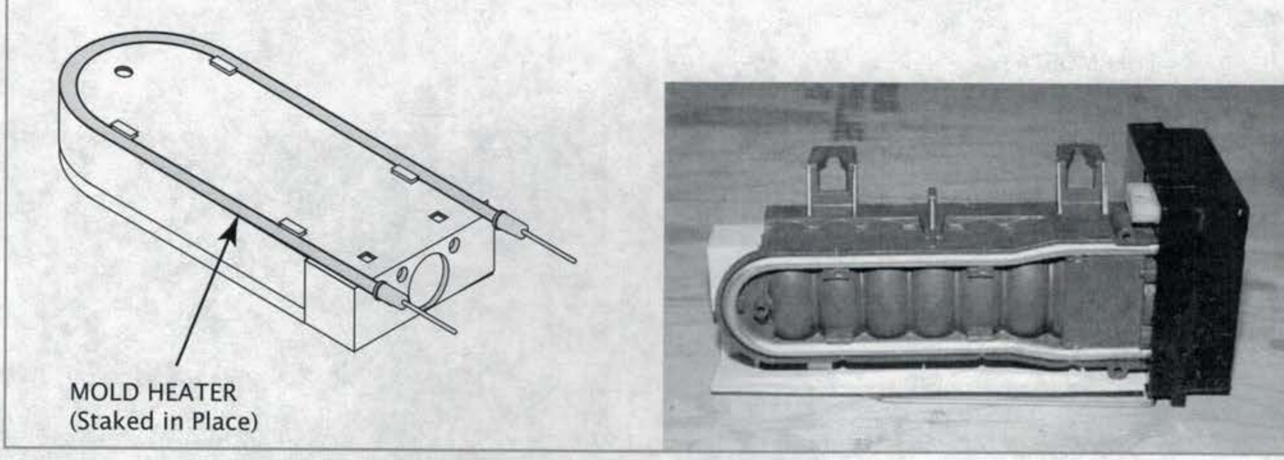
This switch is located on the lower front panel inside the freezer door. To check for continuity, unplug the appliance, and disconnect the wires to the switch. With the switch in the ON position, there should be continuity between terminals 1 and 2.

With the switch in the OFF position, there should be no continuity between the terminals. Any other results indicate a defective switch, and it must be replaced.

8-6.1.2.2 Mold Heater

The mold heater uses 165W to thaw the ice free from the mold. It is wired in series with the thermostat, which also acts as a safety device. With power to the appliance off, check for resistance between the two leads to the heater element. A reading of approximately 80-3/4 ± 10 percent should be obtained. If the heater is found to be defective, the manufacturer recommends replacement of the entire ice-making unit for proper operation.

Figure 8-88 Mold Heater

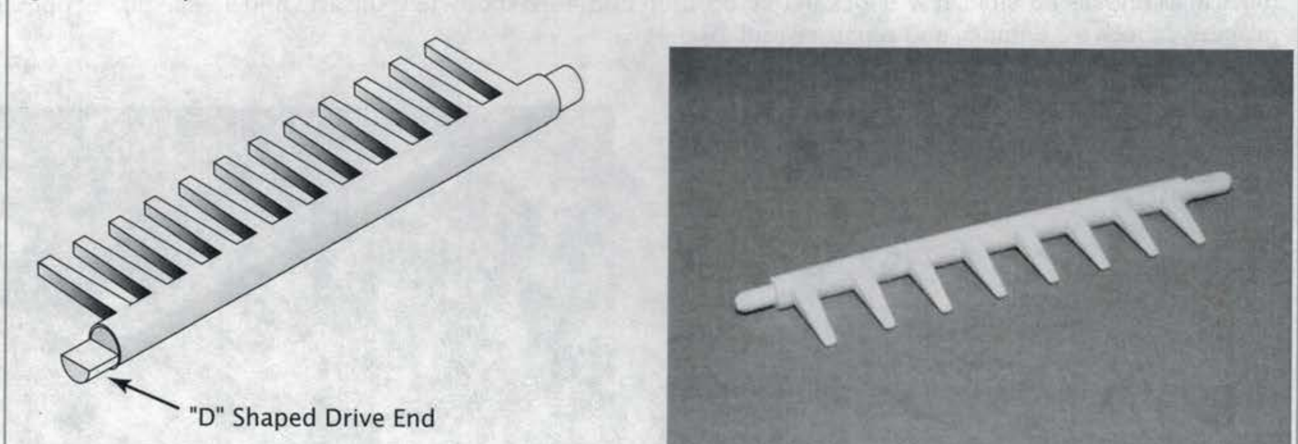


8-6.1.2.3 Ice Ejector

The ice ejector blades sweep the ice from the mold cavities during the ejection cycle.

The drive end of the ejector is D-shaped for positive coupling. The bearings at both ends are lubricated with silicone grease. If the ejector blades are frozen into the ice, defrost the ice maker and manually cycle the ice-making unit, making sure the ejector stops at the right location.

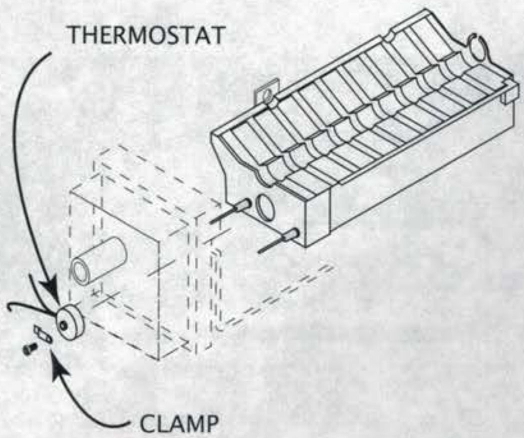
Figure 8-89 Ice Ejector

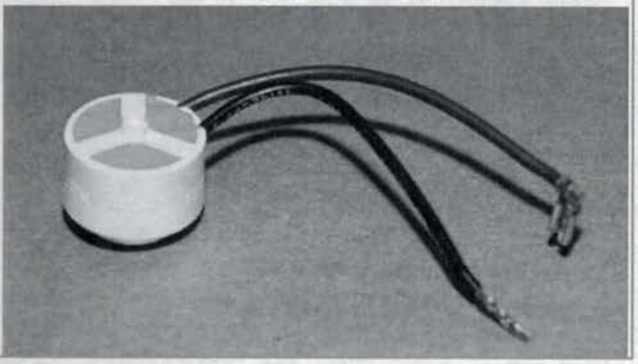


8-6.1.2.4 Mold Thermostat

This is a single-pole, single-throw, bimetal switch. It starts an ejection cycle by closing at 15 ± 5°F (-10 ± 3°C). The reset temperature is 50 ± 5°F (10 ± 3°C). The thermostat is in series with the mold heater and acts as a safety against overheating in case of a mechanical failure. To check the thermostat, disconnect one wire and conduct a continuity check. The temperature surrounding the ice maker must be at 20°F (-7°C) or lower. A continuity reading should be obtained. If the thermostat is defective, replace it. The mold thermostat starts the ice ejection cycle. A cycle can be started by turning the large gear clockwise 1/8th to 1/4th of a turn.

Figure 8-90 Mold Thermostat

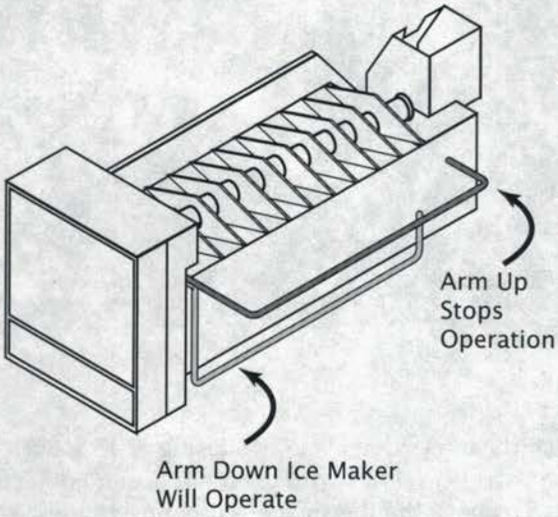


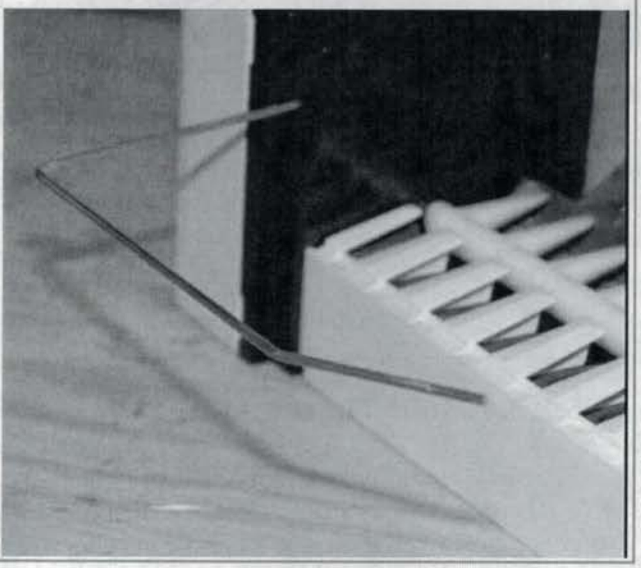


8-6.1.2.5 Shutoff/Ice Level Bail Arm

The shutoff arm is cam driven. It operates a switch to control the quantity of ice produced. During the ejection cycle, the arm is raised and lowered during each of the two revolutions of the timing cam. If the shutoff arm comes to rest on top of the ice in the storage bin during either revolution, the switch will remain open and stop the ice maker at the end of that revolution. The arm has a manual shutoff built into the linkage; by raising the arm as high as possible, it will lock in that position until forced down. If the arm and switch do not operate properly, check for damage and repair or replace parts as necessary.

Figure 8-91 Shutoff/Ice Level Bail Arm





8-6.1.2.6 Mold Switches

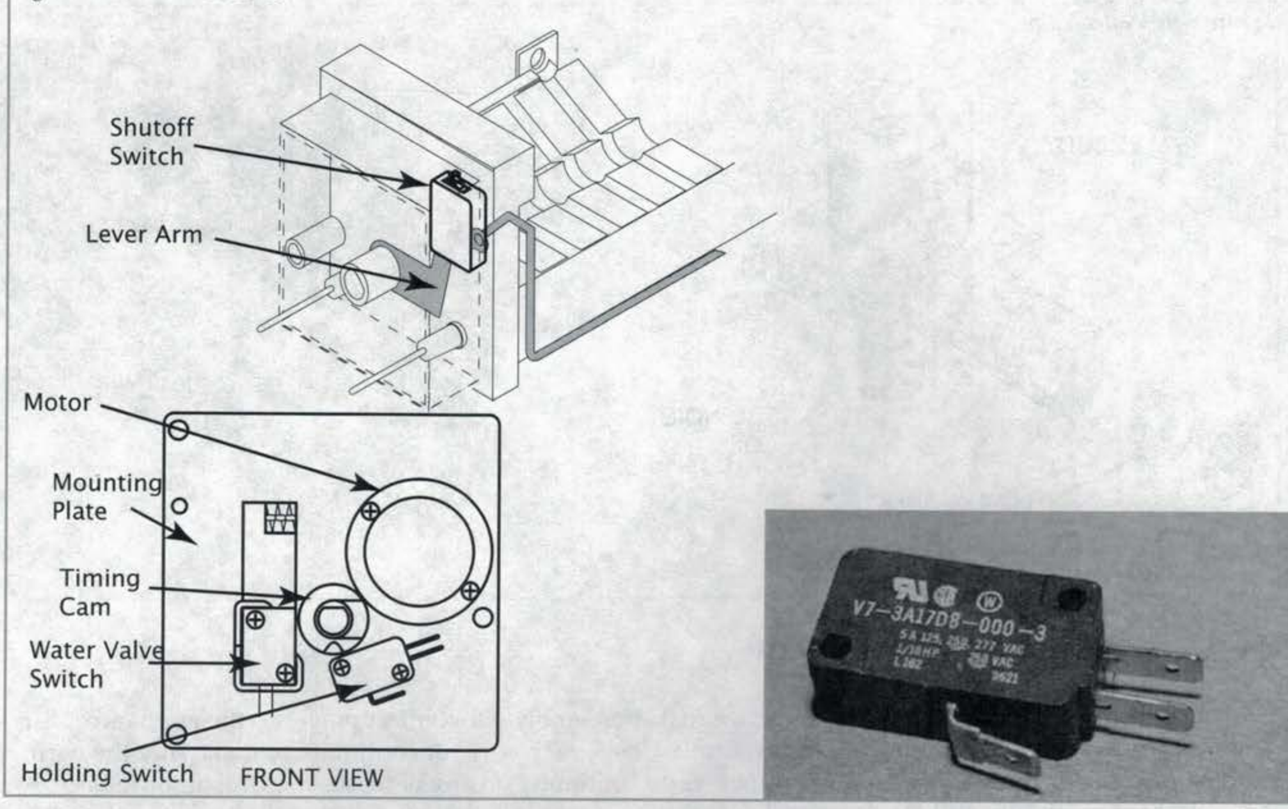
These three switches are single-pole, double-throw (SPDT) style. They are identical and interchangeable.

The holding switch ensures completion of a revolution once a cycle has started.

The water valve switch opens the water valve during the fill stage of the cycle. NOTE: this is the only adjustable component of the ice maker. If a double-throw switch is used, DO NOT use the normally open (NO) terminal.

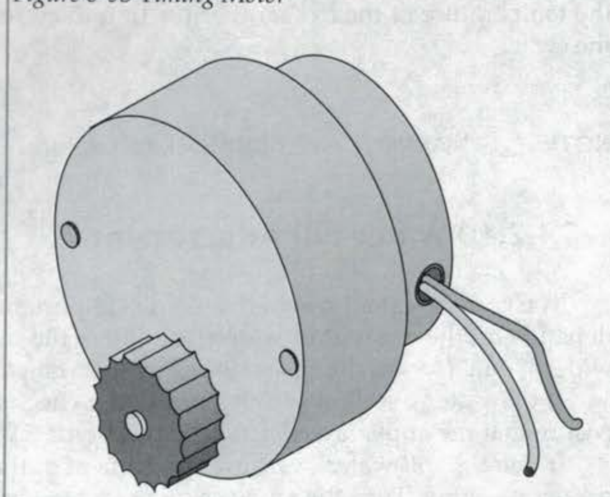
The shutoff switch stops the ice maker's operation when the storage bin is full.

Figure 8-92 Mold Switches



8-6.1.2.7 Timing Motor

Figure 8-93 Timing Motor



This is a low-wattage, stall-type motor, which is geared to the timing cam and ice ejector. It is a 1 rpm motor.

To check the motor, disconnect power to the appliance and test for continuity between the two leads. If continuity DOES NOT exist, replace the motor. If continuity exists and the motor runs, DO NOT replace.

8-6.1.2.8 Water Valve

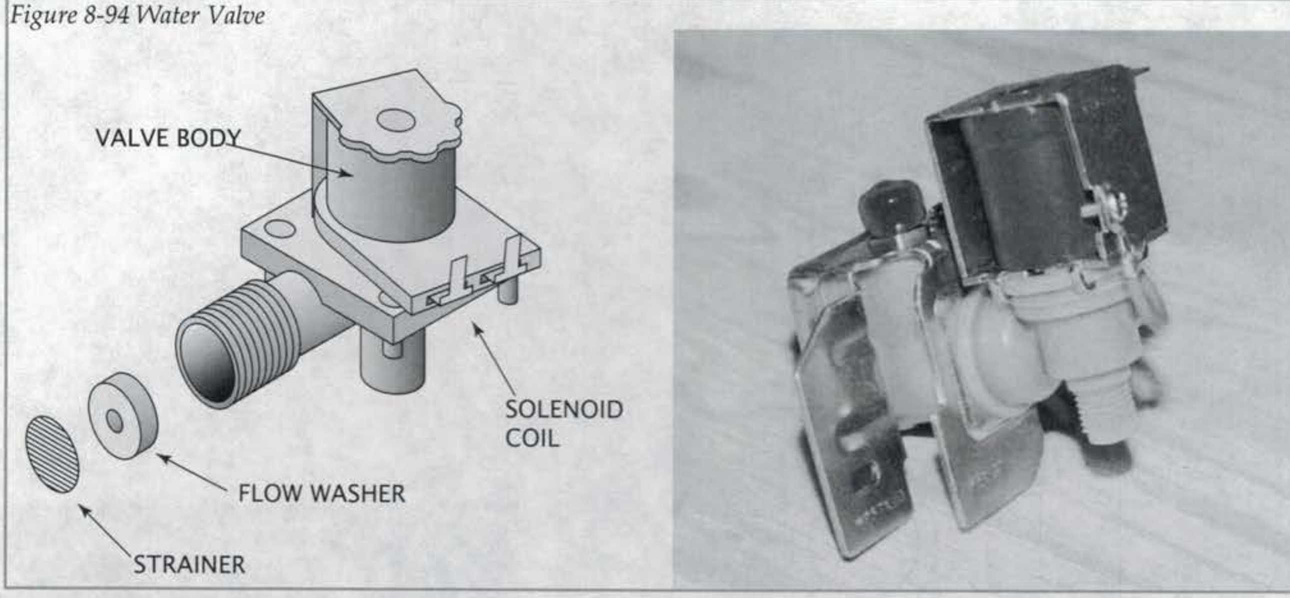
This valve is solenoid operated. When it is open, it releases water from the source to the mold. The amount of water is proportional to the length of time the water valve switch is held closed by its timing cam.

Disconnect power to the appliance, remove the wires to the valve solenoid coil, and check for continuity between the two terminals. An ohmmeter should read between 200 and 500-3/4. If there is continuity, the solenoid is good. It takes 10 to 15 W to energize the solenoid coil.

The mold heater and coil are in series. When the mold heater is activated, this causes the voltage to drop to about 105 VAC at the coil.

The valve has a flow washer inside that acts as a pressure regulator. A strainer is installed to prevent dirt, rust, and so forth from entering the valve. Check for any debris that might obstruct the flow of water or prevent the valve from closing completely when the circuit is not energized. Remove any obstructions. If the valve still fails to operate properly, replace it.

Figure 8-94 Water Valve



8-6.1.2.9 Ice Maker Replacement

It may be necessary to replace the entire ice maker assembly. Disconnect power to the appliance. Disconnect the four-pin connector from the ice maker unit. Check each wire for continuity to make sure the wiring is good before replacing the ice maker unit. If there is no continuity on any of these wires, repair or replace them, then retest for continuity and check ice maker functions. Once it is determined that the ice maker is not functional, remove the three screws holding the unit to the plate. Before replacing the ice maker assembly, check the temperature of the freezer. For the unit to cycle, it should be 12°F or colder as the mold thermostat starts the cycle.

NOTE: WARNING: electrical shock can occur.

8-6.1.2.10 Water Fill Adjustment

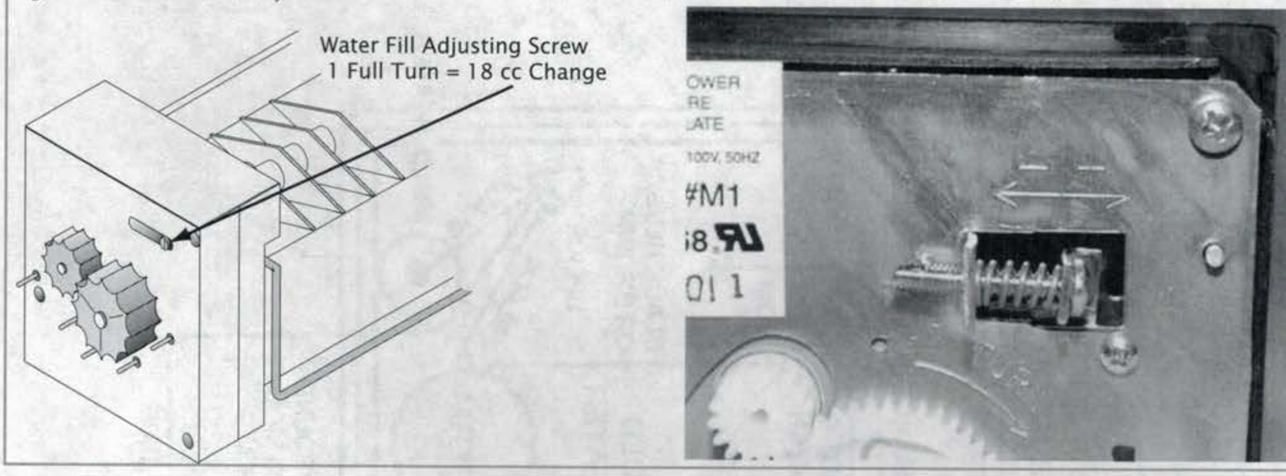
The correct water level in the mold is important for the proper production of ice. The size of the ice cubes depends on the amount of water that enters the mold. The cubes should be approximately 1/2 in. (1.2 cm) wide, 3/4 in. (1.9 cm) high, and 2-1/2 in. (6.35 cm) long.

If the water overflows in the mold, first check to see if the ice maker unit is level in the appliance. Next ensure that the appliance is installed level in the RV.

If there is still water overflow, adjustment of the water fill screw is necessary. Locate the screw on the ice maker assembly. Turn the screw as necessary toward the "+" or "–" side. One full turn of the screw will make an 18 cc (0.6 oz) change in the amount of water. DO NOT turn the screw more than one full turn at a time. If the water level is not set properly, ice production can be affected.

If the water level is too high, it can also cause the ejector blades to become frozen in the ice and stop producing ice cubes. Follow the procedures above to correct the problem.

Figure 8-95 Water Fill Adjustment



8-6.1.3 Water Supply

To operate properly, the water pressure in the water supply line must be between 15 and 125 lb psi. Lower water pressure, water turned off, or obstructions or air in the water line can cause low or no ice production. First check that the water supply is fully turned on. Visually check the line for kinks that might obstruct the flow of water. To remove trapped air, loosen the connection at the water solenoid valve of the appliance. Ensure that pressurized water is reaching this point and bleed off any air in the line. Retighten the connection making sure there are no leaks.

8-6.1.4 Wiring

Refer to the wiring diagram supplied with the unit being worked on, and make sure all wiring connections are correct and tight.

Figure 8-96 Wiring Diagram

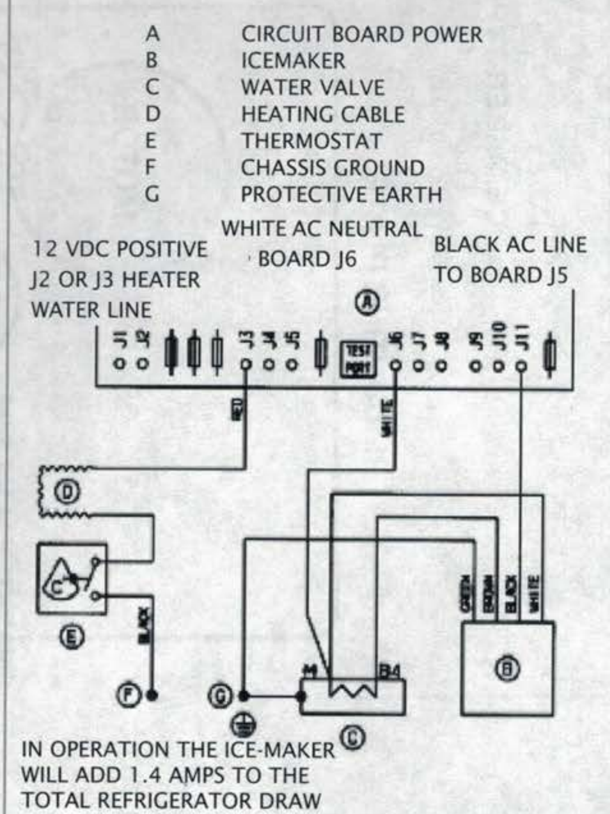
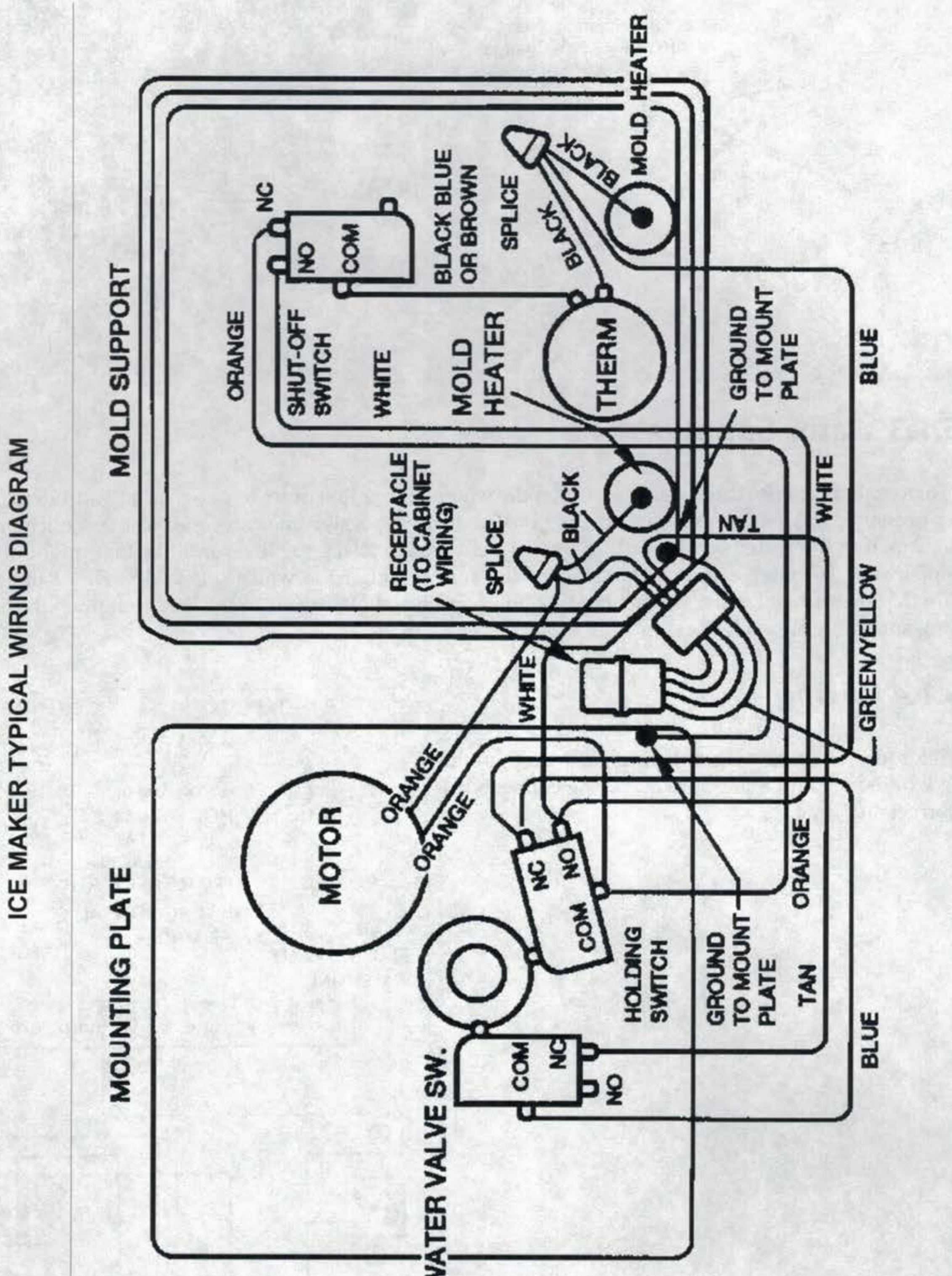


Figure 8-97 Wiring Diagram



8-6.1.5 Water Supply

To remove trapped air, loosen the connection at the solenoid water valve of the appliance. Ensure that pressurized water is reaching this point, and bleed off any air in the line. Retighten the connection, making sure there are no leaks.

8-6.2 Norcold Ice Makers

8-6.2.1 General Description

The ice maker is a factory-installed accessory located on the right side of the freezer compartment. The components that support the ice maker are the wire harness, water fill tube, water fill line, and water valve.

NOTE: An ice maker cannot be added to a refrigerator that was manufactured without an ice maker.

The ice maker is installed by Norcold as optional equipment. The refrigerator installer is required to connect a cold water supply to the water solenoid valve at the rear of the refrigerator. The ice maker requires 120 VAC to operate (even when the refrigerator is operating on propane) and is fully automatic. When the refrigerator's freezer reaches ice freezing temperatures, the ice maker will signal the water valve to fill up the mold cavity. When the ice bin is full, the shutoff arm will stop the ice-making process until the bin is emptied and the shutoff arm is returned to the down position.

8-6.2.2 Ice Maker Specifications

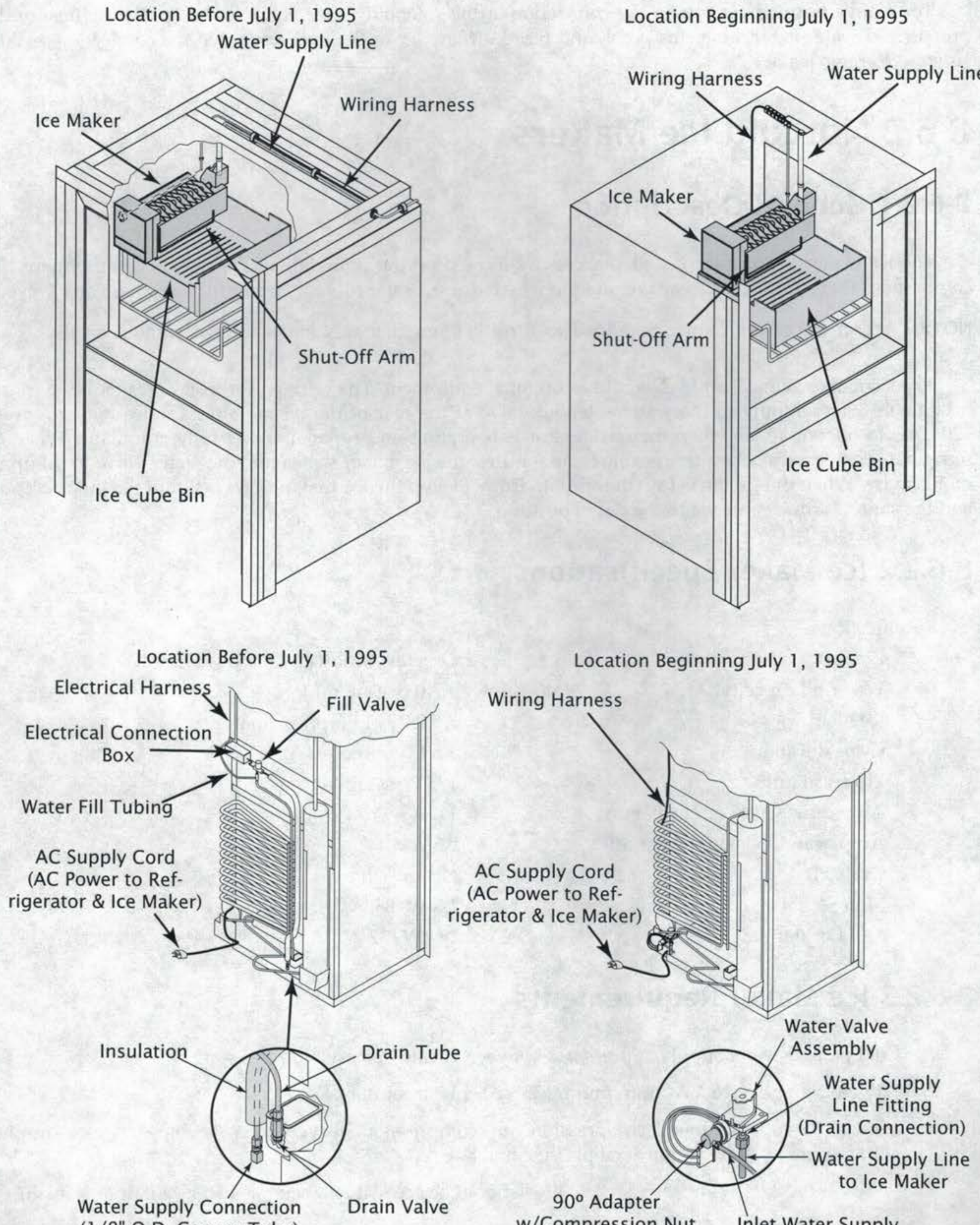
Specifications

Cycle	One revolution (eject and water fill)
Water fill capacity	4.7 fl oz (140 mL)
Ice yield	3.5 lb/24 hr (approximate)
Cycle duration	3.5 to 7 minutes
Electrical rating	185 W @ 115 VAC, 60 Hz
Amp draw Cycle on/heater on	1.6 A
Amp drawCycle on/heater off	0.3 A
Cycle off	No amp draw
Motor	1.5 W/8800 W
Mold heater	185 W/72 W

8-6.2.3 Ice Maker Requirements

1. Cold potable water supply at pressures between 15 and 125 psi.
2. 120 VAC supply (108 VAC minimum, 132 VAC maximum).
3. 1/4 in. OD copper tubing (compression nut, compression sleeve, and 90° tubing adapter supplied with refrigerator) or an approved plastic tubing.
4. 1/4 in. shutoff valve in water supply line (should be accessible when the lower vent door is open).

Figure 8-98 Location of Norcold Ice Maker's Related Components



8-6.2.4 Water Supply Connection

8-6.2.4.1 Connecting the Ice Maker

The ice maker is assembled to the refrigerators at the factory as optional equipment. If the refrigerator does not have a factory-installed ice maker, one cannot be added to the refrigerator at a later time.

The refrigerator installer must connect a cold water supply line to the solenoid valve at the rear of the refrigerator. The following are necessary to connect the icemaker:

- 1/4 in. OD copper tubing for the water supply line.

OR

- 1/4 in. OD plastic tubing for the water supply line.
- 1/4 in. shutoff valve in the water supply line. This should be easily accessible through the lower intake vent.

Connect the water supply line:

- Install a 1/4 in. OD water supply line from the water shutoff valve of the vehicle to the solenoid water valve at the rear of the refrigerator:

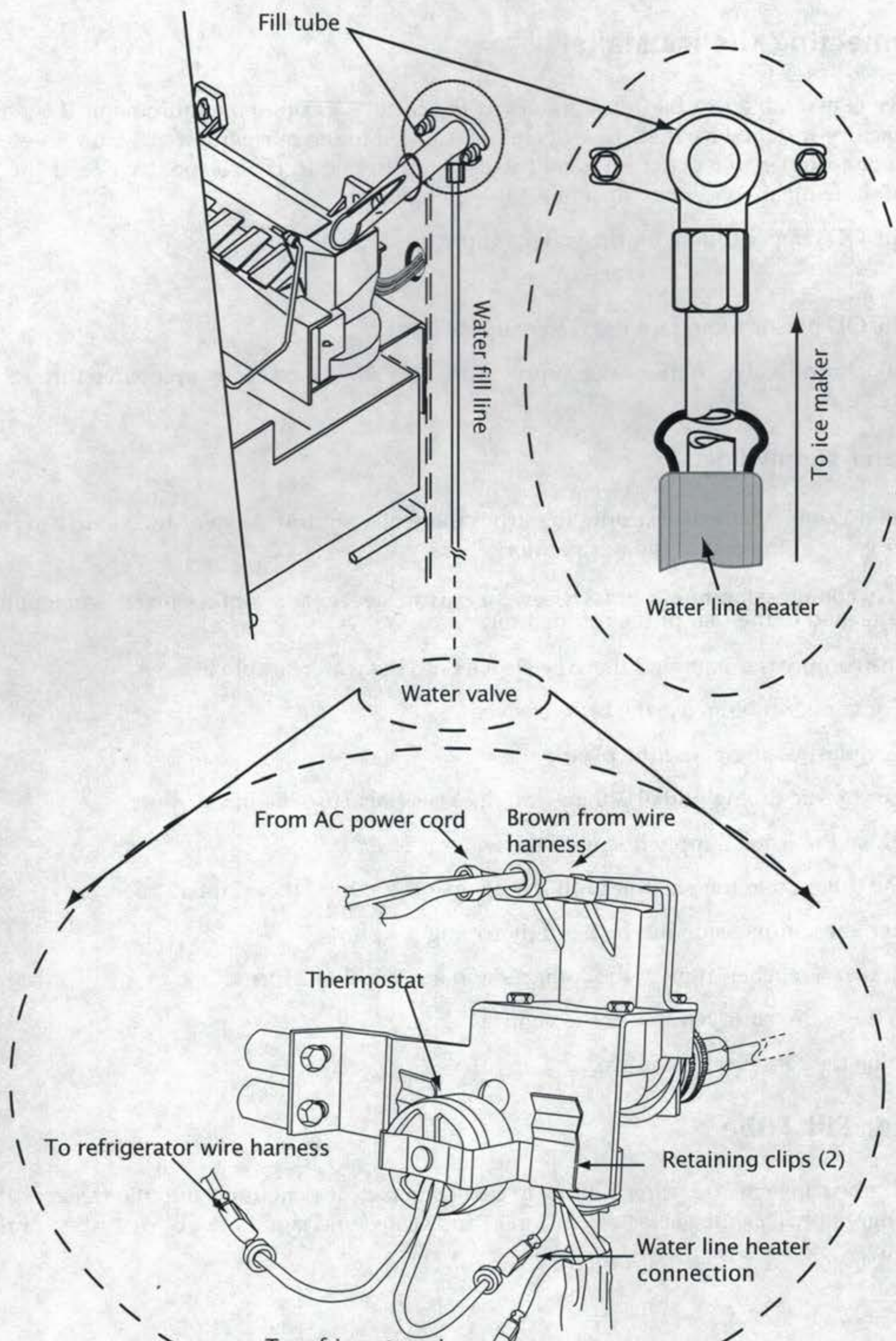
NOTE: A brass compression nut, a brass sleeve, a plastic sleeve, and a brass insert are supplied and attached to the rear of the refrigerator.

- Put the compression nut and then the sleeve onto the water supply line.
  - For copper tubing, use the brass sleeve.
  - For plastic tubing, use the plastic sleeve.
  - For plastic tubing with 0.040 in. wall thickness, also use the brass insert.
  - Flush the water supply line until the water is clear.
- Put the tubing into the adapter until it is against the stop of the adapter.
- Tighten the compression nut by hand (hard finger-tight).
- Using two wrenches, tighten the compression nut 1-1/2 to 2 turns.
- Open the water shutoff valve of the vehicle.
- Examine the connections for leaks.

8-6.2.4.2 Water Fill Tube

The water fill tube connects the water fill line to the ice maker. It penetrates into the freezer cabinet from the rear of the refrigerator. This tube is factory installed and sealed and should not be disturbed or removed; it cannot be replaced.

Figure 8-99 Water Fill Tube, Line, and Heater (Norcold)



8-6.2.4.3 Water Fill Line

The water fill line connects the water fill tube to the water valve at the bottom of the refrigerator. It is constructed of 1/4 in. plastic tubing. It connects to the water valve and water fill tube with 1/4 in. compression-style fittings. The water line is encased in a 12 VDC foil-style strip heater. To replace the water fill line, the refrigerator must be removed from the enclosure.

8-6.2.4.4 12 VDC Water Line Heater

The water line heater encases the entire length of the water fill line. This heater operates on 12 VDC.

Heater operation is automatically controlled by a small thermostat. The thermostat is "clipped" to the water valve bracket. It turns the heater on when the surrounding temperature is 38 ± 4° F (34 to 42° F). It turns the heater off when the temperature rises to 48°F.

8-6.2.5 Operating Instructions

1. Make sure 120 VAC is available to the refrigerator.
2. Turn the water supply on.
3. Move the shutoff arm down to the ON position. Do not allow food packages to interfere with the shutoff arm.

NOTE: If refrigerator is to be opened before the water connection is made or before the water is turned on, ensure that the ice maker's shutoff arm is in the up/OFF position.

4. Allow the freezer to reach ice freezing temperatures. This may take a minimum of 24 hours from initial refrigerator start-up. When the freezer temperature is satisfactory, the ice maker will start.
5. When the bin is filled with ice, the ice maker will stop ice production.
6. The first ice yield may be discolored or have an odd flavor because of the new plumbing connections or because of impurities remaining in the water lines after winterizing.
7. To stop the ice maker, raise the shutoff arm to the up/OFF position.
8. When operation of the refrigerator is to be discontinued for any length of time (e.g., storing the RV for the winter), empty and dry the ice maker.

NOTE: Operating the ice maker when ambient temperatures reach 32˚F (0˚C) or below can cause irreparable damage to the ice maker's water valve and inlet water line.

Winterize in accordance with the procedures below.

1. To drain the ice maker, move the ice maker's shutoff arm to the up/OFF position.
2. Turn off the water at the supply line shutoff valve.
3. Loosen and disconnect the inlet fitting from the water valve. Drain water from the supply line.
4. Loosen and disconnect the outlet fitting (line from the valve to the ice maker) from the water valve. Drain water from the line.
5. Reconnect the inlet and outlet fittings to the water valve.
6. Leave water supply off until the outside temperatures are above freezing (32°F/0°C). Dry the ice maker with a dry cloth.

8-6.2.6 Wire Harness Check

8-6.2.6.1 Wire Harness

The ice maker wire harness (*Figure 8-100*) connects the ice maker to the 120 VAC ice maker power cord. The assembly is bundled together with plastic ties. The wire harness runs through the surface of the cooling unit foam plug. On the upper ice maker end, the harness has a modular plug with a locking tab (*Figure 8-101*). Each wire on the harness has the appropriate connector to connect to the ice maker AC power cord (white AC cord). The four wires making up the wire harness are:

- Black: line voltage (L), black wire with female quick-connect terminal. This conductor is equipped with a thermal fuse. The thermal fuse is held onto the ice mold by a spring clip.
- White: neutral (N), white wire with male quick-connect terminal. It connects to the AC power cord neutral wire.
- Brown: water valve line voltage, brown wire with female quick-connect terminal. It connects to the water valve solenoid, terminal M.
- Green: ground wire, green wire with lug terminal. It connects to the refrigerator cabinet metal plate.

The refrigerator has to be removed from the enclosure to replace the ice maker wire harness. The ice maker connector is set up as follows: black connects to smooth AC wire, white connects to ribbed AC wire, brown connects to water valve, green connects to metal plate.

The ice maker wire harness is not the same as, nor is it connected to, the wire harness that serves the power board and the optical display assembly.

Figure 8-101 Wire Harness Connection to Ice Maker

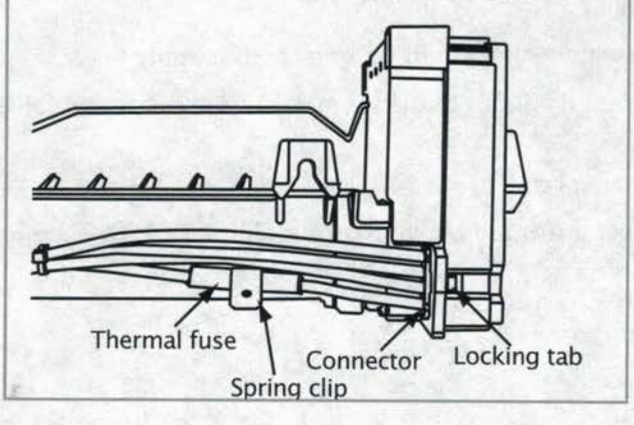
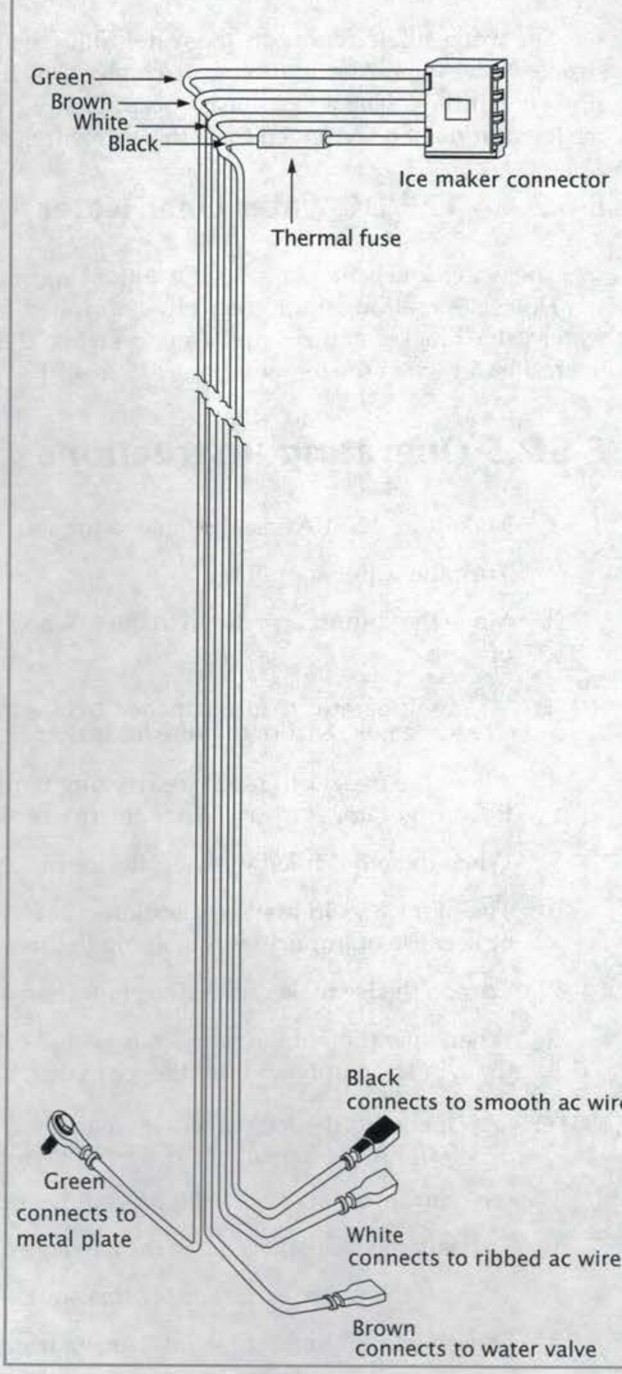


Figure 8-100 Ice Maker Wire Harness (Norcold)

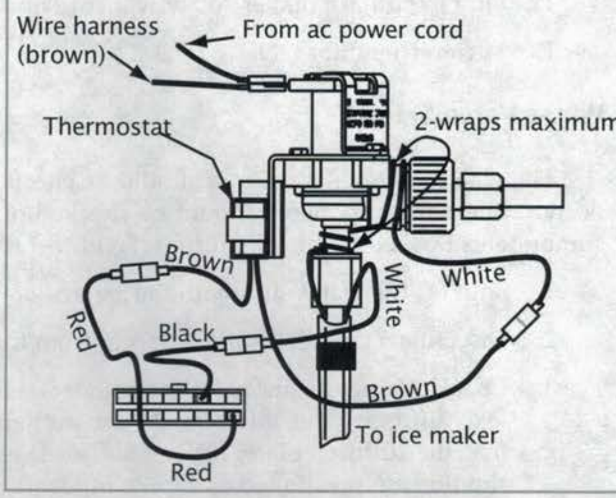


The wire harness is equipped with a thermal fuse. The fuse protects the ice maker mold from overheating. If the fuse is open, the wire harness requires replacement.

8-6.2.6.2 Water Valve

The water valve is solenoid operated. This valve is located on the back of the cabinet on the bottom of the refrigerator The solenoid is supplied 120 VAC through the ice maker wire harness. Spring pressure keeps the valve shut when the solenoid is not energized.

Figure 8-102 Solenoid Water Valve



Water Valve Replacement Procedure

1. Turn the refrigerator OFF.
2. Unplug both the ice maker AC power cord and the refrigerator AC power cord from the RV receptacle.
3. Shut off the water supply to the ice maker.
4. Disconnect the wires from the water valve solenoid terminals.
5. Disconnect the white heater wire from the thermostat wire (white from brown).
6. Disconnect the remaining white heater wire from wire harness lead (white from red).
7. Disconnect the brown thermostat wire from wire harness (brown from red).
8. Disconnect the water supply line from valve's inlet fitting.
9. Disconnect the ice maker water line.
10. Remove the thermostat clips (2) and thermostat. Retain thermostat and clips.
11. Unwrap the heater wire from water valve.
12. Remove the water valve retaining screws, then remove the water valve/bracket assembly. Retain screws and spacers.

To install a replacement solenoid water valve:

1. Install the replacement water valve/bracket assembly on the refrigerator. Use screws and spacers previously removed.
2. Clip the thermostat to water valve bracket. Use clips previously removed.
3. Carefully wrap one white heater wire around the valve as shown in *Figure 8-102*. Do not exceed two wraps at each point.
4. Tape the wire wraps to keep the wire turns in position and to keep wire turns from overlapping. Do not allow wires to overlap.
5. Connect the wrapped white heater wire to a thermostat wire (brown).
6. Connect the remaining white heater wire to the black wire connected to the refrigerator wire harness.
7. Connect the remaining thermostat brown wire to the red wire connected to the refrigerator wire harness.
8. Connect ice maker water line, then tighten fitting firmly. Do not overtighten.

9. Connect the RV water supply to water valve, then tighten fitting firmly. Do not overtighten.
10. Connect the solenoid wires. Brown wire to terminal M and wire from 120 VAC power cord to terminal B4.
11. Open the water supply to ice maker.
12. Plug in both ice maker AC power cord and the refrigerator AC power cord.
13. Turn refrigerator ON.

Water Valve Service

The water valve inlet strainer should be checked annually for scale and sediment deposits. The inlet connection internal components should be checked only when the mold overfills. To access the strainer and the components housed in the inlet fitting (*Figure 8-113*):

1. Shut off the water supply to the ice maker.
2. Disconnect the inlet fitting adapter from the water valve inlet.
3. Check strainer position. If the strainer is seated approximately 1/8 in. in the fitting, the orifice seat, orifice, diffuser plate, and strainer are in their correct position. A creased strainer end usually indicates that the diffuser plate, orifice, and orifice seat are not in their correct positions. These components should be repositioned as shown in *Figure 8-113*. To reposition components correctly:
   A. Press the orifice seat fully against the valve support, then seat the orifice firmly into the orifice seat.
   B. Seat the diffuser plate firmly against the orifice.
   C. Seat the strainer firmly against the orifice plate.
   D. Reconnect the inlet fitting adapter to the water valve.

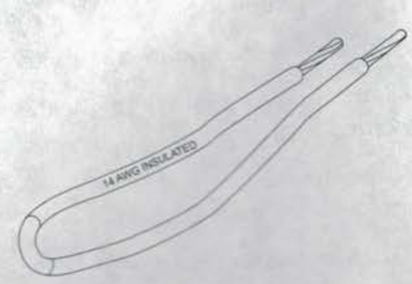
Cycle Testing Ice Maker

Cycle testing the ice maker verifies whether it completes all cycle functions. The cycle test is to be done with the ice maker dry. To cycle the ice maker operation manually:

1. Shut off the water supply to the ice maker water valve.
2. Make sure 120 VAC is available to the ice maker.
3. Remove the ice maker cover.
4. Make sure the shutoff arm is in the down position (on).

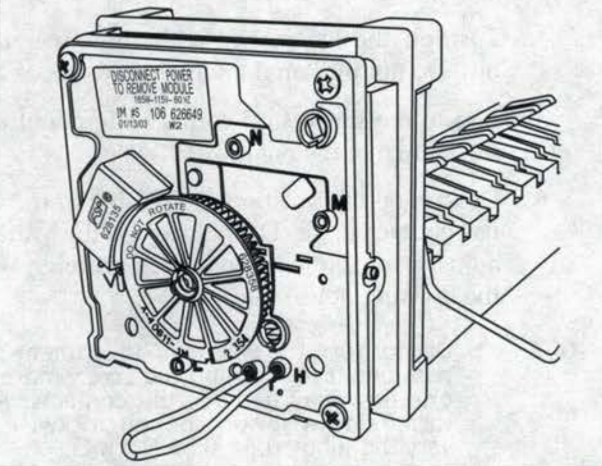
NOTE: Remove the jumper wire immediately after "click" sound or no later than 15 seconds after jumping terminals T and H. Failure to remove jumper wire may damage the ice maker.

Figure 8-103 Jumper Wire



5. Jump terminals T and H. Use a 14 AWG jumper wire with 1/2 in. insulation stripped from ends. Jumper wire is shown in *Figure 8-103*. The jumping of T and H is shown in *Figure 8-104*.
6. The ejector should begin to rotate clockwise starting at the two o'clock stop position.
7. Remove jumper wire from terminals T and H when a "click" sound is heard and no later than 15 seconds after jumping the terminals.
8. Observe ice maker operation as ejector rotates.
9. After the ice cubes break loose from the mold, the ice maker should cycle without stopping. If the ice maker stops or makes loud noises, replace it.

Figure 8-104 Cycle Testing Icemaker



Checking Water Valve Operation

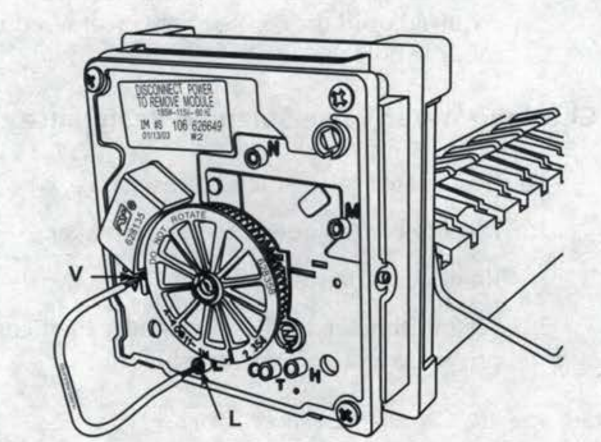
To check water valve operation:

1. Remove the ice maker cover.
2. Jump test point V and L. See *Figure 8-105*.

Use a 14 AWG jumper wire with 1/2 in. insulation stripped from each end (as shown in *Figure 8-103*).

The solenoid should click and buzz when energized. If the solenoid does not click and buzz, replace the water valve (*Figure 8-99*).

Figure 8-105 Checking Water Valve Operation



Water Fill Adjustment

The water fill adjustment screw is set at the factory. Often, the production of thin ice cubes or the ice maker not cycling correctly is related to an unauthorized field adjustment to the water fill adjustment screw. Proceed as follows to adjust the water fill adjustment screw.

1. Remove the two screws holding the ice maker to the mounting plate.
2. Remove the mounting plate from the freezer plate.

3. Remove two screws from the ice maker upper mounting brackets.
4. Position the ice maker with the cover facing out. Do not pull on the wire harness.
5. Locate the screw and contact alignment opening shown in the *Figure 8-107*.
6. Determine the position of the hole in the internal contact plate. Do not adjust the water fill adjustment screw if the hole is centered within the housing hole.

NOTE: Do not turn the water fill adjustment screw past one turn. Turning the screw more than one turn may damage the contacts. A 1/4 turn, clockwise or counterclockwise, will vary the fill by 0.34 fl oz (10 mL).

7. To readjust the water fill level, turn the adjustment screw clockwise or counterclockwise as required until the contact hole is centered in the module hole.

Figure 8-106 Icemaker Screw Locations

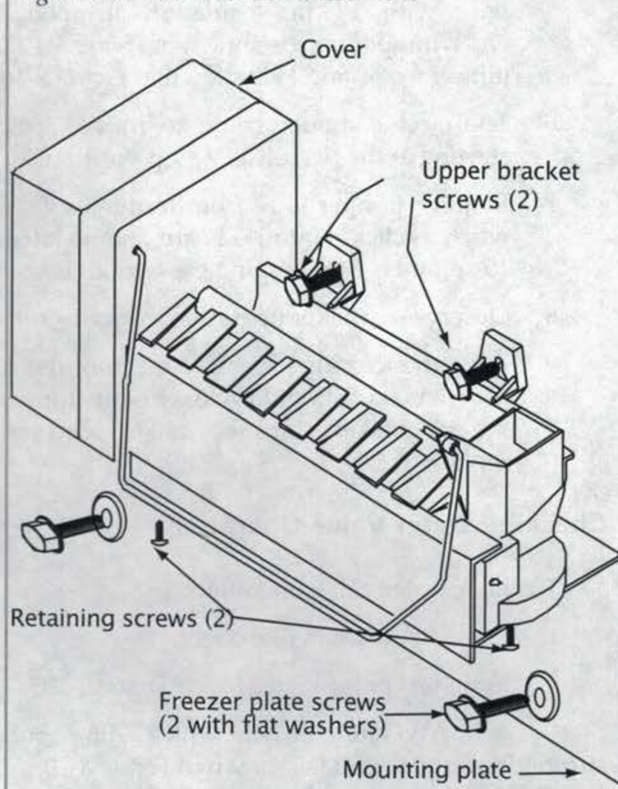
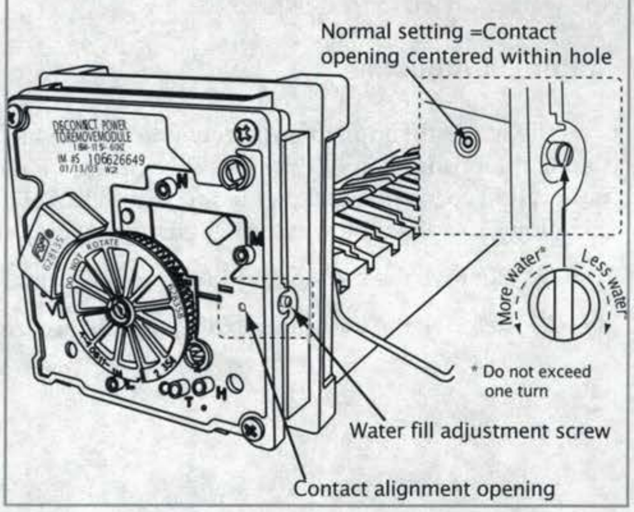


Figure 8-107 Water Fill Adjustment Screw

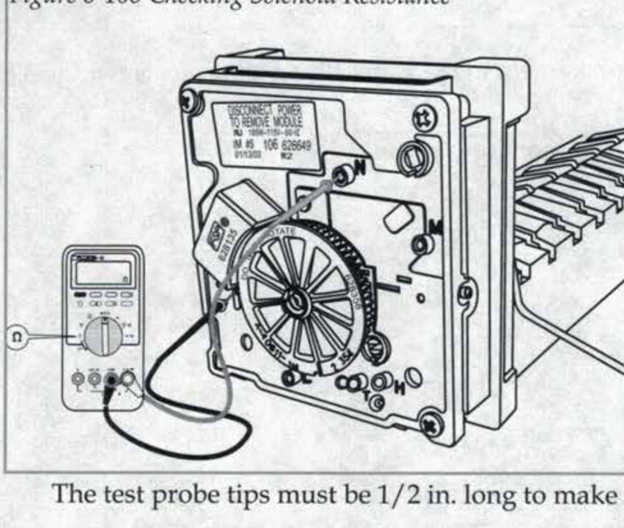


Checking Water Valve Solenoid Resistance

To check water valve solenoid resistance:

1. Disconnect AC power to the ice maker.
2. Remove the ice maker cover.
3. Set multimeter to the ohm scale, then connect probes to test points V and N.

Figure 8-108 Checking Solenoid Resistance



The test probe tips must be 1/2 in. long to make full contact with internal terminals.

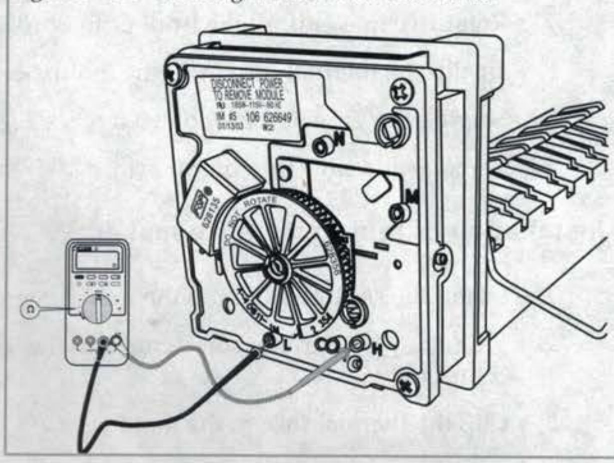
- Reading 295 to 360 Ω – water valve solenoid operating properly.
- Reading OL (open loop) – check for loose wire harness connections at water valve or an open solenoid coil.
- Reading 00.0 Ω – check resistance at solenoid terminals and wire harness continuity.

Checking Mold Heater Resistance

To check the mold heater resistance:

1. Unplug the ice maker AC power cord.
2. Remove the ice maker cover.
3. Set the multimeter to ohm scale, then connect probes to test points L and H. Test probe tips must be 1/2 in. long to make full contact with internal terminals.
   - Reading 71 to 79 Ω—mold heater is operating properly.
   - Reading below 71 Ω or above 79 Ω—replace ice maker.
   - Reading OL—open heater, replace ice maker.

Figure 8-109 Checking Mold Heater Resistance



Checking Voltage to Motor

To check voltage supply to motor:

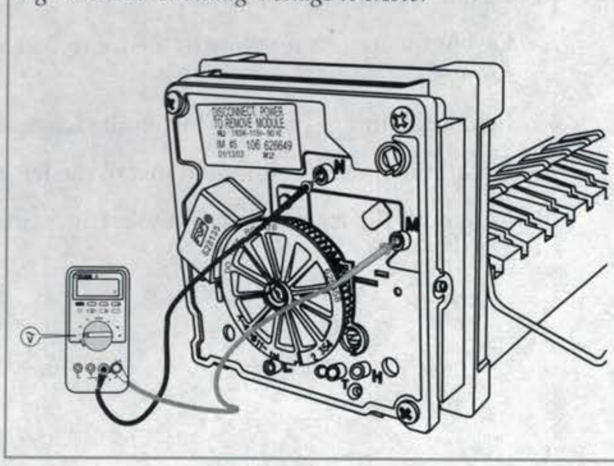
1. Make sure 120 VAC is available to the ice maker.
2. Remove the ice maker cover.
3. Set the multimeter to AC scale, then connect probes to test point N and M.

Test probe tips must be 1/2 in. long to make full contact with internal terminals.

Voltage at the motor should measure 108 to 132 volts.

- Voltage higher than 132 volts—check incoming AC power source and correct overvoltage condition.
- Voltage lower than 108 volts—check incoming AC power source and correct undervoltage condition.
- No voltage present—check wire connections and continuity through thermal fuse.

Figure 8-110 Checking Voltage to Motor



Replacing Ice Maker

Removal of existing ice maker: remove cover freezer plate screws (two with flat washers), upper bracket screws (two), retaining screws (two), and mounting plate.

NOTE: Be sure to save all screws and other components removed from the existing ice maker in this procedure, as these screws and components will be used when installing the replacement ice maker.

1. Turn refrigerator OFF.
2. Unplug both the ice maker AC power cord (white) and the refrigerator AC power cord (black).

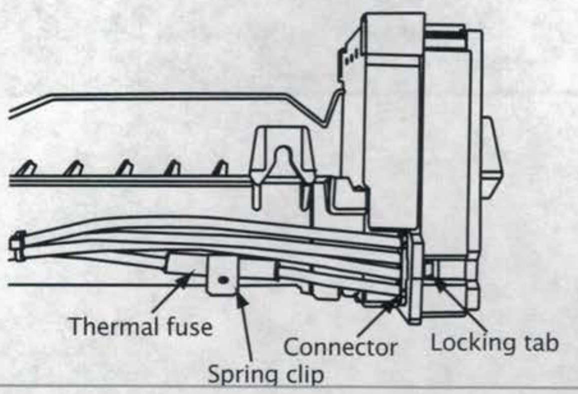
3. Remove the ice bin, then remove the freezer shelf.
4. Unfasten the two retaining screws to detach the ice maker from mounting plate. See *Figure 8-111*. Save the screws.
5. Unfasten the two freezer plate screws to detach mounting plate from the freezer. Save the screws and flat washers.
6. Unfasten the upper bracket screws. Save the screws.
7. Rotate ice maker until the front of the cover faces the door opening, then remove the cover.
8. Unclip the thermal fuse from the mold. See *Figure 8-112*.
9. Unplug the wire harness connector. See *Figure 8-112*.
10. Remove and save the shutoff arm.

Installation of replacement ice maker:

1. Install the shutoff arm onto the replacement ice maker.
2. Plug the wire harness connector into the ice maker. Make sure the connector locks into the ice maker connector.
3. Clip the thermal fuse to the mold.
4. Install the cover, then rotate ice maker parallel with the freezer plate, then align the upper bracket with screw holes.
5. Install and fasten the upper bracket screws. Do not overtighten.
6. Install the mounting plate.
7. Fasten the mounting plate to the ice maker with two retaining screws. Do not overtighten the retaining screws.
8. Install retaining screws to fasten the ice maker to the mounting plate. Do not overtighten the screws.
9. Install the freezer shelf, then install the ice bin.
10. Plug both the ice maker and the refrigerator AC power cords into the RV receptacle.

To disconnect the wire harness from ice maker, (a) unclip thermal fuse, (b) push connector in, (c) press in locking tab with small, flat-blade screwdriver, and (d) while pressing locking tab, pull back on wire harness to unplug the connector from the ice maker connector.

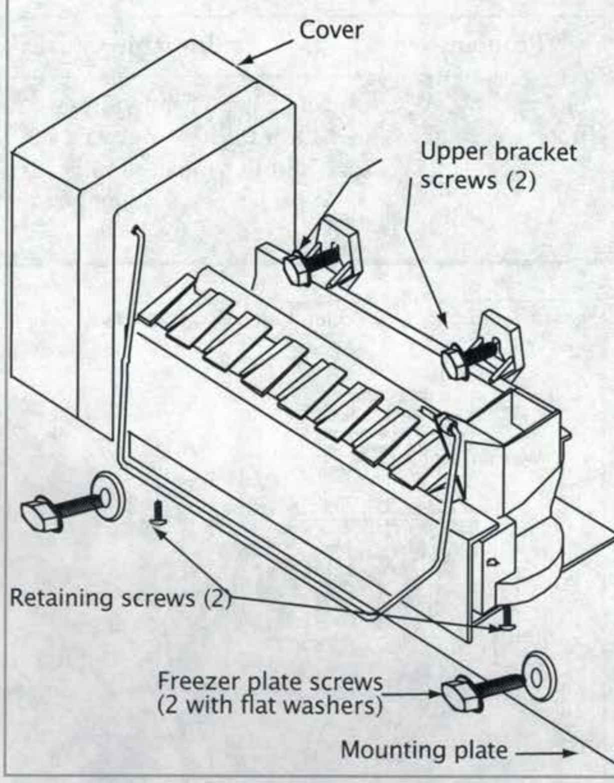
Figure 8-112 Wire Harness Connection to Ice Maker



NOTE: Plug white AC power cord into AC outlet labeled "Ice Maker." Plug black AC power cord into outlet labeled "Refrigerator."

11. Turn refrigerator ON.

Figure 8-111 Icemaker Screw Locations



8-6.3 Troubleshooting

Table 8-2 lists some possible problems and the components that could be the cause. Use this table to identify the component, and refer to the appropriate section within this chapter.

Table 8-2 Ice Maker Troubleshooting Guide (Norcold)

Problem	Probable Causes	Remedy
No ice in mold/no ice yield	A. No AC power to ice maker B. No water available to water valve C. Clogged water valve strainer D. Water valve solenoid faulty	A. Check AC power supply. B. Check water supply to valve. C. Clean water valve strainer. D. Test water valve.
Not cycling, ice in mold	A. No AC power to ice maker B. Ice maker OFF C. Mold overfilled D. Water valve washer seal damaged	A. Check AC power supply. B. Lower shutoff arm to ON position. C. Check position of water valve orifice. Reposition components. See *Figure 8-113*. D. Replace water valve.
Water dripping from mold/mold overflowing	A. Water fill adjustment screw set incorrectly B. Water valve washer seal damaged	A. Readjust water adjustment screw. B. Replace water valve.

Table 8-2 Ice Maker Troubleshooting Guide (Norcold)

Problem	Probable Causes	Remedy
Not cycling, AC power available	A. Mold heater failed open B. Motor faulty C. Mold thermostat faulty D. Wire harness thermal fuse open	A. Check motor continuity. B. Check motor continuity. C. Replace ice maker. D. Check continuity of black wire harness wire.

Figure 8-113 Solenoid Water Valve Components

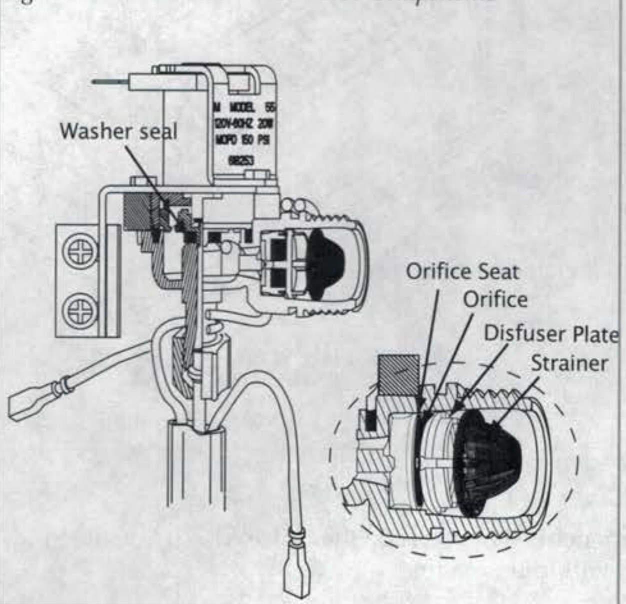


Figure 8-114 Norcold Ice Maker Schematic

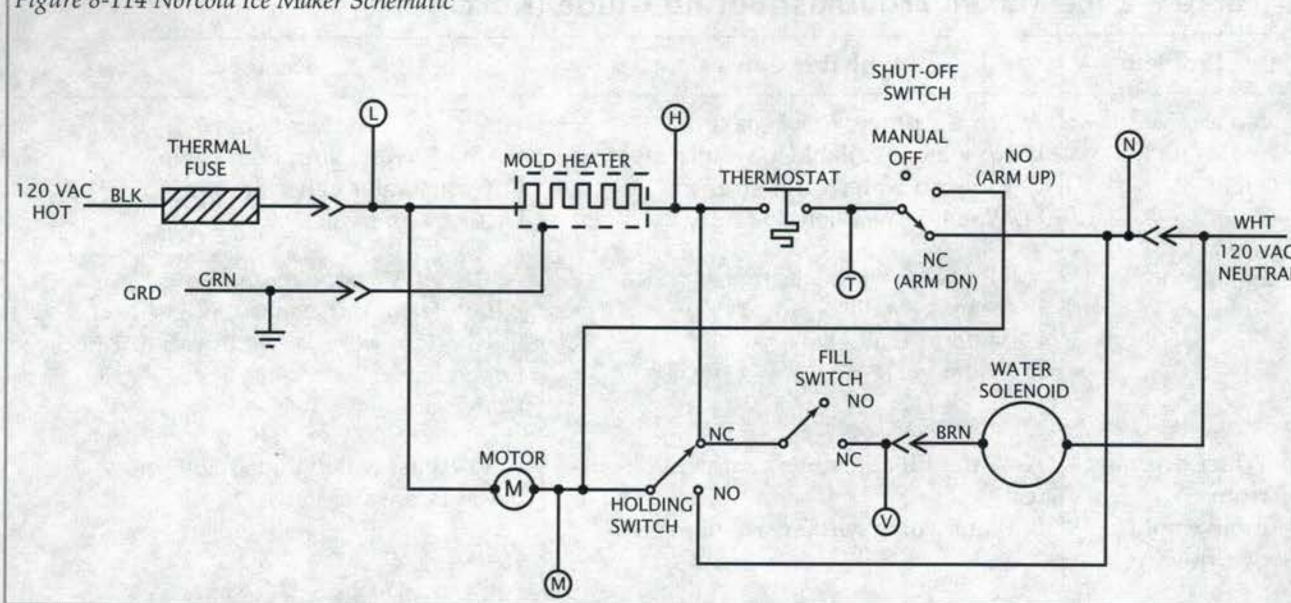
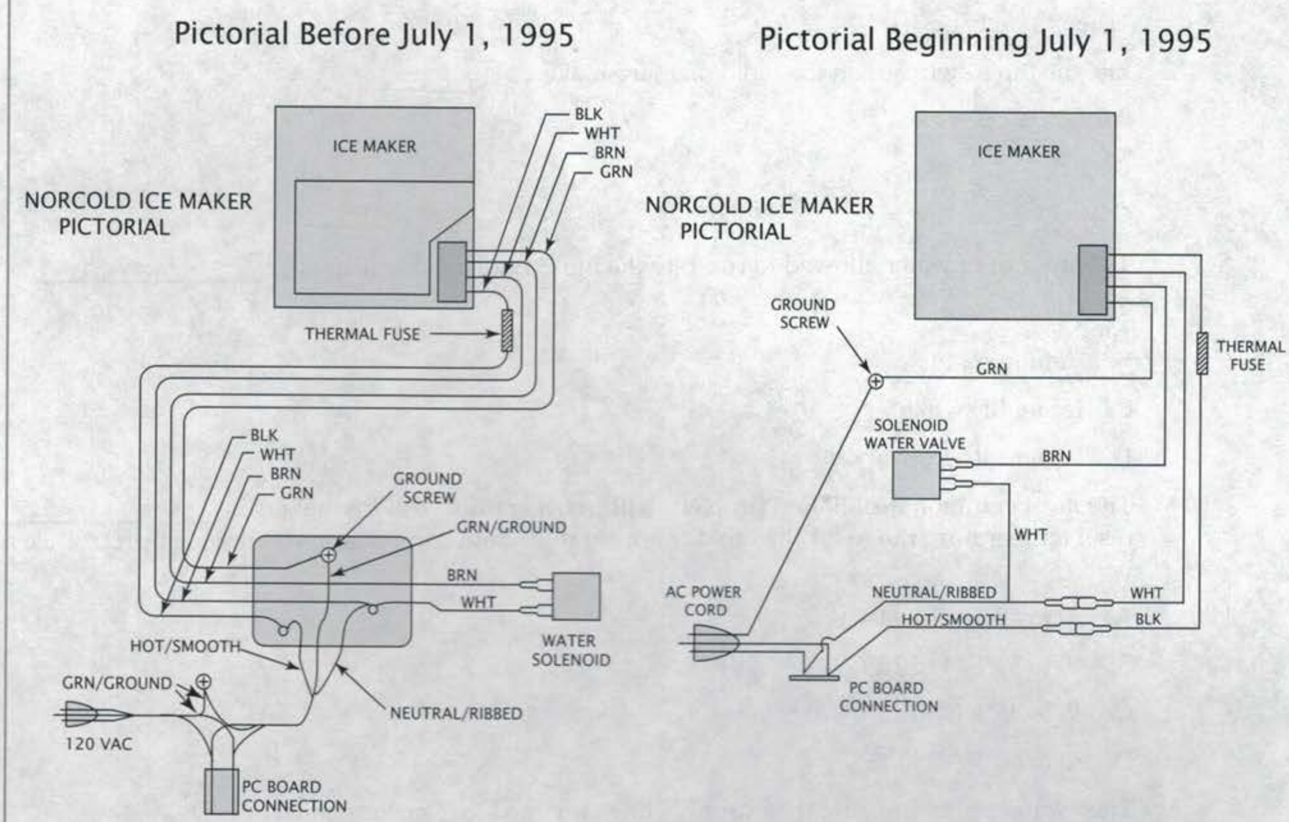


Figure 8-115 Ice Maker Wiring Pictorial



8-6 Review

1. The device that controls when ice is made and when the ice-making process is terminated is called the water valve.

   True   False

2. List the three switches on the mold of an ice maker.

   A.

   B.

   C.

3. The amount of water allowed to run into the mold is adjustable using the ______________.

   A. Compressor

   B. Timing motor

   C. Ice mold switch

   D. Water fill screw

4. The most common installation problem with refrigerators with ice makers is ______________. The reset temperature range for the mold thermostat for both compressor and non-compressor ice makers is:

   A. 30 to 40°F (–1 to 4°C)

   B. 40 to 50°F (4 to 10°C)

   C. 45 to 55°F (7 to 13°C)

   D. 50 to 60°F (10 to 16°C)

5. The water pressure in the supply line for an ice maker must be ______________ to ______________ psi.

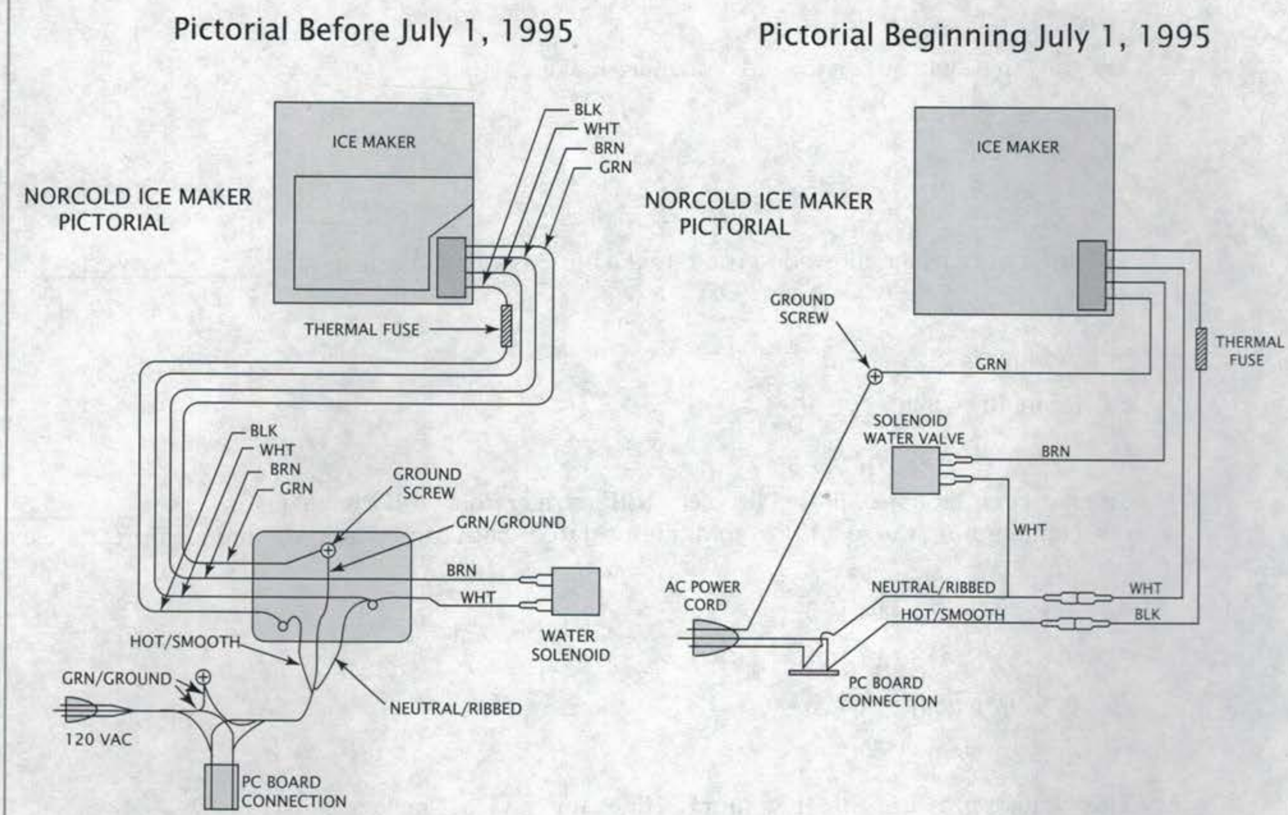
6. The water supply can cause low or no ice production. List the three conditions in the water supply that can cause this problem.

   A.

   B.

   C.

Figure 8-115 Ice Maker Wiring Pictorial



8-6 Review

1. The device that controls when ice is made and when the ice-making process is terminated is called the water valve.

   True False

2. List the three switches on the mold of an ice maker.

   A.

   B.

   C.

3. The amount of water allowed to run into the mold is adjustable using the ________________.

   A. Compressor

   B. Timing motor

   C. Ice mold switch

   D. Water fill screw

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   D. 50 to 60°F (10 to 16°C)

5. The water pressure in the supply line for an ice maker must be ________________ to ________________ psi.

6. The water supply can cause low or no ice production. List the three conditions in the water supply that can cause this problem.

   A.

   B.

   C.

Chapter
8-7 RV Refrigerator Codes and Standards

· Identify and apply codes and standards.

8-7.1 Industry Codes and Standards

Industry codes and standards have been developed to ensure safety and to reduce liability. The major source of RV standards are the *NFPA 1192* and *CSA Z240*. These standards outline requirements for plumbing, heating (propane system), fire and life safety, and electrical.

The RVIA (Recreation Vehicle Industry Association) requires that member manufacturers agree to in-plant visits by the RVIA inspectors. If members refuse or fail to comply, they can be expelled and, therefore, lose the right to bear the association's seal of membership.

To help everyone better understand the requirements of the standard, an industry handbook is maintained by RVIA. Industry stakeholders work with RVIA to document the enforcement positions, which explains the standards in detail. Although standards are primarily designed for RV manufacturers, it is important from a liability standpoint that RV service technicians strive to follow these standards where possible when modifying, servicing, or installing RV systems or their components.

Agencies, state and private, involved with RV safety training use and follow the NFPA and CSA Standards for Recreational Vehicles. This NFPA standard is revised every three years, with dates being 2002, 2005, 2008, 2011, and so on. Industry always begins using the new edition of the NFPA requirements on or near May 1 of the revision year, and manufacturers must comply with requirements by September 1 of the new code edition year.

Table 8-3 is a summary of the current RV Standard that pertains to the normal duties of the RV service technician. This summary is provided as a quick reference, NOT AS A SUBSTITUTE FOR THE ACTUAL STANDARDS. Once the reference in these tables has been found, go to the referenced standard for the exact wording and use the handbook for the detailed explanation.

The *NFPA 1192 Standard for Recreational Vehicles*, RVIA's NFPA 1192 Handbook, *A Guide to NFPA 1192* and *ANSI/RVIA 12V Standard for Low Voltage Systems in Conversion and Recreational Vehicles* are available at www.rvia.org. The *National Electrical Code* is available from NFPA at www.nfpa.org/catalog/ or by calling 1-800-334-3555.

Information on CSA Standards can be obtained by going to their website at www.shopcsa.ca.

Table 8-3 Appliances—Applicable to RV Service Technicians

Service Technicians Task	2008 CSA Z240	2011 1192	Summary of Requirement
Inspect/Repair/Replace Refrigerator	5.1.5 Propane	5.6.2.1	Any propane refrigerator must be listed for RV use and installed according to the installation instructions. The following are common deviations from this requirement: • Refrigerator compartments shall be vapor resistant to the interior of the unit. • Minimum vent openings at top of compartment (per instructions). • Baffle may be required at top of refrigerator.

NOTE: There is no review for this chapter.

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8 Answer Keys

Chapter 8-1

1. B *(page 8-5)*
2. Sodium chromate *(page 8-1)*
3. A. 9 *(page 8-2)*
   B. 7 *(page 8-2)*
   C. 1 *(page 8-2)*
   D. 10 *(page 8-2)*
   E. 2 *(page 8-2)*
   F. 8 *(page 8-2)*
   G. 4 *(page 8-2)*
   H. 6 *(page 8-2)*
   I. 5 *(page 8-2)*
   J. 3 *(page 8-2)*
4. G Condenser *(page 8-5)*
   C Evaporator *(page 8-6)*
   F Gas heat exchanger *(page 8-7)*
   E Absorber *(page 8-7)*
   B Liquid heat exchanger *(page 8-7)*
   D Water separator/rectifier *(page 8-5)*
   A Boiler *(page 8-5)*
5. A. Leveling *(page 8-8)*
   B. Heat *(page 8-8)*
   C. Ventilation *(page 8-8)*
6. A. Propane *(page 8-4)*
   B. 120 VAC *(page 8-4)*
   C. 12 VDC *(page 8-4)*
7. Without proper leveling, the gravity-flow system will not function properly, and the refrigerant within the cooling coils will collect and stagnate at certain areas. The sodium chromate solution can crystallize creating blockages *(page 8-8)*.

Chapter 8-2

1. False. The cooling system coils should never be scraped and repainted, as they easily rupture. Repainting will cause poor heat transfer and unit failure *(page 8-13)*.
2. C *(page 8-13)*
3. True *(page 8-13)*
4. A *(page 8-16)*
5. False. The sodium chromate's function is to prevent heat, water, or ammonia from corroding the pipes *(page 8-14)*.
6. D *(page 8-14)*
7. False. The electricity operates a heating element, which is welded to the boiler for direct transfer of heat *(page 8-15)*.
8. A. Boiler *(page 8-14)*
   B. Heater pocket/Tube *(page 8-15)*
   C. Flue tube *(page 8-15)*
   D. Pump tube *(page 8-16)*
   E. Water separator/rectifier *(page 8-16)*
9. B. Condenser *(page 8-16)*
   C. Evaporator *(page 8-16)*
   A. Absorber vessel *(page 8-17)*
10. D *(page 8-18)*
11. D *(page 8-19)*
12. B *(page 8-19)*

Chapter 8-3

1. A *(page 8-29)*
2. lower; upper *(page 8-29)*
3. True *(page 8-30)*
4. True *(page 8-29)*
5. A Chapter
6. True *(page 8-40)*

Chapter 8-4

1. True *(page 8-43)*
2. True *(page 8-43)*
3. False. The safety valve ensures that the flow of propane is stopped in the event the burner flame goes out *(page 8-44)*.
4. True *(page 8-44)*
5. B *(page 8-45)*
6. G Flue baffle *(page 8-46)*
   H Selector switch *(page 8-47)*
   J Electric thermostat *(page 8-47)*
   F Sourdillon thermostat *(page 8-48)*

D Thermocouple *(page 8-51)*

C Piezo ignitor *(page 8-51)*

E Glow coil *(page 8-52)*

B Sensor probe *(page 8-53)*

I Solenoid valve *(page 8-53)*

A Thermistor *(page 8-55)*

7. True *(page 8-54)*

Chapter 8-5

1. False. 120 VAC is the most common energy source to use *(page 8-59)*.
2. True *(page 8-60)*
3. A *(page 8-59)*
4. True *(page 8-60)*
5. B. Blockage *(page 8-61)*

   A. Leaker *(page 8-61)*
6. True *(page 8-67)*
7. True *(page 8-70)*

Chapter 8-6

1. False. The device is called the shutoff/ice level bail arm *(page 8-77)*.
2. A. The holding switch *(page 8-82)*

   B. The water valve switch *(page 8-82)*

   C. The shutoff switch *(page 8-83)*
3. D *(page 8-84)*
4. C *(page 8-81)*
5. 15 lb, 125 lb *(page 8-85)*
6. A. Low water pressure *(page 8-85)*

   B. Water turned off *(page 8-85)*

   C. Obstructions or air in water line *(page 8-85)*

Chapter 8-7

There is no review for this chapter.

8 Glossary of Refrigerator Terms

Absorber (Coil) The component of an absorption refrigeration system that removes the ammonia from the ammonia/hydrogen mixture and then allows the ammonia to gravity feed back down to the leveling chamber.

Absorber Vessel/Leveling Chamber A collection chamber in which the ammonia vapor and hydrogen gas are collected at the bottom of the refrigerator prior to the vapor solution entering the liquid heat exchanger.

Absorption Refrigeration Refrigeration in which cooling is accomplished by the expansion of liquid ammonia into vapor and then absorption of the vapor by water. This is commonly used in RV refrigerators.

Airflow A rate of flow past a point, measured by a stated mass or volume per unit of time.

Air Gap The unobstructed distance between two components or parts.

Ammeter An instrument used for measuring electric current.

Ammonia A colorless, gaseous, alkaline compound that is very soluble in water, has a characteristic pungent odor, is lighter than air, and is formed as a result of the decomposition of most nitrogenous organic material.

AMP Draw A measurement of the amount of current.

Automatic Refrigerator A refrigerator that automatically selects the mode of operation (120 VAC, 12 VDC, or propane) according to a preset priority based on the availability of the energy source.

Baffle A plate or like construction that regulates the flow of a fluid or air.

Blocked Cooling Unit A situation of crystallized sodium chromate that blocks the proper flow of the refrigerant. This can be caused by too much heat applied to boiler or operating the refrigerator off level.

Boiler/Generator The component of an absorption refrigeration system in which water, ammonia, and a neutralizing agent are combined under pressure by the boiling of the mixture. Sometimes called a *generator,* but the use of the word in this context is not the usual application of the word *generator* in an electrical application.

Bypass Screw Orifice The component that regulates the low flame once the thermostat has been satisfied.

Capillary Tube A tube, the end of which is attached to the high-temperature evaporator fins, filled with refrigerant that expands or contracts due to temperature change. This action moves the bellows, which control the thermostat.

Circuit Board Printed electrical circuits mounted on a board used to control the ignition and mode of operation of the refrigerator.

Compressor A device that uses compression to raise the pressure, temperature, and saturation point of refrigerant vapor (i.e., refrigerator ice maker).

Condensation The process by which a vapor or gas becomes a liquid, such as water vapor to dew, fog, or clouds. This is accomplished by either cooling the vapor to its dew point or the addition of sufficient vapor to achieve its saturation point of 100 percent.

Condenser The component of an absorption refrigeration system in which the ammonia vapor changes back into a liquid (condenses) before it gravity-feeds down into the evaporator.

Cooling Unit A self-contained, hermetically sealed set of steel coils where the refrigeration process takes place. The components are: boiler, condenser, evaporator, and absorber vessel/leveling chamber.

Delay Mode A mode of operation on some older refrigerators that prevents propane operation for a specific period of time.

Door Switch	An open switch which turns the interior refrigerator light OFF when the door is closed and ON when the door is open.
Ejector Assembly	See *Ice Ejector*.
Ejector Blades	The portion of the ice ejector that sweeps the ice from the mold cavities during the ejection cycle.
Electrode	An ignition device in which high voltage is "jumped" through an air gap to the burner when activated to provide ignition.
Electromagnet	A magnet consisting of a coil wound around a soft iron or steel core; the core is strongly magnetized when current flows through the coil and is almost completely demagnetized when the current is interrupted.
Evaporator (Low and High Evaporator Tubes)	The component of an absorption refrigeration system in which the liquid ammonia is combined with hydrogen gas, causing evaporation resulting in a heat transfer cooling the air in the freezer compartment.
Evaporization	The conversion of a liquid to the vapor state by the application of latent heat.
Eyebrow Control	The control panel on automatic refrigerators that controls, as a minimum, the power source and temperature setting.
Fenwal Tester	A diagnostic digital spark ignition (DSI) circuit board analyzer.
Flint Ignitor	An ignitor that uses a flint and knurled wheel to generate a spark to light the propane burner.
Flue Baffle	See *Baffle*.
Flue Tube	A tube used to exhaust the heat and combustion products from the propane flame. It is welded to the boiler.
Gas Heat (Temperature) Exchanger	The component of an absorption refrigeration system in which the heat from the ammonia vapor is transferred to the hydrogen gas, precooling the ammonia before it enters the evaporator.
Glow Coil	An ignition device that uses two D-cell batteries, which are activated when the button is pushed.
Heater Pocket Tube	A tube welded to the refrigerator boiler to transfer heat directly. 120 VAC and 12 VDC heating elements are installed in the pocket(s).
Heating Element Cartridge Type (12 VDC Combination)	A type of heating element that fits into the heater pocket/tube that heats the boiler. They come in 120 VAC, 12 VDC, or a combination 120 VAC/12 VDC types.
Heating Element, Pencil Type (120 VAC)	A type of heating element that fits into the heater pocket/tube that heats the boiler. They come in either 120 VAC or 12 VDC styles.
Hermetic Seal	An airtight seal.
High Humidity Switch	A switch on automatic refrigerators that keeps the surface between door openings dry during high-humidity conditions.
High-Voltage Spark	A spark generated by high voltage, which releases a spring-loaded striker such as contained in a Piezo ignitor.

Holding Switch One of the three mold switches. It assures completion of a revolution once an ice-making cycle has begun.

Humidity Atmospheric water vapor content, expressed in any of several measures, such as relative humidity.

Humidity Heater A small heater controlled by the high-humidity switch that keeps the surfaces between the refrigerator door openings dry during high-humidity conditions.

Hydrogen A chemical element used in the manufacture of ammonia and methanol, for hydrofining, for desulfurization of petroleum products, and to reduce metallic oxide ores.

Ice Ejector A series of blades that sweep ice from the ice mold after the mold heater has melted the ice slightly for easy removal.

Ice Maker Assembly An assembly that allows the making of ice. It is composed of a mold and mold heater, mold thermostat, ice ejector, shutoff arm, mold switches, timing motor, and water valve.

Ignition Module An electronic switch in the primary circuit of the ignition that sends an electrical impulse to the ignition coil where it is stepped up and sent to the spark plugs for firing.

Ignitor Probe/Electrode A metal probe enclosed in a ceramic insulator that produces sparks generated by the electrical charge produced by a Piezo ignitor to ignite the propane at the burner.

Leaker A name given to the condition of a lost charge of hydrogen gas. It is recognizable when the boiler is warm to the touch and the absorber is hot to the touch. This means the ammonia is being boiled into a vapor status, but there is no hydrogen gas to cause evaporation.

Leveling Chamber (Absorber Vessel) See *Absorber Vessel.*

Liquid Heat (Temperature) Exchanger The component of an absorption refrigeration system in which vapor ammonia is cooled back into a liquid on its way back to the boiler. The hydrogen gas rises back up to the absorber.

Liquid Leak Detector A solution of soap and water that contains no chlorine or ammonia used to detect propane leaks by the presence of bubbles. Liquid leak detector is also available commercially.

Low Ambient Temperature Switch A switch that allows normal refrigerator operations at temperatures below 50°F (10°C).

Low-Temperature Evaporator (Secondary Evaporator) (Low Evaporator Tube) The component of an absorption refrigeration system in which the evaporated ammonia vapor and hydrogen gas from the evaporator (freezer compartment) absorb the heat from the air (cool the air) in the refrigerator compartment.

Lower Side Vent A vent installed in the side of the RV at or below the refrigerator floor level and sealed to the interior of the RV. It provides air intake for combustion and airflow draft.

Manometer An instrument used to measure air and gas pressure or vacuum. Its unit of measurement may be inches of water column (WC), ounces per square inch, or kilopascals. It may be either a digital tube or dial type of instrument.

Manual Propane Shutoff Valve The solenoid gas valve to which the incoming propane supply for the refrigerator boiler is attached. It is opened or closed manually.
See *Operating Mode.*

Mold Heater A device in an ice maker that heats the ice mold so that ice is easily separated from the mold by the ice ejector.

Mold Switches Three switches that control the functions of the ice mold of the an ice maker: the holding switch, the water valve switch, and the shutoff switch.

Mold Thermostat A normally bimetal open switch that starts an ejection cycle on an ice maker by closing at 14 ± 5°F (–10 ± 3°C) and that has a reset temperature of 50 ± 5°F (10 ± 3°C).

NFPA 1192 The standard on recreational vehicles that covers fire and life safety criteria considered necessary to provide a reasonable level of protection from loss of life from fire and explosion.

NPT (National Pipe Thread) A plumbing measurement standard. A slightly tapered thread designed for plumbing connections.

Orifice An aperture or hole the size of which controls the amount of flow; in this instance, of propane.

Orifice Assembly A small fitting mounted on the propane line just prior to the refrigerator burner, with a small opening to control propane flow to the burner.

PAL Tester A circuit board tester designed for use on specific brand-name refrigerators.

Percolation The action of causing a substance (liquid) to pass through or ooze through a porous substance or small holes.

Piezo Ignitor A device that creates an electric spark when a button is pushed, releasing a spring-loaded striker.

Pressure Test Port A port on refrigerators used to test propane pressure to the refrigerator orifice when a manometer is properly attached and used.

Primary Air A portion of the combustion air introduced with the fuel into a burner.

Propane Delay Cycle A safety system that prevents operation of a refrigerator by preventing propane flow for a specific period of time after a vehicle engine is turned off, thereby ensuring no flame during possible refueling situations.

Propane Filter A filter that is part of a refrigerator thermostat, designed to remove any large particle impurities from the propane. The filters may be either replaceable or nonreplaceable.

Pump Tube The component of an absorption refrigeration system through which the water, ammonia, hydrogen gas, and sodium chromate solution rise (percolate) toward the top of the refrigerator.

Rectifier (Water Separator) The component of an absorption refrigeration system in which water vapor is removed from the ammonia vapor. It allows the pure ammonia vapor to enter into the condenser.

Reignitor/Relighter A device that begins sparking to ignite propane when it senses an open circuit at the burner; indicating the lack of a flame.

Rejected Heat Heat radiated from the absorber that escapes through vents and creates the necessary airflow (draft) for proper refrigerator operation.

Roof Vent A vent mounted in the roof of an RV to allow warmer air to rise and escape to the outside of the RV, creating a draft that provides airflow behind the refrigerator.

Safety Valve A valve that automatically shuts off the flow of propane when it senses the absence of a flame to consume the propane.

Secondary Air Combustion air surrounding the flame that helps complete combustion after the burner is lit.

Sensor Probe A probe that completes the circuit through the flame to ground to tell the reignitor or ignition module that a flame is present. *See Reignitor/Relighter.*

Shutoff Arm (Ice Level Bail Arm) The shutoff arm operates a switch to control the quantity of ice produced. It may operate automatically when the ice bin is full, or it may be set manually.

Shutoff Switch One of the three mold switches. It stops the ice maker's operation when the storage bin is full.

Sodium Chromate Water-soluble, translucent, yellow efflorescent crystals that melt at 20°C.

Solenoid Gas Valve A valve, operated on 12 VDC, that controls the flow of propane and also acts as a safety valve.

Spiral Baffle see *Baffle.*

Start Device and Overload Two separate components of an ice maker that work together in starting and allowing the compressor circuit to be completed.

Thermistor A temperature sensor used to tell a thermostat when to turn on and off so that its resistance decreases as the temperature increases.

Thermocouple A heat-sensing device that, in the absence of heat, will activate the electromagnet in the safety valve to shut off the flow of propane.

Thermo-siphon Effect The upward movement of air caused when air is expanded by heating, making it lighter (the principle of the hot air balloon) so that it rises and escapes through a vent, creating a draft.

Thermostat An instrument that measures changes in temperature and directly or indirectly controls sources of heating and cooling to maintain a desired temperature.

Thermostat, Propane-Electric Combination A refrigerator thermostat that controls both the propane and electrical operations using single capillary tube and bellows.

Timing Cam A timing device that determines the length of time the water valve switch is held closed during the fill stage of the ice-making cycle.

Timing Motor A low-wattage, stall-type motor that is geared to the timing cam and ice ejector. It is a 1-rpm motor.

Upper Side Vent A vent in the sidewall of an RV, near the roof to allow warmer air to escape to the outside, creating a draft to allow proper airflow across the back of the refrigerator.

Ventilation The movement, circulation, and quality control of air in an enclosed space.

Water Separator/Rectifier The component of an absorption refrigeration system in which water vapor is removed from the ammonia vapor before allowing the pure ammonia vapor to enter into the condenser.

Water Solenoid Switch The switch that opens and closes the water valve on an ice maker. See *Water Valve Switch.*

Water Solenoid Valve See *Water Valve Switch.*

Water Valve Switch One of the three mold switches. It opens the water valve during the fill stage of the ice-making cycle.

Yellow Tipping A burner flame with visible yellow tips caused by improper air mixture, improper gas pressure, improper alignment, or restriction of orifice and tube.

Zip Tube/Ignitor An aluminum tube with perforated holes used to light a refrigerator burner when the safety switch is depressed.

8 Index