$39.95

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Recreation Vehicle Industry Association

Recreation Vehicle

RV Preventive Maintenance

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RV Preventive Maintenance - 4th edition

June 2012

3 Table of Contents

3 List of Figures

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Chapter

3-1 Introduction to Preventive Maintenance

- Explain purpose of preventive maintenance.

The purpose of this course is to provide the knowledge and skills necessary to provide routine inspection and maintenance of a recreation vehicle. With motorized RVs, the powertrain and chassis are also addressed. When preventive maintenance is properly performed, the RV's life is extended, its performance is more reliable, and the customer is safer and more satisfied.

NOTE: There is no review for this chapter.

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Chapter

3-2 Checking the Propane System

- Interpret and understand manufacturer maintenance schedules.
- Check propane system.

The propane system is a system that needs to be periodically maintained. This preventive maintenance activity should ensure the customer safe and worry-free operation. To ensure the maximum safety and reliability, the propane container and mountings, regulators, distribution lines, and appliances need to be addressed.

3-2.1 Container and Appurtenance Inspection

It is a good idea to visually inspect the propane containers periodically to ensure that they remain in good working order and repair. During a visual inspection of the containers, the following should be determined as a minimum:

1. That valve guards are in place and securely attached
2. That the container has not been subjected to physical damage; scraping, denting (see *Table 5-6 on page 5-32* of the *RV Propane Systems* textbook), gouging, excessive rusting, or fire
3. That fittings are working properly and do not leak

Once the containers are determined to be acceptable, also inspect mounting brackets of the containers. Propane containers need to be secured to be the recreation vehicle so they will not become dislodged when a load equal to eight times the container's filled weight is applied to the filled container's center of gravity in any direction (*NFPA 1192 paragraph 5.2.4.1* and *CSA Z240 paragraph 6.3*).

ASME tanks are usually bolted to the RV's frame or floor. Be sure the brackets are securely bolted and all bolts intended to be used are tight and in place. If a bolt has been removed or has fallen out, tighten all bolts and replace missing bolts with bolts of equal size and strength. If washers and lock washers were used, be sure these items are also reinstalled. Bolt strength is often indicated by markings on the head of the bolt. These bolt head markings can be numbers or symbols.

DOT (TC) cylinders are usually located on the front of trailer A-frames or in compartments that are sealed off from the RV's interior. Cylinder securing methods vary, with the most common being adjustable straps around the middle of the cylinders and "T-bars" commonly used to secure double cylinders. Any method used must ensure that the cylinders will remain in place and in their proper and intended position. Be sure the securing method is adequate and the hardware used is in good working order. On double cylinder assemblies, be sure the cylinder tray is adequately attached to the floor or frame.

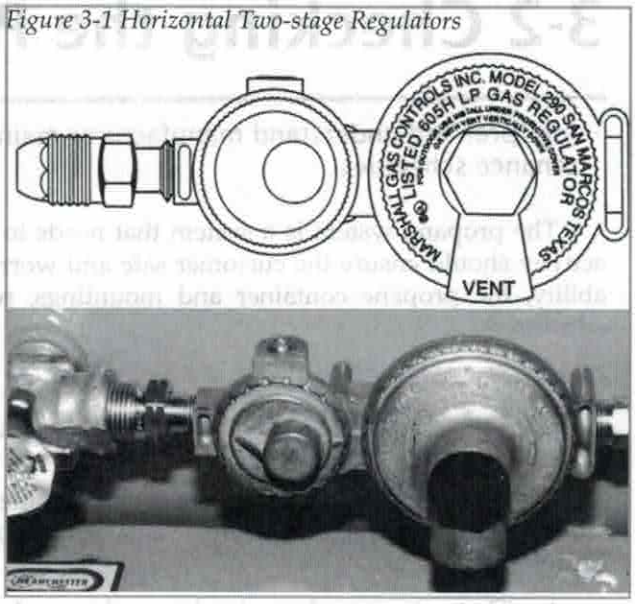
3-2.2 Regulator and Gas Hose Inspection

3-2.2.1 Inspecting Regulators

When checking the propane system, be sure to inspect the regulator. Look to be sure it is secured to the vehicle or container, and make sure the regulator is not encrusted with dirt, mud, or ice. Regulators are rugged and trustworthy instruments, but insects or dirt that have plugged the vent opening can cause pressure problems. If debris obstructs the working mechanism of the regulator, high-pressure propane may pass directly into the appliances. Both conditions create substantial safety problems.

Another source of vent clog is ice that can form quickly in a freezing rain. Tests conducted by both Fisher Controls Company and Underwriter's Laboratories showed that vent openings that point to the ground and have a drip-lip construction are unlikely to freeze completely closed. In support of this, the RV standards require that the regulator's vent must be pointing directly to the ground or within 45° of this vertical plane when installed. This positioning helps drain away any moisture that may accumulate on the diaphragm inside the regulator. Excessive moisture buildup could prevent the regulator from working or permit high-pressure gas downstream of the regulator, especially in cold weather. Always ensure that the regulator's vent points downward within 45° of the vertical plane. This requires use of the model regulator designed for the proper purpose. A regulator for a motorhome's ASME tank has a vent that discharges out of the side of the regulator so that the regulator, when laying on its side, vents downward within 45° and will drain any condensation that might get into the area of the diaphragm. A regulator to be mounted on the front wall of the RV, or on the container assembly, will have the vent pointing to the same side as the regulator's outlet opening. Therefore, when the regulator is mounted on the front of the unit, the vent is pointing downward and will also drain condensation. *Figures 3-1* and *3-2* show two-stage regulators.

Figure 3-1 Horizontal Two-stage Regulators



Most regulators have a fine-meshed vent covering that helps prevent blocked vents. However, regulator vent screens can be quickly clogged with road splash or insects such as mud daubers (wasps). Ensure that nothing is blocking the regulator vent.

DOT cylinders that are not in compartments or under housings should be turned so the relief valve faces away from the RV, the service valve faces the unit, and the regulator is mounted between the cylinder(s) and the RV to protect it from damage from flying rocks and debris. The cylinder guard acts as protection for the service valve in the event of flying objects or collision. This positioning also adds additional protection to the regulator cover that is attached directly to the regulator. Remember that this cover keeps contamination from blocking or plugging the regulator's vent.

Frequent inspection and, if necessary, cleaning is highly recommended, even where the regulator is installed in a compartment or under a cover. Beware of carelessly installed covers or hoods. If installed upside down, they may actually fill with water that can ultimately freeze the vent closed.

Look at the flexible hose connectors, often called *pigtails*, that connect the regulator to the containers and the regulator to the main propane manifold of the RV's propane system. Be sure they are not kinked and they do not have cracks or cuts. Also be sure the fittings are tight.

Figure 3-2 Vertical Two-stage Regulators

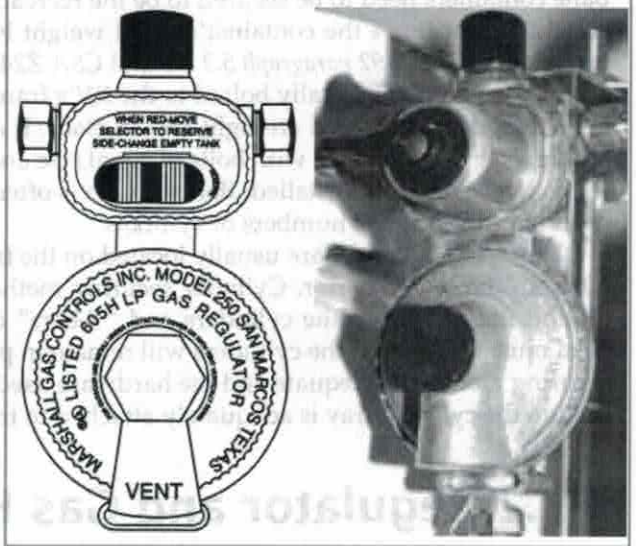


Figure 3-3 Kinked Propane Hose

3-2.3 Propane System Testing

Testing the propane system is an act of preventive maintenance that should be conducted at the start of every camping season or at least once per year. Several system tests need to be performed, and adjusting the regulator, or at least determining if the regulator needs adjustment, should be the starting point. These tests should be performed by an experienced RV service technician.

3-2.3.1 Adjusting Regulators

To adjust the system regulator, an operating pressure test and a lock-up pressure test of the propane system regulator, located at the containers, must be conducted.

The operating test is used to determine the pressure the system regulator is delivering to the system when at least 50 percent of the appliance load is functioning. The lock-up pressure test verifies the pressure at which the regulator locks up, when no propane is flowing through the system. The operating test should show a working pressure of 11 in. (nominal) WC when properly conducted, and the lock-up pressure should never exceed 14 in. WC.

3-2.3.1.1 Conducting an Operating Pressure Test

Prior to conducting an operating pressure test, ensure that the air and piping temperatures are approximately the same and that a uniform temperature is maintained throughout the test. Temperature change in the piping (bringing a unit indoors on a cold day) can cause pressure changes during the test. Pressure will rise as the temperature rises and will fall as temperature falls.

1. Prepare proper documentation to record the results of the operating pressure test.
2. Ensure that the propane system is turned off at the container service valve.
3. Turn off all appliances.
4. Disconnect the propane low-pressure hose from the regulator using backup wrenches. With the propane system off, disconnect the low-pressure hose or piping from the regulator outlet.
5. Connect test apparatus (see *"Making a Test Apparatus" on page 5-53* of the *RV Propane Systems* textbook) to the regulator. Connect the above-referenced pipe cross to the regulator's output by using the short low-pressure flex hose. With this type of test setup, the technician is working at the propane container area with the regulator and the manometer connected close by so that all these devices can be seen at the same time. Attach the gas cock to the remaining leg of the pipe cross, which is the 1/4 in. pipe thread opening. On the outlet side of the gas cock, attach the cap with the #41 drill hole or an orifice that is rated at 75,000 Btu.
6. Connect the propane low-pressure hose to the test apparatus.
7. Install manometer to test apparatus. Use the small 5/16 in. hose barb. This creates an opening for connecting the manometer for measuring the pressure. The system is now ready to test!

NOTE: Make sure all connections are leak free.

8. Open the service valve on the container. With the manometer connected, turn on the gas at the container.
9. Slowly open the gas cock on the test apparatus. Opening the gas cock with the #41 drill hole provides a flow rate of 75,000 Btu/hr. This is equal to the 30 ft^3/hr flow required by UL 144, the *Standard for LP-Gas Regulators*, and represents the flow of about 50 percent or more of the Btu/hr flow rate of the inside appliances. A propane regulator must have a rated capacity equal to or greater than the total Btu/hr input of all appliances.

10. Measure inches of water column on the manometer. The operating pressure is now shown on the manometer. This operating pressure should be 11 in. WC, nominal (±0.5 or 10.5 to 11.5).
11. Adjust regulator if measured inches of water column is not correct (10.5 to 11.5). If the pressure is significantly off the 11 in. WC reading, readjust the regulator by removing the dust cover. Use a screwdriver and turn the adjusting screw until the system's operating pressure is at 11 in. WC. If adjustment of the regulator is required, remember that screwing in the adjusting screw (clockwise) increases the pressure; screwing out the adjusting screw (counterclockwise) decreases the pressure.
12. Document operating pressure test results. As a minimum, the test documentation should include:

    Make, model, and identification number of unit

    The date and inclusive times of the test

    Type of manometer used

    Calibration date of manometer if other than a U-tube type

    The measured inches of water column pressure initially read

    Adjustment procedures taken if necessary

    Corrected pressure reading in inches of water column

    Technician's name and signature

3-2.3.1.2 Lock-Up Pressure Test

Immediately after conducting the operating pressure test outlined in *"Conducting an Operating Pressure Test" on page 3-5*, close the gas cock. This simulates turning off all the appliance burners (no propane demand) so that no propane flows through the system. The pressure now shown on the manometer is the *lock-up pressure*. This is defined as the pressure required to press against the diaphragm and overcome the spring force so the valve closes and no propane flows through the regulator. Lock-up pressure is a direct result of the regulator operating pressure adjustment and the condition of the regulator. It cannot be adjusted to fit within the operating parameters of the regulator lock-up requirements. The only adjustment that can be made to the regulator is operating pressure. If the lock-up pressure exceeds its maximum allowable pressure of 14 in. WC after the operating pressure is adjusted to 11 in. WC, it is defective and must be replaced. Typically, the regulator will lock up at approximately 12 in. WC. Sometimes a regulator will adjust to the correct 11 in. WC operating pressure and shut off at 12 in. WC. However, after a few minutes, the pressure may rise slowly, over several minutes, to 14 to 18 in. WC or more. If this occurs, the regulator is defective and must be replaced. Any lock-up pressure over 14 in. WC after approximately 3 minutes will require the regulator to be replaced. Never allow a regulator in a system that locks up above the maximum pressure of 14 in. WC.

After every operating pressure adjustment, lock-up pressure must be rechecked. After a new regulator is installed, both operating and lock-up pressures must be checked and adjusted as necessary. Always observe the lock-up pressure after the regulator has been adjusted to 11 in. WC with a minimum of 50 percent of the propane load, or equivalent, of the RV. Document all actions taken as described in *"Conducting an Operating Pressure Test" on page 3-5*.

NOTE: Check the lock-up pressure every time the regulator's working pressure has been adjusted! Leak test the appropriate fittings after removing the test apparatus adapter.

3-2.3.2 Leak Testing Regulators

If the regulator passes a visual test and is secure and clean, make sure there are no leaks around the body of the regulator by applying leak-detection solution or use an electronic leak detector. After applying a leak-detection solution, there should be no bubbling around the edges or fittings. If leaks do appear around the fittings, tighten them. If there are leaks around the crimped edges, the regulator will need to be replaced.

Remove the regulator, tag it, and identify in writing the problems detected. If it is under warranty, return it to the manufacturer. **All defective regulators should be disposed of properly. No part of a regulator is repairable by a technician.**

The regulator should also be checked for leaks around the edges where the diaphragm is sealed, at vents, and at any other connection or openings. This test must be conducted while the system is under pressure. If the regulator's operating pressure and lock-up pressure are within tolerances (i.e., 11 in. WC operating and 14 in. WC lock-up), remove the test equipment and reconnect the flex hose onto the recreation vehicle manifold system. Conduct a timed pressure drop test. Document all actions taken as described in *"Conducting an Operating Pressure Test" on page 3-5.*

3-2.3.3 Leak Testing the Piping System

NOTE: When the propane system is opened by loosening a fitting, removing an appliance, replacing a line, or a leak is suspected, perform a timed pressure drop test.

Pressurizing the system allows leaks to be identified and located. Leak testing with air pressure is typically performed using a dial gauge or U-tube manometer and seeing if the pressure drops according to the test device. This test is referred to as a *timed pressure drop test.*

The test used by most RV service technicians is the timed pressure drop test. This will test the entire system to ensure that it is leak free. This test should be performed whenever a fitting is loosened or replaced. Leak testing procedures are stated in the *NFPA 1192* standard and detailed below.

The electronic tester and the leak detector solution provide ways to locate leaks once a leak in the system is identified.

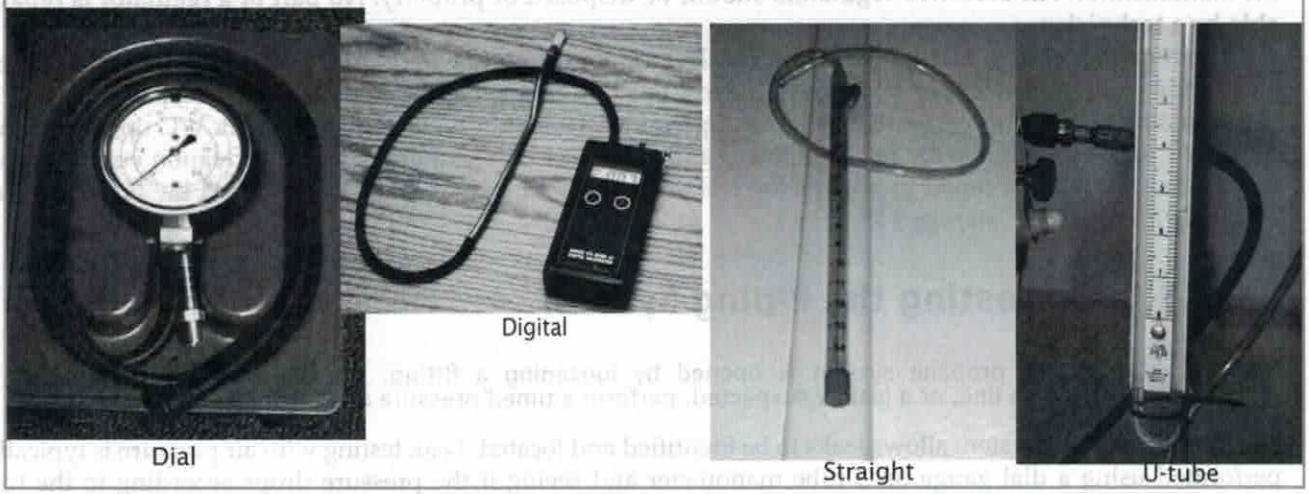
NOTE: Manufacturers recommend that the system be tested for leaks at least once before each camping season. Anytime the system is opened by loosening a fitting, removing an appliance, or replacing a line, or a leak is suspected, have a service technician conduct a test.

3-2.3.3.1 Timed Pressure Drop Test

To leak test the propane system, perform a timed pressure drop test with a dial, digital, straight, or loop (U-tube) manometer shown in *Figure 3-4.* The timed pressure drop test is outlined by the *NFPA 1192 paragraph 5.3.20.6.* The procedure is discussed below.

NOTE: Temperature change in a piping system can cause a timed pressure drop test reading to change. The pressure will rise if the temperature rises and will decrease as the piping cools. The temperature of both the air and piping need to be approximately the same, and a uniform temperature needs to be maintained throughout the test period. If a unit, left out in cold weather overnight, is brought into a warm bay for a timed pressure drop test, the piping could warm up during the test. The pressure will rise as the temperature rises. This rise in pressure could hide the existence of a leak that would remain undetected because what would be a manometer reading drop is offset by the pressure increase.

Figure 3-4 Manometer Examples



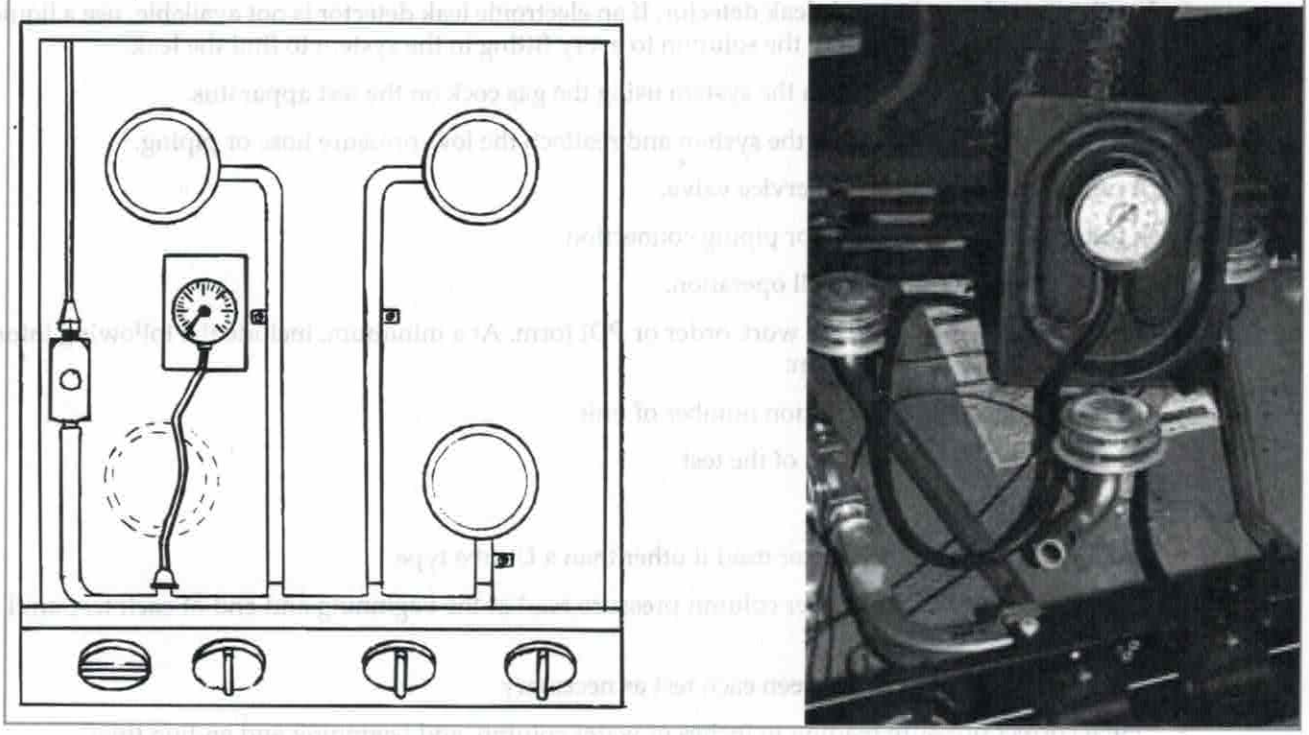
Timed Pressure Drop Test at the Range Burner

1. Prepare documentation for recording the timed pressure drop test results.
2. Turn off the propane system at the container service valve.
3. Turn off all propane appliance valves.
4. Turn off all open pilot lights.
5. Remove a range burner and attach a manometer to the range burner orifice. See *Figure 3-5*.
6. Turn propane system on at the container service valve to pressurize the system.
7. Listen to the regulator for sounds of escaping propane that would indicate an open line. Silence indicates the regulator has locked up. Propane passing through the regulator when the service valve is first turned on usually makes a "PFFFFT" sound until the regulator locks up. Once the regulator locks up, no sound should be heard.
8. Turn on the burner valve with the manometer attached and pressurize the propane system to 10–14 in. WC.
9. Turn off the propane at the container service valve.
10. Slowly open a second burner valve and reduce the operating pressure to a nominal 8 in. (±0.5) WC. Turn the burner valve off after achieving a nominal 8 in. Reducing the system pressure to 8 in. WC ensures that the appliance regulator is not in lockup and becoming a factor in the test. Note that, due to the very low propane flow rate, this bleed-down could take some time.
11. The RV standard requires this test to be conducted for a minimum of three minutes. (*NFPA 1192 paragraph 5.2.30.6*). Watch the manometer for this minimum test period of three minutes. No pressure drop should be detected. If there is a pressure increase due to thermal expansion, the test must be repeated. If a pressure drop is noted, locate and repair the leak and retest from step 8 until a successful test is obtained. If a leak is observed, one method of discovering its location is with an electronic leak detector. If an electronic leak detector is not available, use a liquid leak detector solution and apply the solution to every fitting in the system to find the leak. Do not use an electronic leak detector on an area that has just had leak solution applied. False positives can sometimes occur as a result of the electronic leak detector interacting with the chemicals in the liquid solution.
12. If no leaks are determined, turn off the range burner with the manometer, disconnect the manometer from the range burner spud, and reconnect the range burner.

13. Return the propane system to full operation.
14. Document the test results on the work order or PDI form. As a minimum, the test documentation should include:
    - Make, model, and identification number of RV
    - The date and times of the test
    - Temperature of air and piping
    - Type of manometer used
    - Calibration date of manometer used if other than a U-tube type
    - Recorded pressure at the beginning and end of each test until a successful test is achieved
    - Corrective action taken between each test as necessary
    - Final correct pressure reading in inches of water column, and beginning and ending time with technician's name and signature

Document both the exact manometer measurement and duration when conducting the timed pressure drop test.

Figure 3-5 Manometer at Range Burner with Rangetop Off



Timed Pressure Drop Test with a Test Apparatus

NOTE: See instructions for *"Making a Test Apparatus" on page 5-53* of the *RV Propane Systems* textbook.

Use the following procedures to connect the propane system test apparatus. These procedures are provided as guidance but are not included in the procedures to be followed in conducting the timed pressure drop test.

With all appliances turned off and the propane supply turned off, disconnect the low-pressure hose or piping from the regulator. Connect the 3/8 in. female flare of the test apparatus flex hose to the regulator out-

let fitting. Attach the low-pressure hose, previously attached to the regulator, to the half-union end of the test apparatus. Attach the manometer hose to the 5/16 in. hose barb on the test apparatus. Make sure the gas cock on the test apparatus is closed. Slowly turn the propane supply back on at the service valve. Conduct a leak test to ensure that all connections are leak free.

1. Prepare documentation to record the timed pressure drop test results.
2. Ensure that the propane system is turned off at the container service valve.
3. Turn off the burner valves on the gas range and gas valves on other appliances.
4. Turn off all open pilot lights.
5. Slowly turn propane system on at the service valve. Bleed pressure to a nominal 8 in. WC (between 7.5 and 8.5 in. WC) using the gas cock. Listen to the regulator for sounds of escaping propane that could indicate an open gas line. Propane passing through the regulator when the service valve is first turned on usually makes a sound like "PFFFFT" until the regulator locks up. Once the regulator locks up, no sound should be heard.
6. Turn propane off at the service valve.
7. Monitor the manometer for a period of at least three minutes. Locate and repair any leaks and retest until a successful test (no pressure drop) is accomplished. *NFPA 1192 paragraph 5.3.20.6* requires this test to be conducted for a minimum of three minutes. If a leak is observed, one method of discovering its location is with an electronic leak detector. If an electronic leak detector is not available, use a liquid leak detector solution and apply the solution to every fitting in the system to find the leak.
8. Bleed the propane pressure from the system using the gas cock on the test apparatus.
9. Remove the test apparatus from the system and reattach the low-pressure hose or piping.
10. Turn propane system on at the service valve.
11. Leak test the low-pressure hose or piping connection.
12. Return the propane system to full operation.
13. Document the test results on the work order or PDI form. At a minimum, include the following information on the test documentation:
    - Make, model, and identification number of unit
    - The date and inclusive times of the test
    - Type of manometer used
    - Calibration date of manometer used if other than a U-tube type
    - The measured inches of water column pressure read at the beginning and end of each test until a successful test is achieved
    - Corrective action taken between each test as necessary
    - Final correct pressure reading in inches of water column, and beginning and ending time
    - Technician's name and signature

3-2.3.4 Locating Piping System Leaks

3-2.3.4.1 Detector Solution Test

After it has been determined that a leak is present by using the timed pressure drop test outlined in *"Timed Pressure Drop Test" on page 5-72* of the *RV Propane Systems* textbook, a leak detection solution can be used to

locate the leak. This test can be performed with the system in its normal working condition, the appliances turned off, and the container service valve turned on. Simply use leak detector solution and apply it to each and every fitting until the leak is found by the presence of bubbles.

NOTE: A soap-and-water solution is not to contain any chlorine or ammonia, as these can cause corrosion.

Check the soap's ingredients before using it. Special leak detector solution is recommended and readily available. If a leak is present, the leak detector solution will bubble around the leaking fitting.

NOTE: Using two wrenches to prevent twisting the tubing or stripping the fittings, tighten the leaking joint to make the bubbles stop.

NOTE: Never use a match to find leaks in the propane system.

3-2.3.4.2 Bubble Leak Test

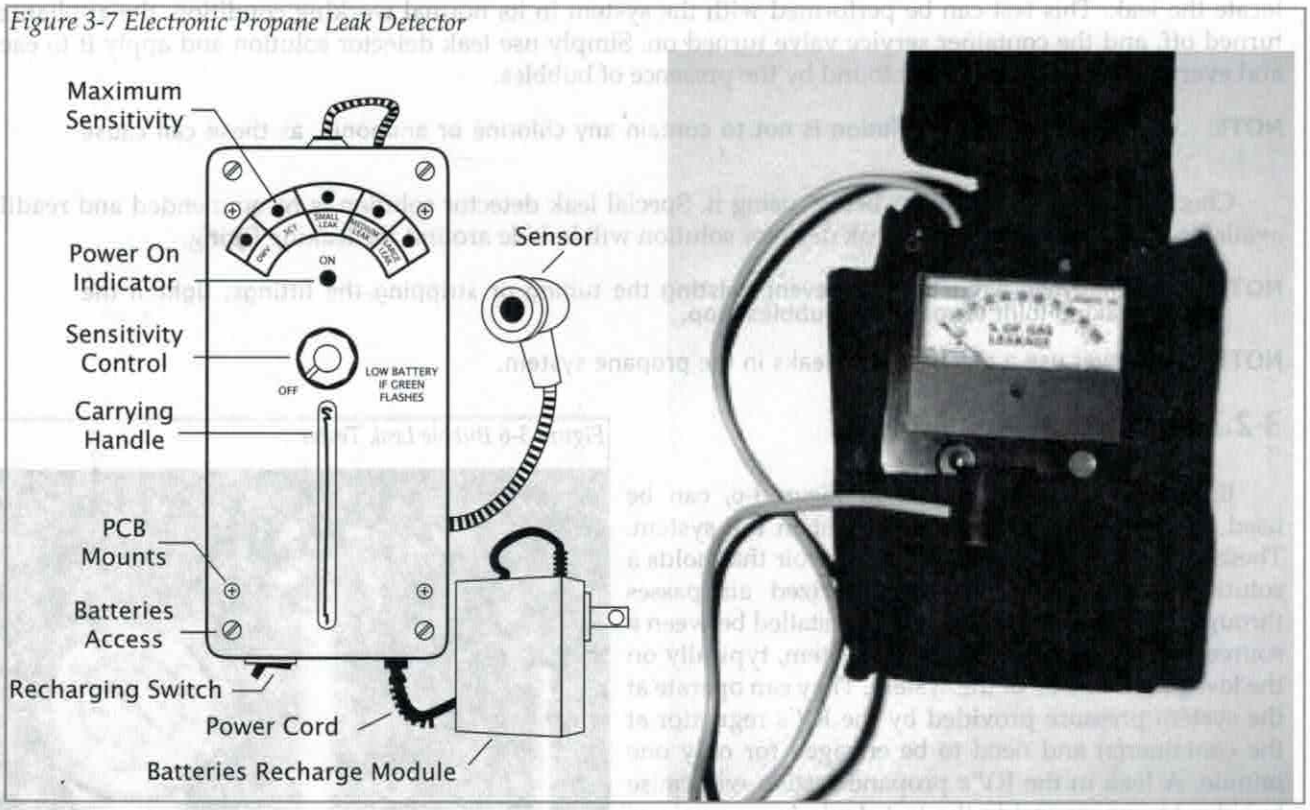
Figure 3-6 Bubble Leak Tester

Bubble leak testers, shown in *Figure 3-6*, can be used to determine if a leak is present in the system. These testers are designed with a reservoir that holds a solution that will bubble if pressurized air passes through it. The bubble tester is to be installed between a source of pressure and the piping system, typically on the low-pressure side of the system. They can operate at the system pressure provided by the RV's regulator at the container(s) and need to be engaged for only one minute. A leak in the RV's propane system will cause bubbles to appear inside the test device's reservoir as air passes through it. This test method is not very common but is recognized as a specific test in the *NFPA 1192*. Usually, when this test method is used, a cylinder of compressed air is used as the pressure source.

3-2.3.4.3 Electronic Leak Test

Leaks can also be located using an electronic leak detector. Follow the electronic leak detector (shown in *Figure 3-7*) manufacturer's instructions to properly conduct testing. Some leak detector solutions may cause an electronic leak detector to activate, indicating there is a leak. If using a leak detector solution, be careful about results obtained when using the electronic tester.

Figure 3-7 Electronic Propane Leak Detector



NOTE: The RV propane detector may sound an alarm indicating there may be a propane leak in the unit. A quick method to test the propane detector is to open a handheld propane torch near the detector without a flame. Once the proper operation of the propane detector has been verified, and other items such as cleaning materials have not contributed to a false indication, conduct the leak test.

3-2.4 Servicing and Adjusting the Appliances

Propane appliances in the RV typically need to be examined and minor maintenance conducted to ensure safe and correct operation. Servicing should be conducted at least annually. Be sure to test the propane system as outlined above before work on the appliances begins. Pay particular attention to system pressure and test the system before beginning. Also verify battery output. If the battery is in a state of low charge, the appliances that utilize low voltage may not perform as well as they should or, in some cases, not at all.

Remember, always use a second (backup) wrench whenever opening or closing propane fittings.

Often, when servicing an RV appliance, the propane supply line needs to be disconnected and low-voltage wires to the appliance disconnected. Before this is done, be sure the propane container is closed and the batteries disconnected. If servicing or adjustment requires the propane line to be disconnected, be sure to plug the end of the propane line with a brass cap. This may seem like an unnecessary step, but capping the line will prevent any unforeseen problems, such as someone trying to use the RV with an appliance removed. Once the service has been completed, be sure all lines are reconnected and perform a documented leak test on the system.

3-2.4.1 Furnace

NOTE: Cleaning and servicing the furnace should be performed only by trained professionals.

Preventive maintenance is essential to the reliable, safe operation of the furnace. Several maintenance areas are important when dealing with a furnace, including the venting system, main burner, blower wheels, sail switch, and combustion chamber.

An obstruction in the vent or main burner will reduce the intake of combustion air, which results in incomplete combustion. Whenever incomplete combustion occurs, the by-products are carbon monoxide (CO) and soot. If the furnace outside exhaust vent shows that black soot may be forming, the furnace should not be operated until the problem is corrected.

NOTE: If operation of the furnace continues under these conditions, it could result in serious injury or death.

The furnace should be cleaned and inspected at least once a year, preferably just before the beginning of the heating season. Some people have the false assumption that if a furnace has not been used, it will not require cleaning. This is NOT true! A furnace that has not been used for some time could be more in need of cleaning than a furnace that has been used extensively.

The main burner should be cleaned and the venting system inspected for proper operation. Dust and lint should be removed from the room air blower wheel and sail switch. All gaskets should be inspected. If any gaskets show signs of leakage or deterioration, they must be replaced to ensure proper pressurization of the sealed combustion chamber.

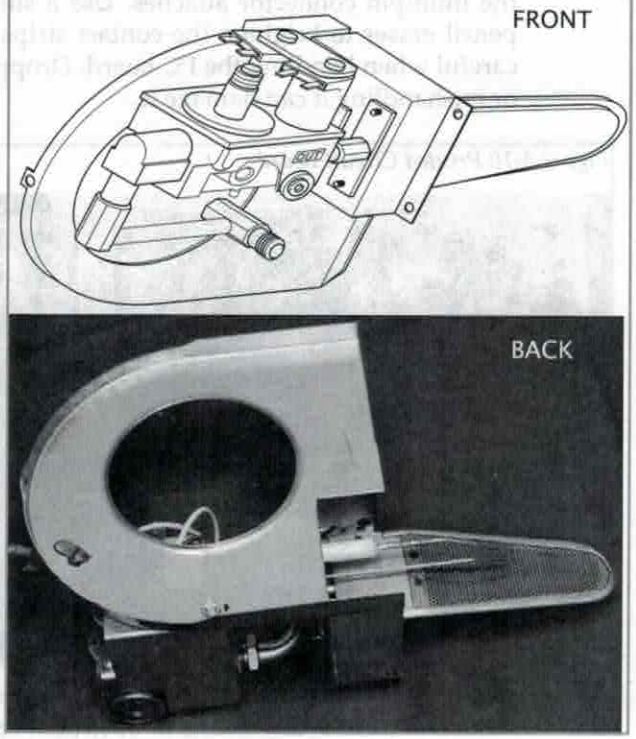
The motors used in some furnaces are permanently lubricated and do not require oiling. Check the specific service manual.

The following is a list of generic tasks that should be performed on furnaces. Since there are differences between models and brands, be sure to also consult the furnace manufacturer's service and owner's manuals.

3-2.4.1.1 Forced Air Furnaces

To clean and service a forced air furnace, the inner furnace assembly usually needs to be removed from its outer casing. Begin by making sure the main propane supply at the container has been turned off and the battery that supplies power to the furnace has been disconnected. Removal of four or fewer screws is typically all that is needed to disconnect the inner furnace from the casing. In some cases, it may only be one. Once separated, vacuum out any debris and wipe away dirt buildup with a damp cloth.

Figure 3-8 Gas Valve and Burner Assembly



Evaluate the following areas as a minimum:

Electrode assembly. Carbon deposits that have built up on the ends of the assembly can be brushed off and the probes brightened with steel wool or emery cloth. Inspect the probes and replace the assembly when the probes become pitted. Check the gap between the probes. If the assembly has three probes, the gap between the spark probe and the ground should be half as much as the gap between the ground probe and the flame sense probe. Adjust or move only the probe not connected to the ceramic insulator to achieve this spacing. Additionally, never allow the spark to jump from the spark probe to the flame sense probe. A new printed circuit board will be needed should that occur. If the assembly has only two probes, the gap should be approximately 1⁄8 in. Take

care when adjusting these probes. If any portion of the ceramic insulator becomes cracked or broken, the entire electrode assembly needs to be replaced. Always refer to manufacturers' specifications.

Pilot assembly. If the model is a pilot model, it will be necessary to clean the pilot orifice. It is recommended that the orifice be soaked in a solution of acetone and then air dried. Never insert anything into or through any orifice.

Main burner. Dirt, spiderwebs, and any other debris should be cleaned from the main burner and the main burner orifice. All gaskets must be replaced when removed and the seal's integrity reestablished. Inspect burners for warpage or cracks.

Thermocouple. If it is a pilot model, clean the thermocouple's end by lightly brushing or brightening with fine steel wool.

Blower wheels. Dust and lint can congregate in the corners of these "squirrel cages" if not cleaned at least once a year. In some cases, this accumulation can actually slow fan speed so that the sail switch will not close. This in turn can damage the motor. Wash and clean the blower wheels thoroughly with warm water and soap. Insects can also build nests on the blower wheels, and washing will ensure their removal.

Printed circuit board. Clean the contacts where the multipin connector attaches. Use a simple pencil eraser to brighten the contact strips. Be careful when handling the PC board. Dropping or mishandling it can damage it.

Figure 3-9 Main Burner Tongues

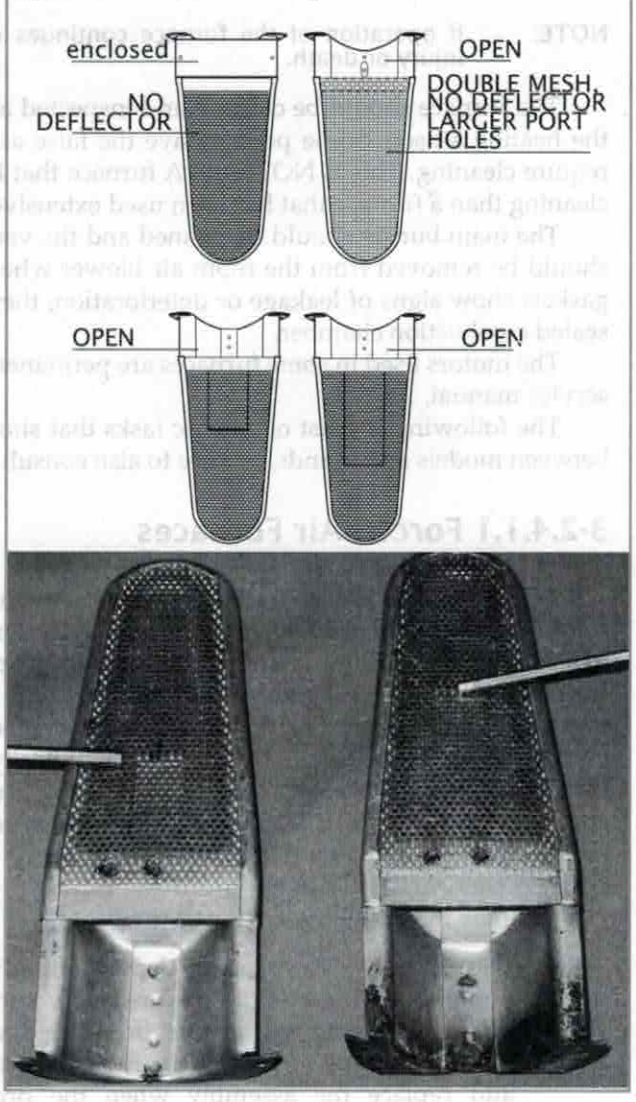
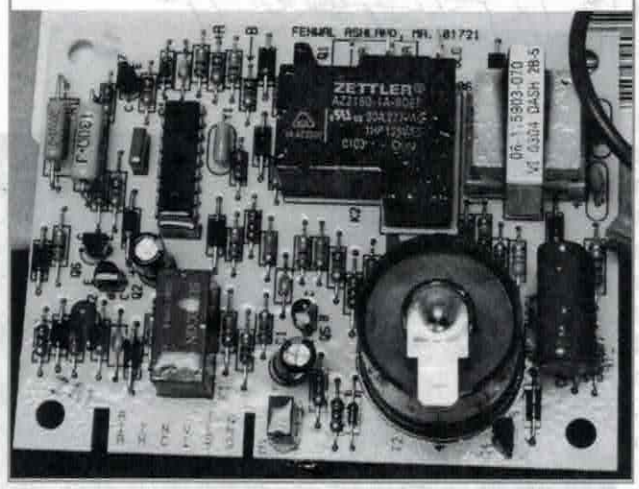


Figure 3-10 Printed Circuit Board



Vent tubes. Check and clean these as often as necessary. It is crucial that the exhaust vent remain clean and clear of any debris or obstructions.

Interior casing. Vacuum in and about the outer casing. Reach into the distribution ducts as far as possible. Cleanliness and furnace performance are related.

Wall thermostat. Clean the contacts by simply inserting a small piece of scrap paper in between the contacts, closing the contacts, and then, slowly pulling the paper out. Never file or sand thermostat contact points. Clean only with plain, dry paper.

Duct system. Inspect all ductwork throughout the system. Straighten any sharp bends or turns. Look for crushed ducts under seating areas or where ducts pass through walls or partitions under cabinets, etc. Shorten any lengths that appear too long. Installers sometimes "snake" excess ducting under cabinets rather than taking the time to cut them to the proper lengths. This can create an overheated situation in the furnace or insufficient heat delivery in the RV. Overheating can cause limit cycling and can lead to premature failure of the limit switch.

A CO test should always be done as a part of the furnace service.

3-2.4.1.2 Return Air Systems and Appliance Clearances

- Check return air passageways for blockage.
- Be sure nothing is stored within listed clearances.
- Clearances are stated on rating plate.

3-2.4.1.3 Catalytic Heaters

While this type of heater has had limited exposure in the RV industry, they are available. Be sure any catalytic heaters considered for installation are listed specifically for RV use (look at the listing nameplate). While all catalytic heaters work on the same principle, the primary difference between listed and nonlisted catalytic heaters is that listed heaters have an oxygen depletion valve that will shut off the heater if the oxygen to support combustion is diminished below a safe level. If the catalytic heater to be worked on is not listed for RV use, be sure to tell the consumer to operate the catalytic heater in strict compliance with the manufacturer's operating instructions. Document that the consumer was told on the work order to adhere to these instructions.

Maintenance of this type of heater is very limited. Be sure no combustible are materials installed near the front of the heater. Cleaning should be limited to vacuuming the front of the pad. Never touch or wash the actual pad. Always follow the manufacturer's maintenance instructions when working on a catalytic heater.

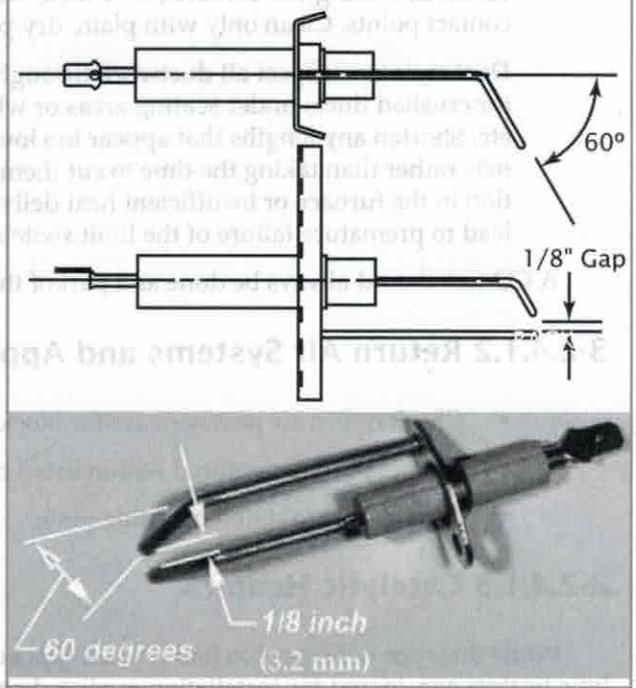
3-2.4.1.4 Water Heater

Once or twice during the camping season, the RV water heater should be cleaned and serviced. Making sure the water heater is clean is the primary concern. The water heater is exposed to the elements; therefore, road grime, dust, and dirt have an ample opportunity to collect at and around the various components. Periodically blowing out the front area of the water heater with compressed air will help minimize this condition. Likewise, soot and other products of combustion will gather in the flue portion of the water heater. Blow through the flue occasionally with compressed air as well. Be sure to wear eye protection when performing this step because of flying debris that may be present.

In addition to general cleaning and blowing off the water heater with compressed air, the following components will need periodic attention:

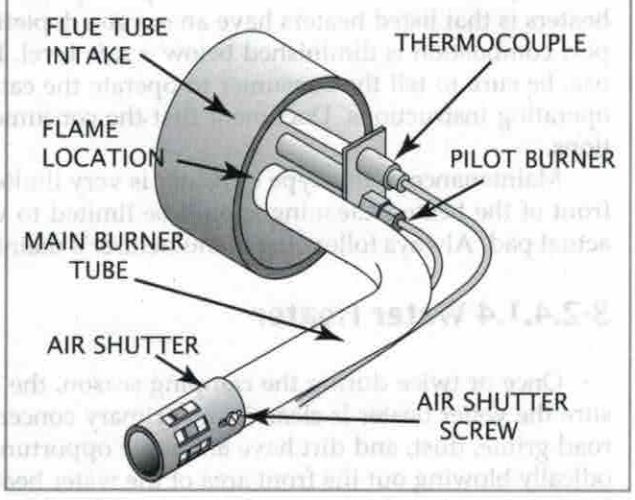
Electrode assembly. Carbon deposits that have built up on the ends of the assembly can be brushed off and the probes brightened with steel wool or emery cloth. Inspect the probes and replace the assembly when the probes become pitted. Check the gap between the probes. If the electrode assembly has three probes, the gap between the spark probe and the ground should be half as much as the gap between the ground probe and the flame sense probe. Adjust or move only the probe not connected to the ceramic insulator to achieve this spacing. Additionally, never allow the spark to jump from the spark probe to the flame sense probe. A new printed circuit board will be needed should that occur. If the electrode assembly has only two probes, the gap should be approximately 1/8 in. Take care when adjusting these probes. If any portion of the ceramic insulator becomes cracked or broken, the entire electrode assembly needs to be replaced. Check for rust in the flue and J tube.

Figure 3-11 Spark Probe



Pilot assembly. If the water heater is a pilot model, it will be necessary to disassemble and clean the orifice and the pilot burner periodically. It is recommended that the orifice be soaked in a solution of acetone and then air dried. Never insert anything into or through any orifice. Also, be sure not to set the pilot (flame) too high, as it could cause the energy cutoff (ECO) to blow.

Figure 3-12 Pilot Assembly

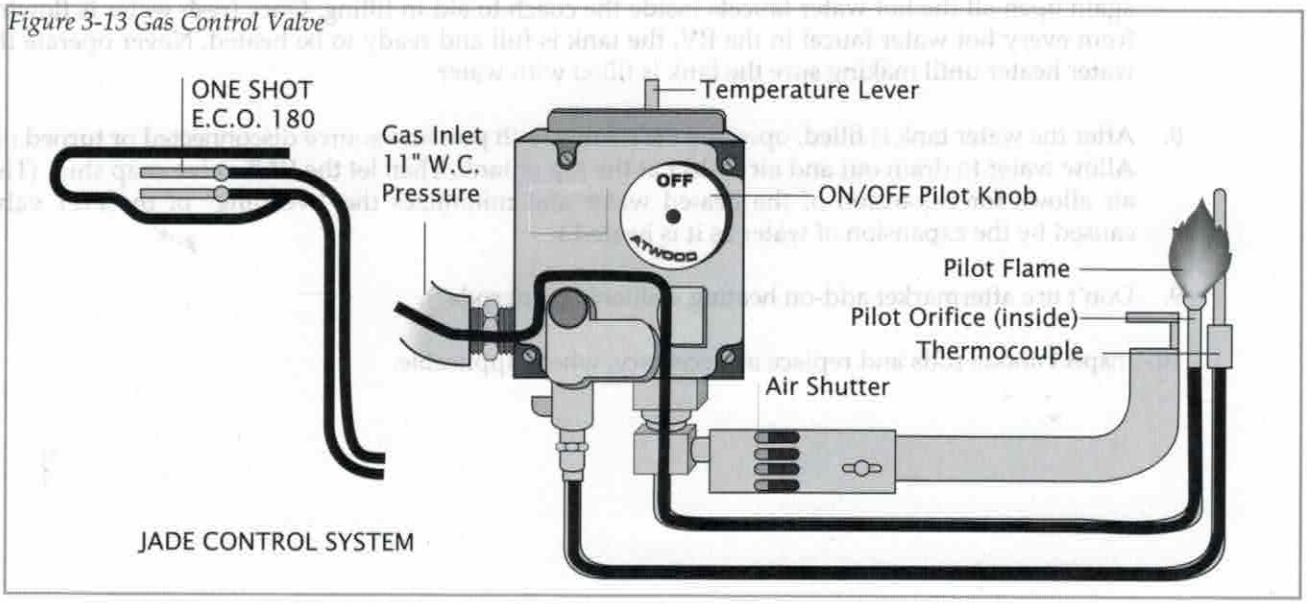


Thermocouple. Clean the thermocouple tip with steel wool or emery cloth. Keep the tip brightened and free from carbon buildup.

Printed circuit board. Clean the contact strip with a common pencil eraser where the multipin connector plugs in. Small amounts of corrosion, invisible to the naked eye, can prohibit proper conducting of current, causing erratic operation. Be careful when handling the PC board. Dropping or mishandling it can damage it.

Gas control valve. Occasionally, it may be necessary to lightly lubricate the main control knob located on top of the gas control valve. Do this only when the water heater is shut off completely. Never spray cleaners or lubricants near the water heater while it is in operation—many are flammable. A light coating of petroleum jelly or a very light white grease can be applied under the cap to the portion of the shank that revolves. It can also be applied to the push button of the gas valve.

Figure 3-13 Gas Control Valve



Mixing tube. Make sure the U-tube or mixing tube is properly centered on the main burner orifice fitting and that the alignment with the gas control valve is correct. Incorrect alignment is one of the most common reasons for improper combustion in water heaters. The mixing tube should be straight, with the flow of propane coming from the control valve, and positioned so the orifice is centered in the opening of the mixing tube. Position the air adjustment shutter to about one-fourth open to begin with, and then adjust the shutter accordingly after lighting the main burner. The roar of the main burner should be audible from farther than five feet away. The fire should be blue with tinges of yellow or orange at the very tips.

Interior tank cleaning. To extend the life of the inner tank and to eliminate the buildup of mineral deposits inside the water heater tank, backflush the heater. Mineral deposits from the water will settle to the bottom of the tank, and simply draining the tank will not rinse these deposits out. Use the following procedure for the most effective way to get mineral deposits out of the water heater tank:

1. Make sure the water in the water heater is cooled.

2. Turn off all sources of water pressure, i.e., the pump or city water connection.

3. Drain the water heater by opening the drain valve or removing the plug, depending on how the water heater is equipped. To aid in draining, open all the hot water faucets throughout the RV.

4. If water barely trickles out the drain, remove the drain valve completely and insert a straightened coat hanger into the drain opening in the tank to help break up any calcified mineral deposits.

5. Close all hot water faucets opened earlier and turn on the source of water, either the city water or the water pump. (The higher the pressure, the better. If a pressure regulator is normally used during travel, temporarily remove it for this task.)

6. Open the pressure and temperature (P&T) relief valve and allow water to pour from the drain opening and the P&T valve simultaneously.

7. Allow this flushing to continue for five to ten minutes. This will remove any stagnant water along with any mineral deposits that typically settle to the bottom of the water heater tank. After about ten minutes of flushing, turn off the water source, reinstall the drain valve or plug, and allow the P&T valve to snap shut. Refill the tank once again with fresh water. It will be necessary to once

again open all the hot water faucets inside the coach to aid in filling. Once fresh water is flowing from every hot water faucet in the RV, the tank is full and ready to be heated. Never operate the water heater until making sure the tank is filled with water.

8. After the water tank is filled, open the P&T valve with pressure source disconnected or turned off. Allow water to drain out and air collect at the top of tank. Then let the P&T valve snap shut. (This air allows for expansion of the heated water and minimizes the "weeping" of the P&T valve caused by the expansion of water as it is heated.)

9. Don't use aftermarket add-on heating elements ("hot rods").

10. Inspect anode rods and replace as necessary, where applicable.

3-2 Review

1. Propane containers need to be secured to the RV so they will not become dislodged when a load equal to eight times the container's filled weight is applied to the filled container's center of gravity in any direction.

   True False

2. ASME tanks are usually bolted to the RV's frame or floor.

   True False

3. Bolt strength is often indicated by markings on the head of the bolt.

   True False

4. Testing the propane system should be conducted at the start of each camping season or at least once a year.

   True False

5. Propane system tests should only be performed by a trained RV service technician.

   True False

6. *NFPA 1192* requires that the regulator's vent must be pointing _____ or within _____ of this vertical plane when installed.

7. Match the following

_____	Lock-up pressure test	A. Used to determine the pressure the system is delivering when at least 50 percent appliance load is functioning.
_____	Operating pressure test	B. Used to test the entire system to ensure it is leak free.
_____	Pressure drop test	C. Verifies the pressure at which the regulator prevents flow of gas through the system.

8. List at least three other functions the technician should perform as routine preventive maintenance on the propane system.

   A.

   B.

   C.

9. Every time the propane system is opened by loosening a fitting, removing an appliance, or replacing a line, or when a leak is suspected, the system must be tested for leaks by pressurizing the system and conducting a pressure drop test.

   True False

10. The maximum allowable pressure of the propane system is _____ inches water column.

    A. 10

    B. 12

    C. 14

    D. 16

11. List the two methods a technician can use to locate a leak.

    A.

    B.

12. Always use a second (backup) wrench when opening or closing propane fittings.
    True False
13. The following steps have been taken when replacing an appliance:
    A. The propane system has been shut off at the container.
    B. The batteries have been disconnected.
    C. The electrical lines have been disconnected.
    D. Using two wrenches, the propane line has been opened, separating the appliance from the gas source.
14. Black soot at the furnace outside exhaust vent is an indication of possible _____.
15. Incomplete combustion by-products are soot and _____.
16. When cleaning a furnace pilot orifice, it is recommended that the orifice be soaked in a solution of _____.
    A. hot, soapy water
    B. leak detector fluid
    C. acetone
    D. silicone
17. When cleaning the end of the thermocouple on a pilot model furnace, _____ should be used.
    A. plain, dry paper
    B. sand paper
    C. acetone
    D. fine steel wool
18. _____ should be used when cleaning the electrical contacts on a wall thermostat.
    A. Plain, dry paper
    B. Sandpaper
    C. Acetone
    D. Fine steel wool
19. Cleaning the interior of the water tank of a hot water heater should be done by _____.
    A. using compressed air
    B. backflushing
    C. soaking with a "Drano®"-type solution
    D. using hot, soapy water

Chapter

3-3 Checking the 120 VAC Electrical System

- Interpret and understand manufacturer maintenance schedules.
- Check 120 VAC electrical systems.

3-3.1 Shoreline Power Cord

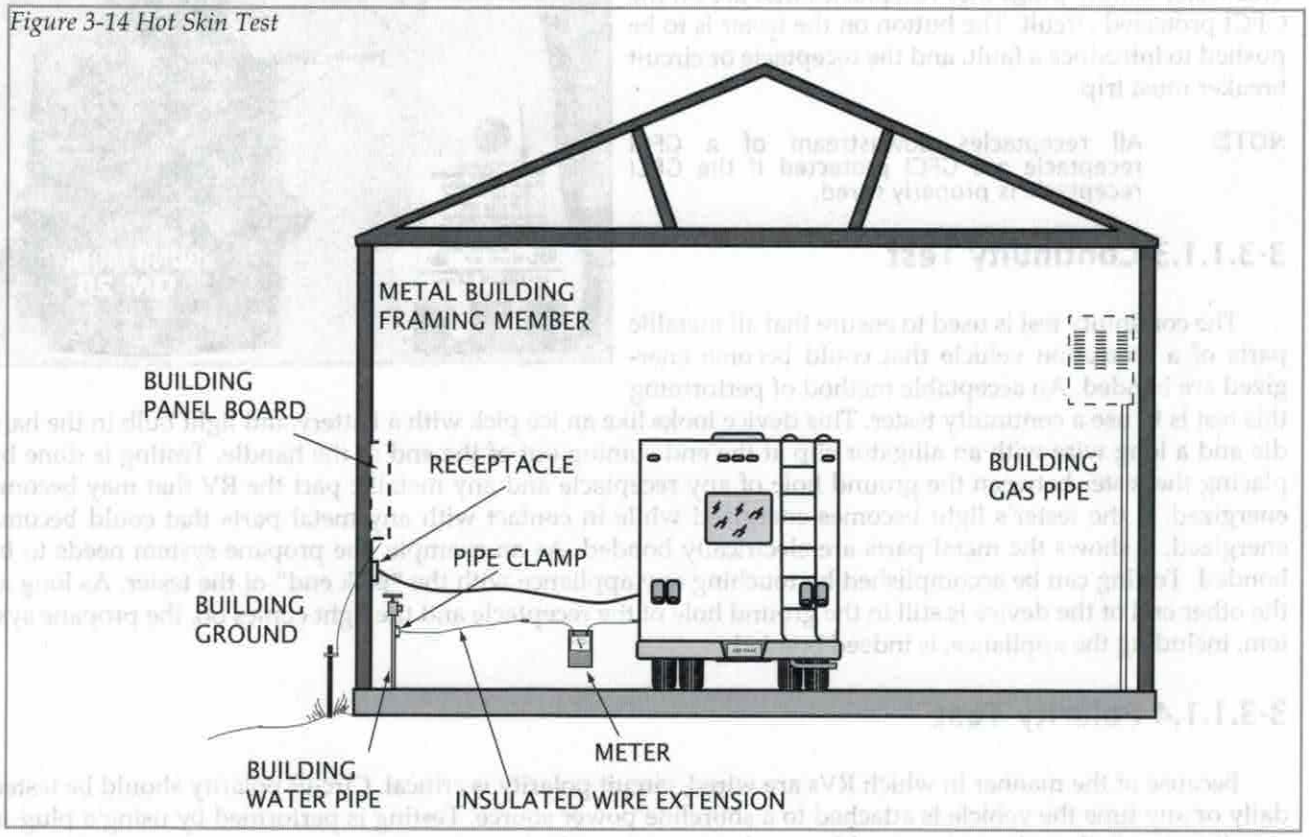
The shoreline power cord conveys electricity into the coach from a stationary source. Because of this it is exposed to the elements. To keep the cord in good shape and easy to handle, it should be wiped clean with a damp cloth after it has been disconnected from its stationary connection and prior to stowing it in its compartment. Check the power cord for cuts or scrapes that penetrate the outer covering of the cord.

3-3.1.1 Tests for the 120 VAC System Voltage Supply

Test for proper voltage (110 to 120 VAC) using a multimeter at each outlet in the RV with the RV plugged in. Also check for proper voltage output of both the generator and inverter by checking receptacles with the generator running and by checking receptacles serviced by the inverter with the unit unplugged and the generator off.

3-3.1.1.1 Hot Skin Test

Figure 3-14 Hot Skin Test



determine if the fault is at the source or in the RV. If the problem is at the source, which is determined by using the plug-in tester at the source receptacle, contact the owner/operator that controls the source. If it is determined that the condition is in the RV wiring, search for the location of the problem through a process of isolation. When the problem is located, repair the fault.

3-3 Review

1. To test for proper AC voltage at each outlet, a _____ would be used.
   A. manometer
   B. hydrometer
   C. multimeter
   D. amp meter
2. A reading on the voltmeter during a properly conducted hot skin test indicates _____.
   A. there is an electrical short
   B. there is no problem
   C. there is an open circuit
   D. there is a problem with the voltmeter
3. Fiberglass and other nonmetal composite materials have eliminated the need to conduct a hot skin test.

   True False
4. High resistance shorts do not cause breakers to trip or fuses to blow.

   True False
5. Which of the following electrical tests should be conducted on every RV that is having service to the electrical system.
   A. continuity test
   B. polarity test
   C. hot skin test
   D. GFCI test
6. A polarity test is used to ensure that all metallic parts of an RV that could be energized are bonded.

   True False
7. Circuit polarity should be tested daily or any time the vehicle is attached to a shoreline power source.

   True False

Chapter

3-4 Servicing the 12 VDC Electrical System

- Service batteries.
- Service electrical systems.
- Interpret and understand manufacturer maintenance schedules.

3-4.1 Servicing the Battery(ies)

RVs are equipped with two electrical systems that operate equipment and devices from the power supplied by batteries. The systems are often referred to as the *12 VDC chassis system* and the *12 VDC house system.* The 12 VDC chassis system has one or more 12 VDC automotive batteries to supply power for chassis components such as the ignition system, electronic fuel injector (if equipped), running lights, air conditioning, and so forth. The system consists of an alternator, an automotive battery for starting, and all the necessary wiring fuses, circuit breakers, and other components common to an automotive electrical system. The 12 VDC house system has one or more 12 VDC batteries or two 6-VDC batteries in series, which are designed to charge and discharge many times. This system operates such accessories as interior lights, fans, furnaces, and water pumps. It's usually isolated from the chassis electrical system so that house appliances cannot drain the automotive battery. The house batteries are charged by the same engine-mounted alternator that charges the automotive battery. An isolator or solenoid prevents any interconnection between batteries in the two systems. Systems using battery power are commonly referred to as being direct DC current systems, 12 VDC systems, or low-voltage systems. To get the most out of the system, the batteries must be charged and maintained. If the batteries are in poor condition, they will not be able to hold a proper charge.

Visually inspect the battery to ensure that it is secured and in its proper place. Visually inspect hold-down brackets, straps, and other tie-down devices to make sure the batteries are secured to minimize shifting and stress on the battery connections.

NOTE: WEAR EYE PROTECTION. Wear eye protection whenever there is even the slightest risk of eye injury. Face shields, safety goggles, and safety glasses protect from injuries resulting from splashed acids, solvents, or and flying metal fragments. Eye protection should always be worn in shop areas to avoid injury. Eye injuries can occur from hazards created by other employees. Safety glasses should include side shields and meet OSHA and CSA standards.

It should be noted that a physically dirty battery can have a parasitic draw created by the electron flow across the dirt, dust, moisture, and grime on the top of the battery. Inspect the battery terminals to be sure there is not an undue buildup of corrosion. This corrosion looks like a lumpy white sand and should be cleaned off. Cleaning should include both mechanical and chemical cleaning. A battery terminal brush should be used to mechanically clean the surface of the battery posts and the battery cable terminals. Using regular baking soda and water will clean the terminals chemically, and applying a petroleum solution will help prevent future corrosion buildup.

Inspect the terminal connections on the battery cables. Make sure they are tight and all the copper strands of the cables are in the terminals. If necessary, tighten or replace the terminal connectors. Be sure the top of the battery is clean.

Finally, check the battery's electrolyte level. Electrolyte is a combination of sulfuric acid and distilled water. Electrolyte is very corrosive and can cause severe burns to skin and eyes and damage painted surfaces, metal parts, and clothing.

NOTE: WEAR EYE PROTECTION. Wear eye protection whenever there is even the slightest risk of eye injury. Face shields, safety goggles, and safety glasses protect from injuries resulting from splashed acids, solvents, and flying metal fragments. Eye protection should always be worn in shop areas to avoid injury. Eye injuries can occur from hazards created by other employees. Safety glasses should include side shields and meet OSHA and CSA standards.

Always be extremely careful when working with electrolyte fluid. If the electrolyte level is low, fill the battery cells to the "full" level with distilled water. If water was added, proceed to place the battery on a charger.

After the battery has been fully charged, check the strength of the battery charge using a temperature-compensated hydrometer.

To check the battery charge with a hydrometer, proceed as follows:

NOTE: WEAR EYE PROTECTION. Wear eye protection whenever there is even the slightest risk of eye injury. Face shields, safety goggles, and safety glasses protect from injuries resulting from splashed acids, solvents, and flying metal fragments. Eye protection should always be worn in shop areas to avoid injury. Eye injuries can occur from hazards created by other employees. Safety glasses should include side shields and meet OSHA and CSA standards.

1. Remove the battery cell caps.
2. Insert the hydrometer syringe into the cell and withdraw electrolyte to the required level.
3. Hold the hydrometer slightly above the height of the battery and read the hydrometer at eye level.
4. Compare the specific gravity reading shown on the hydrometer with the following table to determine the level of battery charge.
5. Return the electrolyte to the battery cell.
6. Repeat procedures for remaining cells.
7. If there is more than 0.05 difference in specific gravity between any two cells, there is a problem, and the battery will need to be replaced.

Table 3-1 Specific Gravity Values

Charge Level (%)	Specific Gravity
100	1.265
75	1.223
50	1.190
25	1.155
Discharged	1.120

3-4.2 Testing the DC Power Source Voltage Output

Knowing the voltage output of the DC source will tell a technician quite a bit about the system.

3-4.2.1 Batteries

The available voltage of the battery can be determined by conducting an open-circuit voltage test. Use this test only on batteries that have not been charged in the last eight to ten hours. This will allow the surface charge to dissipate. To conduct a open circuit battery voltage test, proceed as follows:

1. Disconnect the negative battery cable to ensure there is no load on the battery.
2. Connect a voltmeter across the negative and positive posts of the battery and read the voltage shown on the meter. Compare the voltage reading with *Table 3-2*.

3. Reconnect the negative battery cable.
4. Perform a battery load test. Follow the load tester's operating instructions.

Table 3-2 Open-Circuit Voltage

Volts	State of Charge (%)
12.6 or higher	100
12.4	75
12.2	50
12.0	25
11.7 or lower	Fully discharged

3-4.3 Operational Test of Each Lighting Fixture and Device

Once the power source(s) have been verified, systematically conduct an operational test of each item that uses low-voltage power. Turn on each light, appliance, and device. Note any that do not work and fix them accordingly.

3-4 Review

1. The two electrical systems powered by battery on an RV are commonly called the _____ and the _____.
2. An _____ prevents any interconnection between batteries in the two systems.
3. To chemically clean battery terminal, use _____.
4. Electrolyte is a combination of sulfuric acid and petroleum jelly.
   True False
5. Specific gravity is measured using a manometer.
   True False
6. The available voltage of a battery can be determined by conducting a closed-circuit voltage test.
   True False
7. A battery that tests 11.7 V or lower is considered to be fully discharged.
   True False

Chapter

3-5 Inspecting the RV's Exterior

- Service exterior electrical.
- Interpret and understand manufacturer maintenance recommendations.
- Service sealants and mouldings.
- Service chassis.

3-5.1 Checking the Exterior Lighting System

1. Check for cracked and broken lenses and bulbs. Replace any damaged items found.
2. Inspect light housing seals on the RV. Seal as needed with a manufacturer-recommended sealant.
3. Service light sockets and ground connections as needed. Ground paths for the exterior lights may be the RV's aluminum skin. In these RVs, a screw holding the light onto the RV is the point of ground. Use a screwdriver to tighten the screw. In some instances, a larger-diameter screw may be needed to reestablish ground continuity.

3-5.1.1 Grounds (Return Paths)

Locate the ground returns for each circuit. Often in an RV, all grounds are located at a single buss bar, and the primary ground wire to the chassis is connected between this buss bar and the chassis. Locate the chassis connection and be sure it is tight and corrosion free. If there is corrosion on the termination fitting of the ground wire, clean it off with a wire brush or a baking soda and water solution.

3-5.1.2 Clearance and Identification Lamps

These lamps are the amber and red lights on the front, side, and rear walls of RVs. Clearance lamps are amber in the front, front sidewalls, and in the middle of sidewalls of units 30 ft or more in overall length. Red clearance lamps are used on the back and rear sidewalls.

Operate the clearance and identification lamps and verify that they all function.

3-5.1.3 Headlights, Brake Lights, Signal Lights, and Backup Lights

Check headlight aim in accordance with a recognized procedure. Adjust as required.

NOTE: Headlight adjustment should be done with the RV in loaded condition

NOTE: If there is no equipment available, take the motorhome to a truck service center and have the headlights adjusted and aimed.

Check brake-light operation, including high-mount brake lights.
Check signal-light operation, including front, side, and rear as equipped.
Check backup-light operation.

3-5.1.4 Exterior, Docking, and Compartment Lights

Check all exterior lights for operation.
Check all docking lights for operation.
Check all compartment lights for operation.

3-5.1.5 Inspect Sealants and Moldings

When looking at the vehicle's exterior, be sure to inspect all moldings and sealants. If they are cracked or otherwise damaged, either replace or repair them according to the manufacturer's recommendations. Areas to inspect include:

1. Windshield
2. Windows
3. Doors and compartment doors
4. Roof seams

3-5.1.6 Inspecting and Replacing Windshield Wiper Blades

Spray water on the windshield and operate the wipers. If the field of view is not being wiped clear, it may be necessary to adjust the wiper blades. If the adjustment is correct and there are still areas not being wiped clear, replace the wiper blades and recheck.

NOTE: There is no review for this chapter.

Chapter

3-6 Checking Fluid Levels on Motorized RVs

- Identify lubricants and proper applications.
- Inspect and service coolant.
- Inspect and service brake fluids.
- Inspect and service transmission fluids.
- Inspect and service power steering fluids.
- Inspect and service engine oil.
- Service and understand manufacturer maintenance recommendations.

3-6.1 Coolant Level

The RV engine coolant level should be checked. This check should be performed only when the engine is cold.

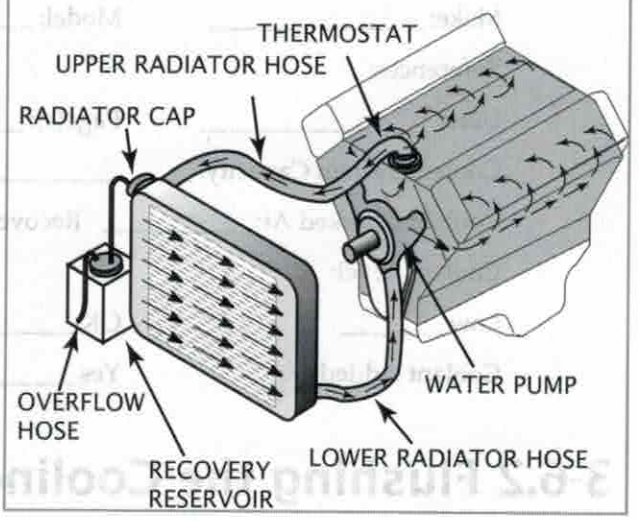
The coolant is approximately 50 percent water and 50 percent ethylene glycol, commonly referred to as *permanent antifreeze*. Adding this proportion of ethylene glycol to the coolant system lowers the freezing point of water to about -34°F (-37°C) to help prevent winter freezing of the liquid. This also prevents the liquid from boiling until approximately 230°F (110°C) instead of the 212°F (100°C) temperature at which water normally boils. Additives and inhibitors are added to the antifreeze to lubricate moving parts in the system, help to prevent rust formation, and reduce foaming in the coolant systems. New RVs are filled with coolant before leaving the factory, and coolant changes are recommended every 12 to 24 months, as the benefits of antifreeze are lost over time. Before adding coolant, check the manual for the correct type of coolant.

3-6.1.1 Pressurized Coolants

All recreation vehicle engines have pressurized coolant systems (see *Figure 3-16*). The pressure is created by the expansion of the coolant and controlled by a pressurized radiator cap. The coolant must reach approximately 15 psi (pounds per square inch) pressure before it is allowed to flow into the recovery bottle.

NOTE: NEVER remove a radiator filler cap from a vehicle while the engine is running. Because the coolant system is pressurized, ANY release of pressure will allow the coolant to boil. Steam will force coolant out of the filler neck and cause severe burns. If additional coolant is needed, it is added to the recovery reservoir.

Figure 3-16 Sample Pressurized Coolant System



3-6.1.2 Checking Coolant Level

1. Check the coolant level in the recovery reservoir when the engine is cold.

NOTE: If no coolant is present in the overflow recovery reservoir, the radiator coolant level will need to be checked and filled.

2. If it is below the FULL level, mix equal parts water and ethylene glycol, remove the recovery reservoir cap, fill to required level, and replace the cap.

The procedure for checking and adding coolant at the radiator is as follows:

NOTE: Never remove the radiator filler cap from a running or hot engine. Serious burns resulting from scalding coolant and steam can occur, along with cooling system damage.

1. Wrap a heavy shop rag around the radiator filler cap.
2. Remove the radiator filler cap. At the first detent, any pressure in the system is released.

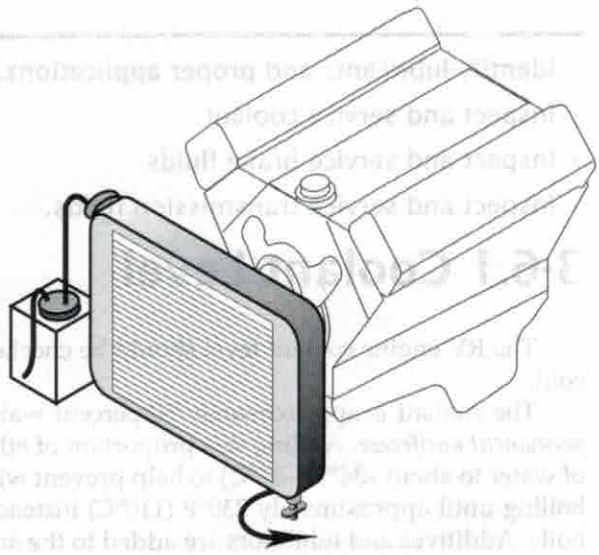
NOTE: STAND BACK, AWAY FROM THE RADIATOR, UNTIL ALL PRESSURE HAS BEEN RELEASED.

3. Ensure all the pressure has been released.
4. Push down and turn the radiator filler cap and lift off the cap.

NOTE: Never add coolant to a hot engine unless the engine is running. Coolant should be added slowly to prevent the engine head or block from cracking

5. Add coolant to the radiator if necessary; use one part water to one part ethylene glycol.
6. Replace the radiator filler cap, turning it clockwise until it is tight.

Figure 3-17 Removing the Radiator Pressure Cap



After adding coolant to the system, the engine should be run for approximately an hour, and the coolant's specific gravity should be checked and recorded.

3-6.1.2.1 Coolant Inspection Information

Make: _____ Model: _____ Year: _____

References:

Used: _____ Page(s): _____

Coolant System Capacity: _____ (Quarts)

Coolant Checked At: _____ Recovery Reservoir _____ Radiator Filler Cap

Coolant Level:

Low _____ OK _____ Too High _____

Coolant Added: Yes _____ No _____

3-6.2 Flushing the Cooling System

To maintain maximum cooling system efficiency, the system needs to be cleaned periodically. In addition, the coolant needs to be replaced to prevent corrosion of the cooling system parts. Manufacturers recommend that engine coolant be replaced at least every one to two years.

Regardless of the cleaning product or flushing equipment used, it is very important that the technician read and understand all instructions for the specific product and equipment being used. Listed below are several factors to consider when cleaning and flushing the recreation vehicle cooling system.

1. System cleaners can cause burns and are poisonous. Use EXTREME care when working with them.

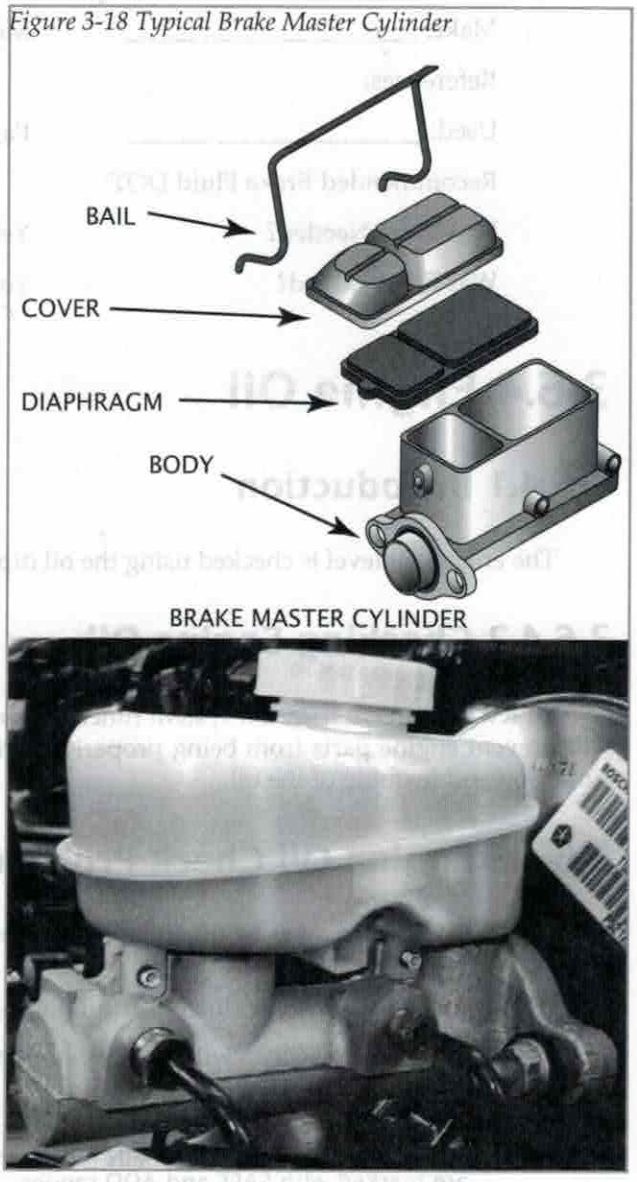
2. Chemical cleaners can damage the vehicle's finish. Use care when putting the cleaners into the system. It is also important to use drain hoses to direct the cleaner away from the vehicle while flushing the system.
3. Removal of the thermostat increases the flow rate through the system during the cleaning process.
4. Turning the dash heater to the high/wide-open position allows maximum flow through the heater.
5. When using equipment that utilizes the shop air supply, remember to limit the MAXIMUM PRESSURE TO 20 psi. Higher pressure will damage the radiator, water pump seal, and block core plugs.
6. Completely flush the cleaner from the system. If any of the cleaner is left in the system, the corrosion inhibitor in the antifreeze will be neutralized.
7. When refilling the system, add the needed antifreeze first. Then fill the system with water (soft water is recommended). This will ensure that the required amount of antifreeze has been added.

Carefully read the label instructions of the cleaner being used. Read the operating directions for the flushing equipment being used and verify the flushing instructions from the vehicle manufacturer.

NOTE: WEAR EYE PROTECTION. Wear eye protection whenever there is even the slightest risk of eye injury. Face shields, safety goggles, and safety glasses protect from injuries resulting from splashed acids, solvents, and from flying metal fragments. Eye protection should always be worn in shop areas to avoid injury. Eye injuries can occur from hazards created by other employees. Safety glasses should include side shields and meet OSHA and CSA standards.

Follow the manufacturer's requirements and procedures when replenishing the coolant system.

Figure 3-18 Typical Brake Master Cylinder



3-6.3 Service Brake Fluid

3-6.3.1 Checking Brake Fluid Level

Brake systems have reservoirs that are usually located in the engine compartment, on the driver's side of the RV. Reservoirs are either plastic or metal. The brake fluid level in a plastic reservoirs can be visually inspected without removing the cover. The brake fluid level in a metal reservoir can be checked only after the cover(s) have been removed.

Covers on metal reservoir are either bail or clamp type. Plastic reservoirs may have one or two threaded caps.

Brake fluid is corrosive; it will remove paint, burn skin, and possibly cause eye injury.

NOTE: WEAR EYE PROTECTION. Wear eye protection whenever there is even the slightest risk of eye injury. Face shields, safety goggles, and safety glasses protect from injuries resulting from splashed acids, solvents, and from flying metal fragments. Eye protection should

always be worn in shop areas to avoid injury. Eye injuries can occur from hazards created by other employees. Safety glasses should include side shields and meet OSHA and CSA standards.

Refer to the manufacturer's service manual for procedures on how to check, add, and flush the brake fluid in the RV brake system. Refer to the manufacturer's specifications for information on the type of brake fluid used in the RV brake system.

NOTE: Clean the brake fluid reservoir cover(s)/cap(s) thoroughly with a clean shop towel to prevent contaminants from falling into the reservoir.

3-6.3.2 Brake Fluid Level Inspection Information

Make: _____ Model: _____ Year: _____

References:

Used: _____ Page(s): _____

Recommended Brake Fluid DOT:

Was Fluid Needed? Yes _____ No _____

Was Fluid Added? Yes _____ No _____

3-6.4 Engine Oil

3-6.4.1 Introduction

The engine oil level is checked using the oil dipstick with the engine stopped.

3-6.4.2 Checking Engine Oil

An RV's engine lubrication system functions properly only when the oil level is maintained. Too little oil will prevent engine parts from being properly lubricated, whereas too much oil may cause excessive oil consumption and foaming of the oil.

3-6.4.3 Engine Oil Check Procedure

NOTE: The engine must be off for at least three minutes and parked on a level surface before an accurate oil check can be made.

1. Locate and remove the dipstick from the engine.
2. Wipe the dipstick clean with a clean shop towel or paper towel.
3. Locate oil level markings on the dipstick.

NOTE: Some dipsticks are labeled MIN for minimum and MAX for maximum oil levels, while others are marked with SAFE and ADD ranges.

4. Reinsert the dipstick until seated in the tube.
5. Remove the dipstick and keep its tip pointing down.
6. Read the oil level on the dipstick. Reinsert the dipstick in the tube.

7. If oil needs to be added, add the oil grade recommended by the manufacturer as in steps 8 through 11.
8. Locate and remove the engine oil cap.

NOTE: NEVER add oil so that the level goes above the operating or full level.

9. Pour in the motor oil using a funnel.
10. Reread the dipstick.
11. Repeat until the dipstick reading is at the full level.

3-6.5 Automatic Transmission Fluid

The automatic transmission fluid level is also checked using a dipstick. Because proper operation of the transmission is determined by the fluid level, this check should be carefully and accurately done.

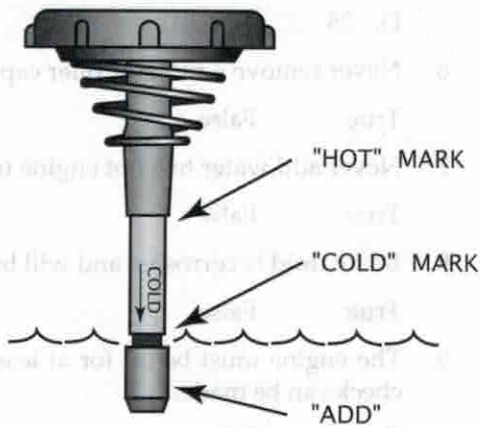
3-6.5.1 Checking Automatic Transmission Fluid

Automatic transmission fluids are available for the different designs of transmissions and must meet manufacturers' specifications. Check the owner's manual for the transmission fluid required. If there is no owner's manual, call the chassis manufacturer for this information before adding transmission fluid. Different transmission fluids ARE NOT COMPATIBLE. The addition of the wrong type of transmission fluid can seriously affect the performance or lead to the failure of the RV transmission.

3-6.5.2 Transmission Fluid Check Procedure

Follow the manufacturer's specifications and recommendations when checking the transmission fluid.

Figure 3-19 Power Steering Dipstick



3-6.6 Power Steering Fluid Level

The power steering fluid is checked by the use of a dipstick. In many cases, this dipstick is part of the cap for the power steering pump reservoir.

3-6.6.1 Checking and Adding Power Steering Fluid

The power steering fluid must be checked according to the manufacturer's procedure. Some manufacturers recommend that the power steering fluid level be checked only when the fluid is "cold" (70°F, or 21°C) while others recommend that it be checked while "hot" (160°F, or 71°C) or at normal operating temperatures. When adding power steering fluid, it must meet the manufacturer's specifications.

3-6 Review

1. Engine coolant level should be checked when the engine is hot.

   True False

2. The proper mixture of engine coolant is 50 percent water and 50 percent _____.

3. A proper mixture of engine coolant lowers the coolant freezing point to _____ °F.

   A. 0

   B. –15

   C. –34

   D. –45

4. A proper mixture of engine coolant raises the boiling temperature of the coolant to _____ °F.

   A. 212

   B. 220

   C. 230

   D. 250

5. Engine coolant must reach approximately _____ psi pressure before it can flow into the recovery bottle.

   A. 10

   B. 15

   C. 20

   D. 25

6. Never remove a radiator filler cap from a radiator when the engine is running.

   True False

7. Never add water to a hot engine unless the engine is running.

   True False

8. Brake fluid is corrosive and will burn the skin.

   True False

9. The engine must be off for at least ten minutes and parked on a level surface before an accurate oil check can be made.

   True False

10. Manufacturers use different transmission fluids. However, they are all compatible.

    True False

11. Since some manufacturers recommend checking power steering fluid when it is cold and others recommend checking it when hot, always check the owner's manual for the correct procedures.

    True False

Chapter

3-7 Fluid Replacement

- Discussion of lubricants and proper applications.
- Engine oil and filters.
- Lubricate the chassis.
- Interpret and understand manufacturer maintenance schedules.
- Flush and refill engine coolant.
- Transmission filter, gasket, and fluid.

3-7.1 Engine Oil and Filters

There are two important factors to be considered when changing engine oil. One is the selection of the correct oil viscosity. The other is determining how often to change the engine oil.

3-7.1.1 Engine Lubrication Servicing

The most common preventive maintenance performed under the hood is checking the oil. Although this is a simple procedure, using the wrong oil, allowing the oil to get too low, adding too much oil, and infrequent oil changes can all cause serious engine problems. To properly maintain the engine, knowledge of engine lubrication systems and lubricating products currently available is very important.

3-7.1.2 Engine Lubrication Systems

All engine lubrication systems have common components. They include the oil pump, oil filter, oil pan, and distribution channels called the oil gallery. Each vehicle also has a dipstick located on the engine block for measuring the amount of oil within the lubrication system.

When the engine is not running, the oil drains into the oil pan. When the engine is running, the oil is pumped by the oil pump under pressure, into the oil filter where impurities and contaminants are removed so that they do not enter the engine block. Once filtered, the oil enters the engine through a series of passages. When the engine is shutoff, the oil drains back into the oil pan where it remains until the engine is again started and the lubrication process is repeated again.

Engine oil is used to reduce friction by minimizing both wear on metal engine parts and loss of engine power. Today's engine oils perform several other important functions such as cooling the engine and creating a seal between engine parts.

3-7.1.3 Oil Additives

Oil additives are chemical compounds added to the oil during processing to improve engine lubricating and cleaning performance and to protect engine parts.

3-7.1.3.1 Anti-scuff Additives

These additives help to polish the engine's moving parts. It is especially helpful for RV engines running at extremely high temperatures (i.e. heavy loads).

3-7.1.3.2 Corrosion Inhibitors

Corrosion inhibitors help to neutralize the harmful effects of acids and water produced in the combustion process before they can damage the engine.

3-7.1.3.3 Oxidation Inhibitors

Oxidation inhibitors neutralize the harmful effects of sludge and varnish. Sludge is a by-product of engine combustion. Varnish forms on engine surfaces when the sludge is cooked by the high engine temperatures.

3-7.1.3.4 Detergents & Dispersants

Detergents and dispersants keep contaminants suspended in the oil, to be removed from the oil as it passes through the oil filter and help keep clean the engine parts.

3-7.1.3.5 Foam Inhibitors

Foam inhibitors reduce oil foaming caused by heat, agitation, and air and oil mixing. Foaming reduces the lubrication properties of oil leading to engine damage.

3-7.1.3.6 Viscosity Index Improvers

These additives improve the oil by giving it more body at high temperatures. They also improve the oil's ability to flow at low temperatures.

3-7.1.3.7 Pour-Point Depressants

As a viscosity index improver, pour-point depressants improve oil fluidity at low temperatures. This reduces engine cranking efforts in cold weather and improves lubrication during cold weather warm-ups.

3-7.1.4 Synthetic Oils

Synthetic oils were developed when crude petroleum supplies were scarce. They are chemically produced and/or altered compounds falling into two groups. One class is called "esters" and is produced from the chemical reaction between alcohol and acids. The second class is formed from man-made hydrocarbons resulting from the reconstruction of hydrogen and carbon molecules.

Claims of synthetic oil manufacturers as to its superior performance include: greater viscosity, stability over a wider temperature range, reduced friction, improved power and fuel economy, reduced evaporation loss, and reduced oil consumption.

Manufacturers claim extended mileage between oil changes when synthetic oil is used. The disadvantage of synthetic oils is their increased cost.

3-7.1.5 Viscosity

Viscosity for motor oils are established under the guidelines of the Society of Automotive Engineers (SAE). Viscosity is the ability of oil to flow. As oil heats, it thins. Therefore, a low viscosity oil (SAE 5) will lubricate well in a cold engine, but as the engine heats, it thins and becomes less effective in preventing friction and wear. The lower the viscosity number, the thinner the oil. The higher the viscosity number, the thicker the oil. A high viscosity oil (SAE 40) will lubricate well at high operating temperatures, but is too thick to prevent engine wear when starting the engine in cold conditions.

Multigrade or multiviscosity oils were developed to solve these operation problems. A SAE 10W-30, for example, will flow as a SAE 10W when cold, and as a SAE 30 weight when hot. Samples of different viscosities available are:

SAE 5W - 30: A cold-weather oil.

SAE 10W - 30: An all-weather oil.

SAE 10W - 40: An all-weather oil.

SAE 20W - 30: A high-temperature (hot weather or high rpm), anti-wear oil.

SAE 15W - 50: A high-temperature (hot weather or high rpm) oil.

3-7.1.6 Oil Changing Procedure

Changing the oil is an easy procedure, and a very important one in providing the engine with effective lubrication. A damaged oil plug, gasket, or threaded hole in the oil pan can cause oil leakage which can prevent engine lubrication and destroy the engine. Engine oil should be changed when it is hot. If it is cold, run the car 5 minutes before stopping the engine and draining the oil. Always replace the oil filter when the oil is changed. A dirty or clogged oil filter reduces oil circulation and therefore reduces the oil's effectiveness.

Equipment needed:

- Frame contact lift
- Service manual
- Drain pan
- Clean shop rags
- Funnel/can spout
- Oil
- Oil filter
- Box or socket wrench
- Safety glasses

Steps to follow in changing oil:

1. Lift (and support) the RV.
2. Locate the drain plug on the engine oil pan. It is usually on the bottom (check service manual, if necessary).
3. Locate a drain pan under oil plug.
4. Using a box or socket wrench, loosen and remove the hexagonal drain plug with a socket, while covering your hand with a rag to prevent against being burned by the hot oil.

NOTE: The correct size socket or box-end wrench prevents the plug from being rounded off.

5. Inspect the plug and gasket for damage, replacing them if they are damaged.
6. Once the oil has been completely drained out of the oil pan, carefully thread the plug into the oil pan hole.

NOTE: If the plug is loose, or can be pulled out, replace it with a new plug. If the new plug is loose, fit an oversized plug into the oil pan, making sure the gasket is in place.

7. Using a box-end or socket wrench, carefully tighten the plug.
8. Remove and empty the used oil into the appropriate receptacle, and store the pan.
9. Lower the RV to the shop floor.
10. Remove the old oil filter and dispose of it properly. Install a new oil filter (See procedure below).
11. Fill the crankcase with the amount and type of oil specified by the manufacturer.

12. Start the engine and check to see that the oil pressure warning light goes off or that the oil pressure gauge registers adequate oil pressure.
13. Double check the drain plug and floor for any leaks.
14. Turn off the engine, double check the oil level and adjust it if necessary.

3-7.1.7 Replacing the Oil Filter

Oil filters are designed to trap dirt and contaminants as the oil is pumped from the oil pan into the filter. From the filter, the oil passes directly into the engine lubrication passages.

Oil filters are replaced at regular intervals because they lose filtering effectiveness. Since an oil filter retains a certain amount of old oil, RV makers often recommend that it be changed when the oil is changed to prevent contaminating the new oil with the old oil retained in the filter.

Equipment Needed:

- Service manual
- Oil filter wrench
- Oil filter
- Oil
- Drain pan
- Frame contact lift
- Safety glasses
- Clean shop rags

Steps to follow when changing an oil filter:

1. Replace an RV's oil filter according to manufacturers specifications.
2. Locate the oil filter and place a drain pan on the floor beneath it.
3. Using the oil filter wrench, turn the filter counterclockwise to loosen it.
4. Covering your hand with a clean shop rag to protect it from the hot filter/oil, remove the wrench, and unscrew the oil filter.
5. Taking a clean rag, clean the engine block where the filter is attached.
6. Put a coat of new oil on the filter gasket using a finger.

NOTE: This makes installation easier, smoother, and aids in sealing the filter to the engine block.

7. Always fill the oil filter with oil if possible before installation. This provides instant oil flow without wear on start up.
8. Screw on the new filter by hand until it contacts the engine block.
9. Tighten the filter to specifications (located on filter box).

NOTE: The oil filter wrench may have to be used to obtain this tightness.

10. Discard the old filter, empty the drain pan in an approved container and store it.
11. Lower the RV to the shop floor.
12. Check oil level, adding oil if necessary.

13. Start the engine and check to see that oil pressure warning light or oil pressure gauge registers adequate oil pressure.

NOTE: If this does not happen in 10 seconds, stop the engine, and check for leaks.

14. If the oil pressure is OK, let the engine run for a few minutes and check the filter for leaks.
15. Turn off the engine when oil has returned to oil pan; recheck the oil level (3 minutes).

3-7.2 Flushing Cooling System

To maintain maximum cooling system efficiency, the system needs to be cleaned periodically. In addition, the coolant needs to be replaced to prevent corrosion of the cooling system parts.

Most manufacturers recommend that engine coolant be replaced at least every one to two years. This replacement is necessary because the corrosion inhibitor and water pump lubricant become depleted during the heating and cooling of normal operation, and rust and scale deposits form on the cooling system passages. These deposit coatings reduce the heat transfer ability and reduce flow through the narrowest passages of the cooling system. In extreme cases, overheating of the engine may result. For this reason, the system needs to be chemically cleaned and flushed.

Although there are a variety of cleaners and flushing equipment available, some basic procedures are followed. A chemical cleaner is added to the coolant and the engine operated to circulate the cleaner to allow it to loosen rust and scale deposits. After a prescribed length of time, the coolant is drained. The system is then flushed using plain water. To help dislodge particles, the water is circulated through the system in the opposite direction of normal coolant flow. To further aid in the removal of particles of contamination, some flush equipment uses blasts of compressed air to increase turbulence. Removal of dislodged particles is a very important part of the system flushing procedure. If this contamination is not removed during the cleaning process, it can collect in small passages like the radiator tubes and totally eliminate the benefits of the cleaning job.

Regardless of the cleaning product or flushing equipment used, it is very important that the technician read and understand all instructions for the specific product and equipment being used. Listed below are several factors to consider when cleaning and flushing the recreation vehicle cooling system.

1. System cleaners can cause burns and are poisonous. Use EXTREME care when working with them.
2. Chemical cleaners can damage the vehicle's finish. Use care when putting the cleaners into the system. It is also important to use drain hoses to direct the cleaner away from the vehicle while flushing the system.
3. Remove the thermostat. This increases the flow rate through the system during the cleaning process increasing the cleaners effectiveness.
4. Turn the dash heater to the high/wide open position. This allows maximum flow through the heater for better cleaning.
5. Flush the heater core, radiator, and engine SEPARATELY to increase effectiveness of contamination removal.
6. Remember to direct the water into the system in the opposite direction to the normal flow then flushing the system.

NOTE: Some manufacturers use a check valve in the heater core so that reverse flushing is not possible, check the Service Manual.

7. When using equipment that utilizes the shop air supply, remember to limit the MAXIMUM PRESSURE TO 20 psi. Higher pressure will damage the radiator, water pump seal, and block core plugs.
8. Completely flush the cleaner from the system. If any of the cleaner is left in the system, the corrosion inhibitor in the antifreeze will be neutralized.

9. When refilling the system, add the needed antifreeze first. Then fill the system with water (soft water is recommended). This will ensure that the required amount of antifreeze has been added.

3-7.2.1 Flushing/Replenishing the Cooling System Fluids Procedure

Periodic cleaning and flushing of the cooling system is an important part of cooling system maintenance. Before starting this job, carefully read the label instructions of the cleaner being used. Read the operating directions for the flushing equipment being used as well.

Equipment needed:

- Safety glasses
- Chemical cleaner
- Compressed air
- Water
- Flushing gun and hoses
- Hand tools
- Antifreeze
- Service manual

Steps to follow when flushing/replenishing the coolant:

1. Drain the cooling system.
2. Remove the thermostat and replace the housing.
3. Add the cleaning chemical and refill the system with water.
4. Start and run engine for the time required by the cleaning product being used.
5. Stop engine and allow it to cool down.
6. Drain the system.

NOTE: If the water temperature is above 210°F, it will boil when pressure is removed.

7. Remove block drain plugs if possible.

3-7.2.1.1 Flushing the Radiator

1. Remove upper and lower radiator hoses.
2. Attach flush gun and hose to bottom (outlet) radiator connection.
3. Connect a drain hose to top (inlet) radiator connection. Direct drain hose to area underneath the vehicle.
4. Turn on water to fill radiator.
5. Make sure the air pressure from gun is adjusted to 20 psi MAXIMUM. Less pressure for older vehicles is recommended.
6. As soon as the radiator is full, apply short blasts of air.

NOTE: Be sure to allow the radiator to fill between blasts.

7. Continue this procedure until the water from the drain hose is clear.

3-7.2.1.2 Flushing the Engine

1. Disconnect the heater hoses. Cap or by-pass the heater connections on engine.
2. Connect flush gun and hose to upper radiator connection.
3. Turn on water and fill engine.
4. Apply blasts of air as water drains from engine.
5. Continue this procedure until water draining from engine is clear.

3-7.2.1.3 Flushing the Heater Core

An appropriate paraphrase of Murphy's Law is: "The more difficult it is to replace a heater core, the more likely it is to rupture during power flushing."

When flushing the heater core, USE REDUCED AIR PRESSURE and follow these steps:

1. Attach flush gun to heater outlet hose.
2. Fill heater core with water. Carefully apply blasts of air.
3. Continue until the water draining from the heater core is clear.

3-7.2.1.4 Coolant Replacement

Follow these steps when replacing coolant:

1. Replace the thermostat, radiator, heater hose, and the block plugs.
2. Determine the correct amount of antifreeze for the system being worked on.
3. Pour correct amount of antifreeze into radiator.
4. Fill system with water.
5. Replace radiator cap and bring engine to operating temperature.
6. Carefully inspect system for leaks.
7. Clean work area and store tools.
8. Recheck coolant level before turning RV over to customer.
9. Check antifreeze for temperature. Make sure its mixed correctly.

3-7.3 Lubrication of Chassis and Doors

To provide long service life, the suspension, steering, and door hinge mechanism need periodic lubrication. Proper lubrication selection is very important.

3-7.3.1 Chassis Lubrication

Chassis lubricants coat the moving metal parts that contact one another to minimize friction and wear. Most manufacturers require a lithium based, multipurpose grease for chassis lubrication. But not all lubricants are compatible. Use the service manual for each vehicle being serviced to determine the correct lubricant to use.

Parts to be lubricated vary from vehicle to vehicle, as does the regular intervals of lubrication. Lubrication intervals can range from 6,000 to 35,000 miles. The service manual for a particular RV is the best guide to the correct lubricant to use, the parts to be lubricated, and the frequency of lubrication recommended.

Some RV manufacturers recommend the use of hand-operated grease guns. They do not damage boots and seals as frequently as compressed air driven grease guns do. The pressure of the hand-held grease gun is enough to force grease into the fitting to lubricate the parts. Zerk fittings have a valve that allows the lubricant to enter, but not to leak out. Many different thread sizes and angles are made.

Some manufacturers install plugs where grease fittings are normally located. This is done to discourage lubrication attempts except by professions who have the fittings to replace the plugs while lubricating, and then reinstall the plugs. Adapters are also available for grease guns that allow lubrication without installing fittings.

3-7.3.2 Rubber Bushings

Rubber bushings are used where the motion between metal parts is minimal. These are not lubricated with petroleum-based products, because the petroleum attacks the rubber, destroying the bushing. Replacement of noisy bushings is, therefore, recommended.

3-7.3.3 Chassis Lubrication Procedure

Because each recreation vehicle has different chassis lubrication recommendations, each is lubricated as indicated by its service manual. The procedure below is the typical process for completing a chassis lubrication.

Equipment needed:

- Frame contact lift
- Grease gun/adapters
- Chassis lubricant
- Safety glasses
- Service manual
- Clean shop rags

When lubricating the chassis, follow these steps:

1. Raise (and support) the RV.
2. Locate the lubrication points using the RV's service manual.
3. Using clean shop rags, wipe the area around the fittings and/or plugs clean, so that no dirt will be forced in with the grease.
4. Force grease into the fittings using a hand-operated grease gun. The correct amount of grease is in when either the rubber boots begin to expand OR the grease begins to leak from a hole designed into the boot for "bleeding" the excess grease.

NOTE: If plugs are installed at the lubrication points, remove them, and install grease fittings, or an adapter on the grease gun to force the grease into the parts. Reinstall the plugs after the parts are lubricated.

5. Apply grease to each steering stop ONLY IF RECOMMENDED BY THE MANUFACTURER.
6. Operating the lift, lower the RV to the shop floor.
7. Select appropriate lubrication for all doors, properly apply and clean-up.

3-7.2.1.2 Flushing the Engine

1. Disconnect the heater hoses. Cap or by-pass the heater connections on engine.
2. Connect flush gun and hose to upper radiator connection.
3. Turn on water and fill engine.
4. Apply blasts of air as water drains from engine.
5. Continue this procedure until water draining from engine is clear.

3-7.2.1.3 Flushing the Heater Core

An appropriate paraphrase of Murphy's Law is: "The more difficult it is to replace a heater core, the more likely it is to rupture during power flushing."

When flushing the heater core, USE REDUCED AIR PRESSURE and follow these steps:

1. Attach flush gun to heater outlet hose.
2. Fill heater core with water. Carefully apply blasts of air.
3. Continue until the water draining from the heater core is clear.

3-7.2.1.4 Coolant Replacement

Follow these steps when replacing coolant:

1. Replace the thermostat, radiator, heater hose, and the block plugs.
2. Determine the correct amount of antifreeze for the system being worked on.
3. Pour correct amount of antifreeze into radiator.
4. Fill system with water.
5. Replace radiator cap and bring engine to operating temperature.
6. Carefully inspect system for leaks.
7. Clean work area and store tools.
8. Recheck coolant level before turning RV over to customer.
9. Check antifreeze for temperature. Make sure its mixed correctly.

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To provide long service life, the suspension, steering, and door hinge mechanism need periodic lubrication. Proper lubrication selection is very important.

3-7.3.1 Chassis Lubrication

Chassis lubricants coat the moving metal parts that contact one another to minimize friction and wear. Most manufacturers require a lithium based, multipurpose grease for chassis lubrication. But not all lubricants are compatible. Use the service manual for each vehicle being serviced to determine the correct lubricant to use.

3-7.4 Transmission Fluid and Filter

To keep an automatic transmission operating smoothly, periodic replacement of the transmission fluid is necessary. Because RVs place greater demands on the drive system than do automobiles this periodic maintenance procedure is very important.

3-7.4.1 Determine the Need for Service

1. Consult the appropriate service or chassis owner's manual for guidelines.
2. Determine the vehicle service conditions.

3-7.4.2 Selecting Fluid and Filters

1. Consult the service manual to determine the correct fluid. The following are the more common automatic transmission fluids (ATF) available today.
   A. Type F: Meets Ford Motor Company Specification M2C33-F.
   B. Mercron: Meets all other Ford Motor Company Specifications.
   C. Dexron, Dexron II, Dexron IIE, and Dexron III: Meet General Motor Specifications.
   D. Dexron III/Mercron: Meets all GM and Ford Specifications except for Type F above. This is the most commonly used ATF in automobiles and trucks today.
2. Select the filter for the transmission type.
   A. Use VIN (vehicle identification number).
   B. Oil pan identification charts from manufacturers.

3-7.4.3 Changing Fluids and Filters

When changing fluids and filters, follow these steps:

1. Safely support the vehicle if needed.
2. Correctly remove the pan.
3. Remove and replace the filter.
4. Replace the pan properly.
5. Replace the fluid. Do not overfill.

3-7 Review

OIL CHANGING

Match the term with the correct description by placing the letter next to it.

_____	Additives	A. A measurement of the fluidity of a liquid.
_____	Detergent	B. An additive that keeps dirt suspended in the oil.
_____	Dispersant	C. Organization that grades motor oil viscosity.
_____	Lubricate	D. Additive that cleans engine parts.
_____	Multigrade	E. Removes dirt from motor oil.
_____	Oil Filter	F. Chemicals added to motor oils to improve their performance.
_____	SAE	G. Chemically produced motor oil
_____	Sealing	H. One of two functions of motor oil.
_____	Synthetic Oil	I. Motor oil providing lubrication over a broad temperature range.
_____	Viscosity	

COOLANT FLUSHING

Fill in the blanks.

1. Some cleaners can cause burns and are _____.
2. When flushing the cooling system, remove the _____.
3. When using an air gun to flush the cooling system make sure the gun is adjusted to _____.
4. When refilling the system add the _____ before adding water.
5. Flush the heater core, the radiator, and the engine _____.

Chapter

3-8 Inspecting Onboard Systems

- Inspect potable water system.
- Inspect wastewater systems.
- Inspect air conditioning.
- Inspect safety devices.
- Interpret and understand manufacturer maintenance recommendations.

The onboard systems discussed in this chapter are freshwater, wastewater, air conditioning, and safety devices.

3-8.1 Potable (Fresh) Water

The potable or freshwater system contains the water used in the house portion of the vehicle. It is composed of one or more plastic storage tanks, water pump, water lines, and plumbing fixtures. Proper sanitation and adding only potable water are key to maintaining the system.

To ensure complete disinfection of the potable or freshwater system, it is recommended that the following procedure be followed on a new system, a system that has not been used for a period of time, or a system that may have become contaminated. This procedure is also recommended before long periods of RV storage.

Instructions for disinfection of potable or freshwater system on recreation vehicles are as follows:

1. Prepare a chlorine solution using 1 gal of water and 1/4 cup of household bleach (sodium hypochlorite solution). With tank empty, pump chlorine solution into the tank. Use 1 gal of solution for each 15 gal of tank capacity. This procedure will result in a residual chlorine concentration of 50 parts per million (ppm) in the water system. If a 100-ppm concentration is required as discussed in item 3, use 1/2 cup of household bleach with 1 gal of water to prepare the chlorine solution. One gallon of the solution should be used for each 15 gal of tank capacity.

NOTE: Chlorine is poisonous. Recap bottle and clean utensils after use.

2. Complete filling the tank with fresh water. Open each faucet and run water until a distinct odor of chlorine can be detected in the water discharge. Do not forget the hot water taps and exterior faucets and showers.
3. Allow the system to stand at least 4 hr when disinfecting the 50-ppm residual chlorine. If a shorter time period is desired, then a 100-ppm chlorine concentration should be permitted to stand in the system for at least 1 hr.
4. Drain and flush with fresh water.

NOTE: Do not let solution remain in system for more than four hours without flushing with fresh water, as it may cause plumbing component failures.

3-8.1.1 Water Filter

Some vehicles are factory equipped with a water filter in the potable water supply system. Review the manufacturer's instructions to determine when and how the filter should be changed. Some filters must be removed from the system before sanitization or winterization of the system.

3-8.2 Wastewater

The wastewater system receives and stores liquid and body waste. The wastewater system is divided into two systems: the gray water system and the black water system. The gray water system handles wastewater

from any fixture except the toilet. The black water system handles body waste from the toilet and, in some cases, another fixture. In some RV applications, depending on floor plans, each system has its own holding tank. In some applications, both wastewater systems will flow to a common holding tank.

3-8.2.1 Waste Holding Tank Level Sensor

The holding level sensor can become coated with waste that interferes with their proper operation. Consult manufacturer's instructions for the waste holding tank level service procedure. In the event the monitor probes of the holding tank need to be replaced, be sure to properly plug the existing holes and add new sensors to the tank. The probes that penetrate the holding tank's sidewall need to be installed diagonally to ensure the best operation. If the probes are installed horizontally or stacked, toilet paper, as an example, could contact all of the probes, giving a false reading. Installing probes diagonally does not guarantee that false readings won't occur, but this positioning helps avoid those issues.

3-8.2.2 Drain Valves

Waste drain valves can sometimes become hard to operate. The use of a drain valve lubricant is recommended to maintain free operation of the valve. These products can be periodically added to the wastewater system, and between its presence in the system and the act of draining, the valves remain lubricated. A light coat of oil on the termination valve shaft will prevent rust and make valve easier to operate.

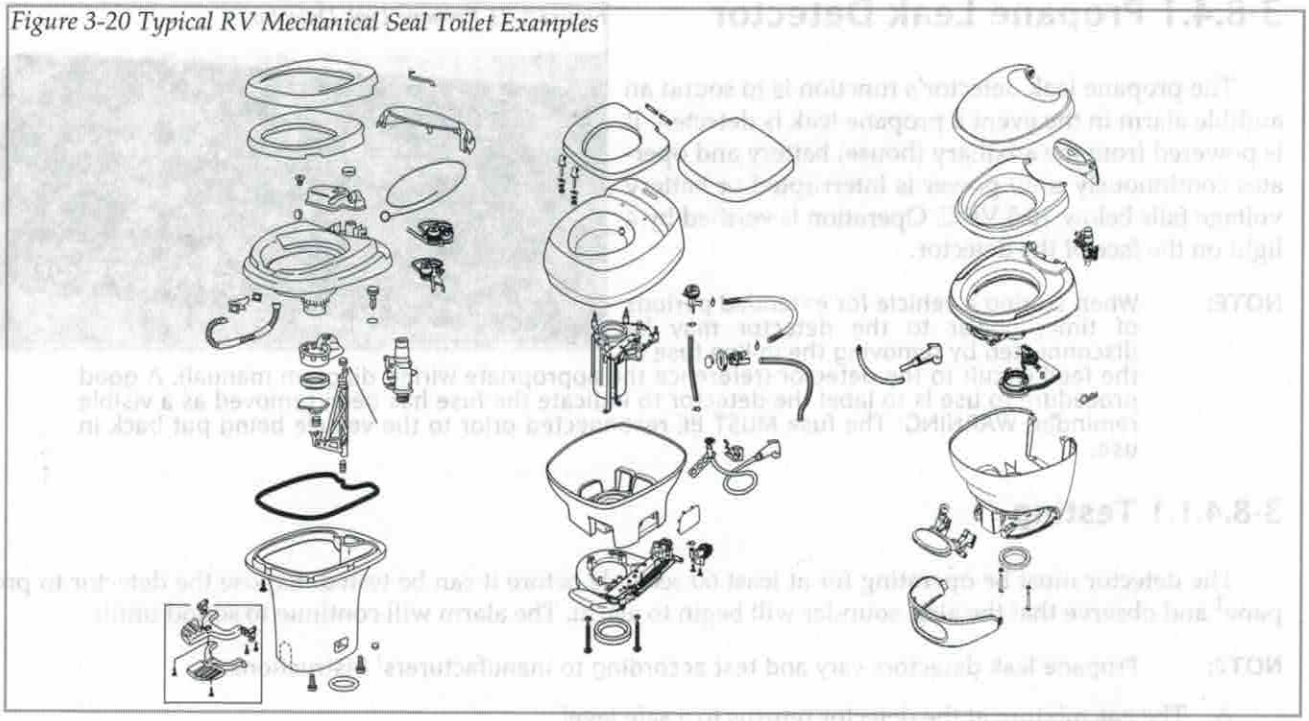
3-8.2.3 Toilet

Regardless of the style of toilet (either plastic or china), care and cleaning is the same.

1. Rinse the bowl after use.
2. Wash with a nonabrasive cleaner.

The toilet has a blade seal to maintain water in the bowl (acts as a water trap). The water in the bowl keeps black-water odors from entering the coach. This seal should be lubricated with drain valve lubricant every six months. To lubricate, simply pour 2 oz into the bowl of the toilet and allow to it stand overnight.

Figure 3-20 Typical RV Mechanical Seal Toilet Examples



3-8.3 Air Conditioning

There are two different types of air conditioning systems used in RVs: automotive air and house air.

3-8.3.1 Automotive Air Conditioning System

The automotive air conditioning system is powered by the vehicle's engine. It should be serviced and maintained according with the manufacturer's service manual.

3-8.3.2 House Air Conditioning System

The house air conditioning system is powered by 120 VAC electricity. It can be one of two styles: roof-mounted or a central package. Roof-mounted means that the unit is physically located on the roof of the vehicle. Central package units are located in a compartment below the floor line of the vehicle.

Both styles of coach air have the same maintenance requirements:

1. Clean or replace the filters on a monthly basis or sooner as needed. Roof-mounted systems may have either disposable or washable filters. Central package systems utilize disposable filters. To determine filter locations, consult the manufacturer's guide.
2. Inspect and clean the evaporator and condenser assemblies on an annual basis.

3-8.4 Safety Devices

NOTE: Do not disable or in any way alter these devices.

3-8.4.1 Propane Leak Detector

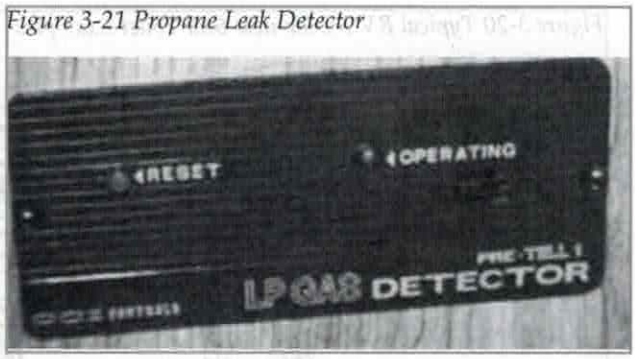


Figure 3-21 Propane Leak Detector

The propane leak detector's function is to sound an audible alarm in the event a propane leak is detected. It is powered from the auxiliary (house) battery and operates continuously until power is interrupted or battery voltage falls below 10.5 VDC. Operation is verified by a light on the face of the detector.

NOTE: When storing a vehicle for extended periods of time, power to the detector may be disconnected by removing the in-line fuse in the feed circuit to the detector (reference the appropriate wiring diagram manual). A good procedure to use is to label the detector to indicate the fuse has been removed as a visible reminder. WARNING: The fuse MUST BE reconnected prior to the vehicle being put back in use.

3-8.4.1.1 Testing

The detector must be operating for at least 60 seconds before it can be tested. Expose the detector to propane[1] and observe that the alert sounder will begin to alarm. The alarm will continue to sound until:

NOTE: Propane leak detectors vary and test according to manufacturers' instructions.

A. The gas mixture at the detector returns to a safe level.

B. The reset button is pressed. If the reset button is pressed, the detector cannot be retested for at least 60 seconds.

3-8.4.1.2 Propane Leaks

If gas can be smelled within the vehicle, quickly and carefully perform the procedures listed.

1. Extinguish any open flames, pilot lights, and all smoking materials.
2. Do not touch electrical switches.
3. Shut off the gas supply at the tank valve(s) or gas supply connection.
4. Open doors and other ventilating openings.
5. Leave the area until odor clears.
6. Have the gas system checked and leakage source corrected before using again.

3-8.4.2 Carbon Monoxide Detector

The function of the carbon monoxide (CO) detector is to alert the occupants when carbon monoxide is present at a certain level for a certain period of time. The detector is powered by an internal battery (battery pack). When the battery weakens and needs replacement, the alarm will sound.

NOTE: The LED will flash every 30 to 50 seconds. This indicates the alarm is operating normally.

NOTE: Carbon monoxide detectors vary and must be tested according to manufacturer's instructions. The following represent testing of one type of CO detector.

---

1. One method of simulating gas is to use a butane lighter. Do **NOT** rotate the flint wheel. Just press on the gas release button and point the exit nozzle into the gas-sensing area below the light of the detector.

A continuous beeping and flashing of the red LED indicates the presence of carbon monoxide. Carbon monoxide is colorless, odorless, and tasteless. If alarm sounds, shut down all combusting appliances, and open doors and windows to air out vehicle. Sensors should be replaced every five to seven years according to the manufacturer's instructions.

Test the CO detector by depressing and holding the blue test button until the red LED begins to flash and the alarm beeps continuously.

3-8.4.3 Smoke Detector

The function of the smoke detector is to alert the occupants when smoke is detected. The detector is powered by a 9-V battery, which should be replaced annually or as indicated by the detector. The detector will begin to "beep" when the battery is weak.

Keeping the detector clean is critical to its proper operation. Gently vacuum any dirt or lint from the cover using a soft brush or wand attachment on the vacuum.

Test by depressing the test button on the face of the detector. The detector should sound an audible alarm.

Figure 3-22 Smoke Detector

3-8.4.4 Fire Extinguisher

Every RV must contain a fire extinguisher at the time it leaves the factory. The fire extinguisher should be inspected. During inspection, make sure:

1. The extinguisher is charged.
2. The locking pin is in place.
3. The extinguisher is clean and free from dents, scratches, corrosion, and any other damage.
4. The discharge nozzle is clean and free of obstructions.

NOTE: Never partially discharge a fire extinguisher to test it. If an extinguisher is not fully charged, it should be refilled (rechargeable type) or replaced immediately (non-rechargeable type).

Figure 3-23 Fire Extinguisher

3-8 Review

1. List the three situations that would make sanitization of the freshwater system necessary.

   A.

   B.

   C.

2. When sanitizing the freshwater system, allow the system to stand for at least _____ hours when disinfecting the 50-ppm residual chlorine.

   A. 1

   B. 2

   C. 3

   D. 4

3. Chlorine is poisonous and must be handled with care.

   True False

4. Wastewater level sensors cannot be cleaned and must be replaced whenever they become coated and no longer function properly.

   True False

5. Drain valves and toilet seals should not be lubricated.

   True False

6. Preventive maintenance requirements for RV air conditioners is limited to:

   A.

   B.

   C.

7. A propane detector must be operational for a minimum of _____ minute(s) before it can be tested.

   A. 1

   B. 3

   C. 5

   D. 7

8. The red LED is flashing every 30 to 50 seconds on the carbon monoxide detector. This means that the carbon monoxide levels inside the RV are above the safe level.

   True False

9. Preventive maintenance on smoke detectors consists of:

   A.

   B.

   C.

10. The proper operating test for a fire extinguisher is to partially discharge it to verify pressure.

    True False

Chapter

3-9 Wheels and Tires

- Inspect wheels and tires.
- Inspect wheel bearings.
- Interpret and understand manufacturer maintenance requirements.

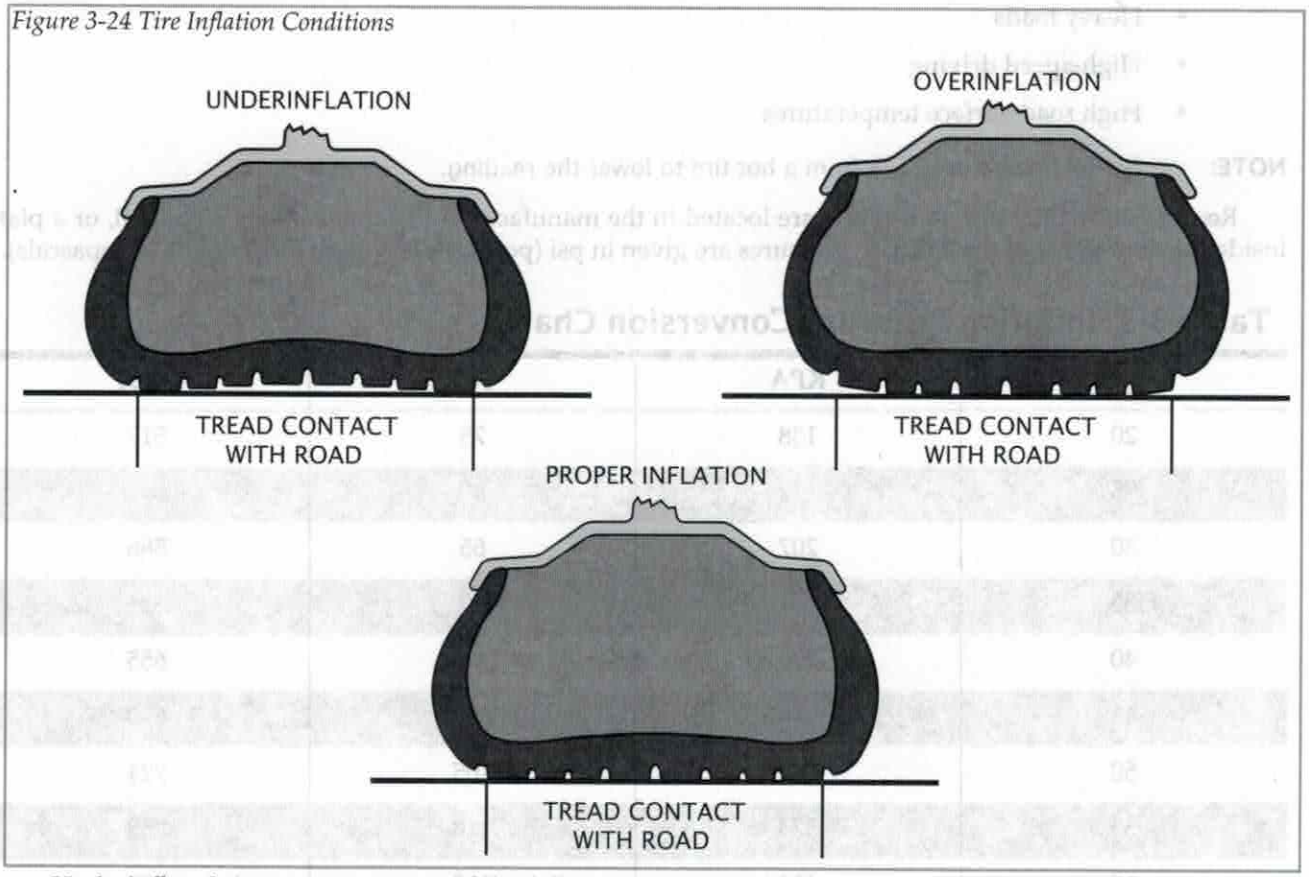
3-9.1 Tires

When tires are correctly inflated and in good condition, they will provide economy, safety, and good performance.

3-9.1.1 Checking Tire Pressure

Tire pressure should always be checked "cold." For general purposes, "cold" is to mean at 70 ± 10°F (21 ± 5.6°C). Improperly inflated tires often lead to premature tire failure, repairs to the steering and suspension systems, and tire replacement.

Figure 3-24 Tire Inflation Conditions



Underinflated tires can cause any of the following problems:

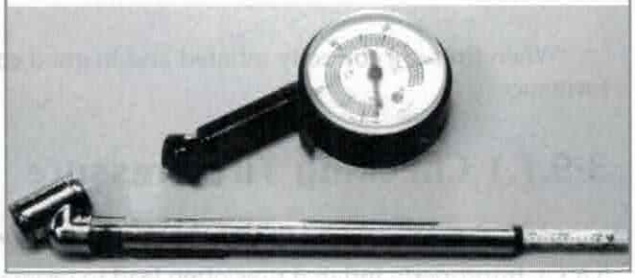
1. Poor steering response and stability along with increased steering effort
2. Abnormal tread wear on the outer edge
3. A tendency to skid and poor turn control due to tread distortion
4. Early tire failure due to heat generated by excessive flexing of the sidewalls

5. Erratic braking action
6. Increased possibility of tire and rim damage when driving in rough pavement or gravel
7. Increased fuel consumption due to increased friction and reduced tire surface

Overinflated tires pose the following performance problems:

1. Decreased tread-to-road contact
2. Poor traction
3. Excessive road shock being transferred to the steering and suspension systems, resulting in unnecessary stress of these systems and a poor ride
4. Abnormal wear in the center of the tread

Figure 3-25 Handheld Tire Pressure Gauge



The proper tire pressure of an RV varies according to the size and type of tires. Three factors can increase tire pressure up 10 psi:

- Heavy loads
- High-speed driving
- High road-surface temperatures

NOTE: NEVER release pressure from a hot tire to lower the reading.

Recommended tire pressure charts are located in the manufacturer's manual, owner's manual, or a plate inside the door panel of the RV. Tire pressures are given in psi (pounds per square inch) or kPa (kilopascals).

Table 3-3 Inflation Pressure Conversion Chart

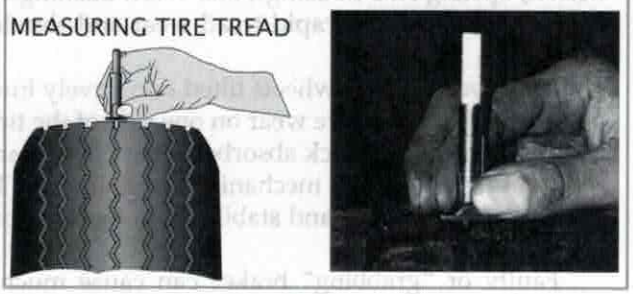
PSI	KPA	PSI	KPA
20	138	75	517
25	172	80	552
30	207	85	586
35	241	90	621
40	276	95	655
45	310	100	690
50	345	105	724
55	379	110	758
60	414	115	793
65	448	120	827
70	483		

Conversion: 6.9 kPa = 1 psi.

3-9.1.2 Measuring Tire Tread

Check the center groove in three different locations to give an overall reading. The device pictured is typical of most found in auto supply stores. Simply depress the indicator pin into the tire groove, and the reading will show against the main body of the instrument. The gauge is calibrated in 1/32 in. If the reading shows 2/32 in. or less (4/32 in. for truck front wheels), the tire is at the danger level.

Figure 3-26 Tire Wear Gauge



3-9.1.3 Inspecting Tires for Visible Damage

Inspect the tires carefully and remove from service if any of the following conditions are present:

1. Tread worn to the level of the tread wear indicators or when cord or fabric is exposed
2. Fabric break or non-repairable injury
3. Cracks, cuts, or snags deep enough to expose the body cords
4. Any indication of possible separation
5. Tire marked "unsafe for highway use," "not for highway use," "for racing purposes only," or "agricultural use only"
6. Mismatched tire sizes or types
7. Tires with less than one half the gross axle weight rating
8. Tire punctured by nails or other foreign objects
9. Rim bent, cracked, or otherwise damaged

Figure 3-27 Visible Tire Damage

3-9.1.3.1 Abnormal Tread Wear

The uneven tread wear patterns shown in *Figure 3-29* were probably caused by conditions such as wrong inflation pressure, misalignment, improper balance, or suspension neglect. These conditions can be avoided or corrected.

Mechanical irregularities often cause abnormal tread wear. Misalignment of front or rear wheels, bent wheels, sprung axle housings, and worn bushings contribute to uneven and rapid tread wear and should be corrected.

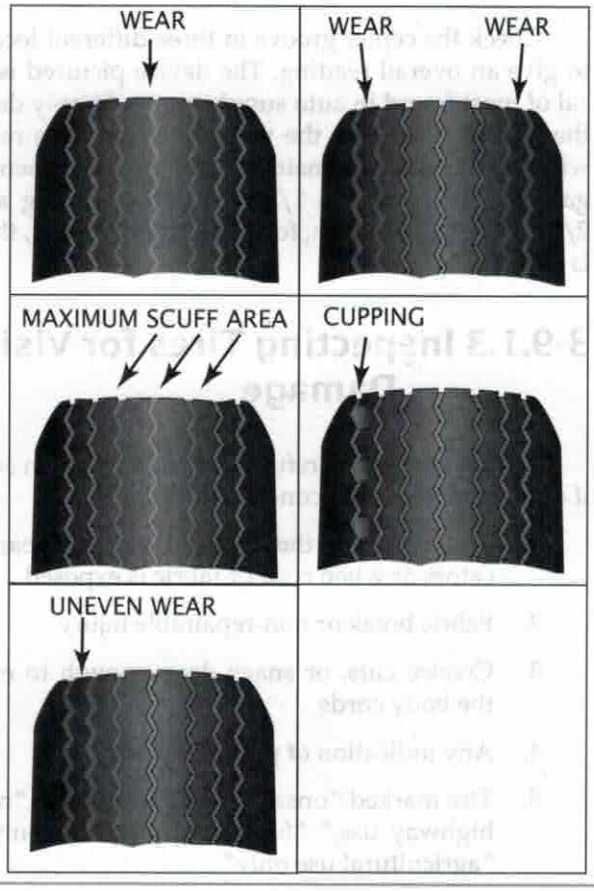
Improper camber (wheels tilted excessively inward or outward) causes more wear on one side of the tires.

Faulty or worn shock absorbers cause irregular tire wear and lead to other mechanical irregularities. They can also affect steering and stability and thereby constitute a safety hazard.

Faulty or "grabbing" brakes can cause much the same conditions as out-or-balance wheels, i.e., flat spots and bald spots.

Overweight vehicles and vehicles with improper weight distribution can adversely affect the tires directly by exceeding the recommended psi or indirectly by affecting the performance of the suspension, shock absorbers, and brakes.

Figure 3-28 Samples of Abnormal Tread Wear



3-9.1.3.2 Hidden Tire Damage

Figure 3-29 illustrates various types of tire damage. Damage often occurs before the resulting tire failure. This is frequently difficult for people to understand, but there are several reasons:

- Undetected punctures cause a slow loss of air, which results in excessive heat buildup and leads to serious tire damage; e.g., tread separation, destruction of tire body, and blowouts.
- Any tire, even a new one, may be damaged by impact. Determining factors are the size and shape of the object hit, the angle at which it is hit, and the force of the impact. Accordingly, damages vary in severity and appearance.

The body of a tire may be damaged by impact with little or no visible exterior indication. Impact or bruise injuries may cause blowouts or flat tires, but not necessarily at the time an object is struck. The tire may run many miles before failing. The break usually starts on the inside of the tire and is aggravated by the constant flexing of the tire until failure occurs.

Figure 3-30 also shows what often happens when a tire is crushed between a curb or chuckhole and the steel rim of the wheel. The angle at which the object is struck determines the position and shape of the break.

In tubeless tires, impact damage may result in a slow leak (a "slow-out" instead of a "blow-out"). Investigate any air leakage immediately.

Driving on a tire inflated below the minimum recommended level causes the tire to heat excessively. This can lead to tire damage and possibly to tire failure, which may result in vehicle damage and/or personal injury. Frequent tire inspection can detect under inflation. To prevent tire damage, always maintain the inflation pressure recommended by the vehicle manufacturer.

Overinflation creates stresses in the tire and may result in damage and/or failure due to impacts with road hazards. Never exceed the maximum inflation pressure labeled on the sidewall of the tire.

Figure 3-29 Hidden Tire Damage

3-9.2 Rotation

Tires should be inspected and rotated in accordance with the recommendations in the vehicle owner's manual or at 6,000 to 8,000 mile intervals. The first such rotation is the most important one in setting the stage for long and even tread wear. In some instances, if irregular wear begins to develop, rotation will be advisable before the recommended mileage interval. Before rotating, though, determine the cause of wear and correct any misalignment, imbalance, or other mechanical problems. Earlier and more frequent rotation may also be desirable due to differences in tread wear between front and rear wheel tires.

If tires of different size or construction (diagonal, belted bias or radial) are mixed on the vehicle, consult a tire dealer for the correct relocation of these tires.

After rotation, adjust individual tire air pressure to conform to the tire's new location on the vehicle.

3-9.3 Wheel Bearing Service

Wheel bearings should last the life of the vehicle. However, if this length of service is expected, routine maintenance is necessary.

3-9.3.1 Wheel Bearing Service Procedure

Equipment needed:

- Service manual
- Jack and safety stands or lift
- Wheel wrench
- Side cutters
- Cotter pin remover
- Tools to remove disc brake caliper, if necessary
- Measuring equipment, if necessary
- General purpose hand tools

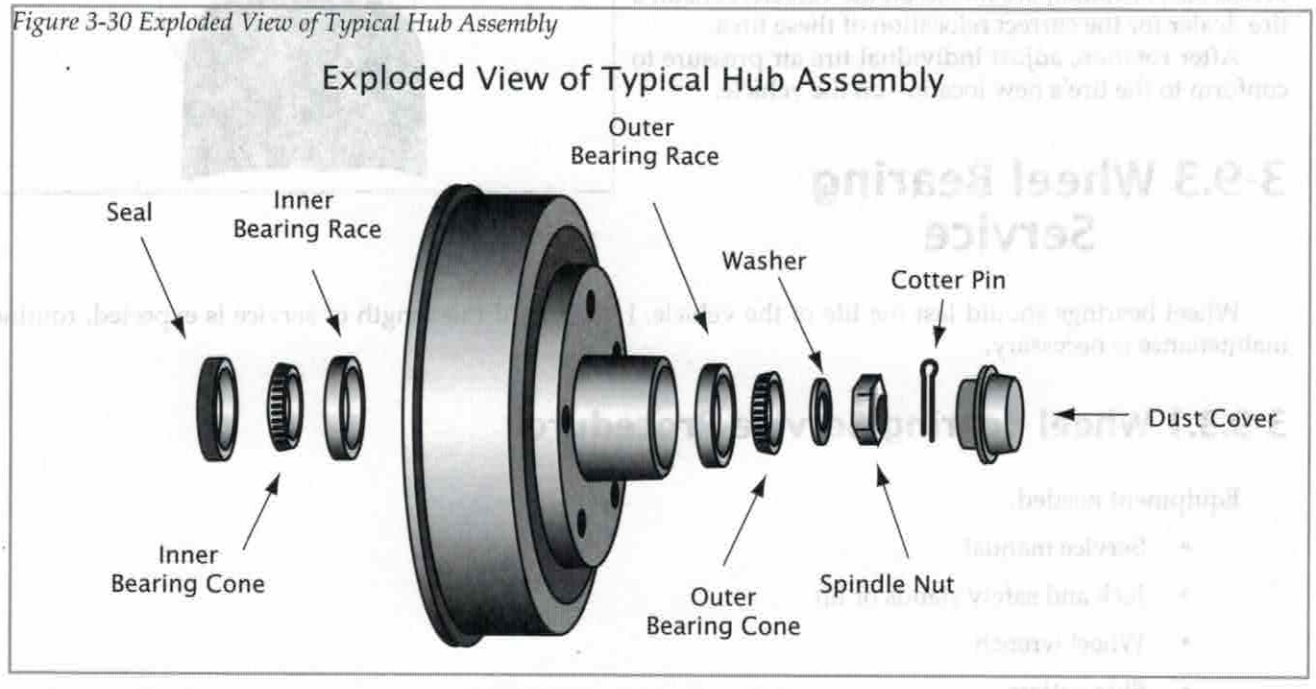
3-9.3.1.1 Disassembly

1. Safely support the RV.
2. Remove the wheel assembly.
3. Remove the disc brake caliper, if needed.
4. Remove the dust cap, cotter pin, retaining nut, and safety washer.
5. Carefully remove the hub assembly (do not drop the outer bearing).
6. Remove the outer bearing.
7. Remove the inner bearing and seal. (Use the proper tools. Do not knock out the bearings from the front side. This can damage the inner bearing.)
8. Discard the old seal.

3-9.3.1.2 Bearing Inspection

Wash all grease and oil from the bearing cone using a suitable solvent. Dry the bearing with a clean, lint-free cloth and inspect each roller completely. If any pitting, spalling, or corrosion is present, then the bearing must be replaced. The bearing cup, also referred to as a *race*, inside the hub must also be inspected; see *Figure 3-31*.

Figure 3-30 Exploded View of Typical Hub Assembly



NOTE: Bearings must always be replaced in sets of a cone and a cup.

When replacing the bearing cup (race), proceed as follows:

1. Place the hub on a flat work surface with the cup to be replaced on the bottom side. To remove the race shown in *Figure 3-32*, the hub assembly would will need to be turned over so the cup (race) is on the bottom side.

Figure 3-31 Hub Assembly with Cup (Race)

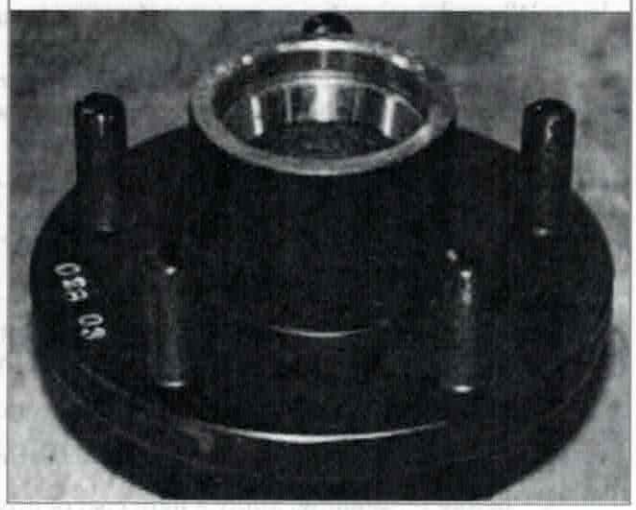
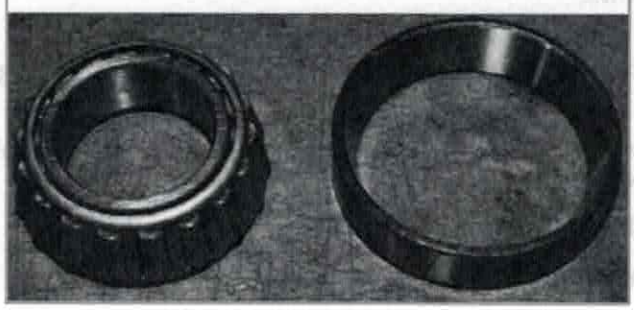


Figure 3-32 Cone and Cup (Race)

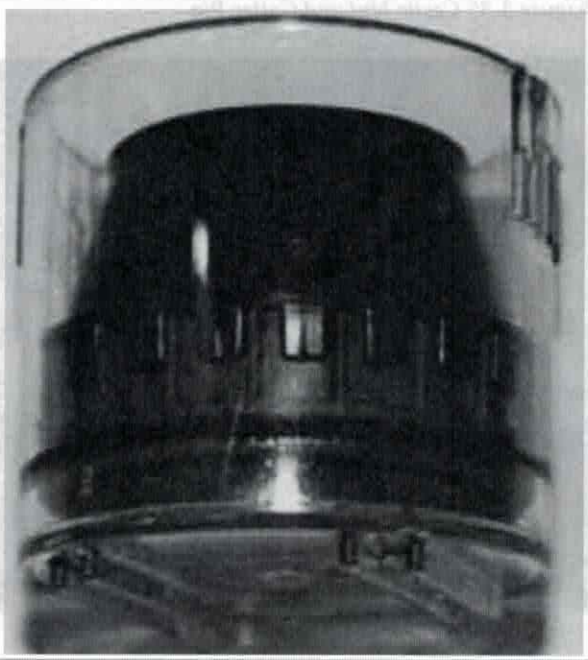


2. Using a brass drift punch, carefully tap around the small-diameter end of the cup to drive it out. If the cup (race) is being replaced, so should the cone. These items are shown in *Figure 3-33*.
3. After cleaning the hub bore area, replace the cup by tapping it in with a race/seal installer as shown in *Figure 3-34*. Be sure the cup/race is seated all the way up against the retaining shoulder in the hub.

Replace only with bearings that are specified for the specific hub.

Figure 3-33 Race/Seal Installer

Figure 3-34 Bearing Packer



3-9.3.1.3 Grease Lubrication

Do not mix lithium, calcium, sodium, or barium complex greases due to possible incompatibility problems. When changing from one type of grease to another, it is necessary to ensure that all the old grease has been removed.

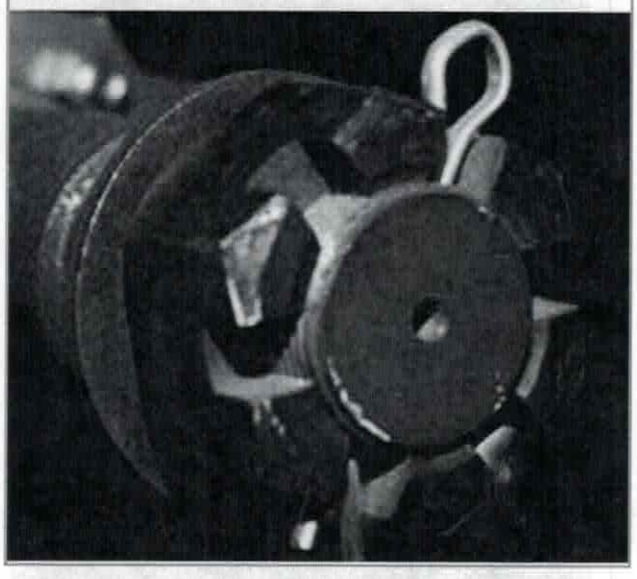
Grease should be replaced at least once a year or as mandated by the manufacturer. Prior to repacking bearings, old grease should be removed from the wheel hub cavity and bearings. Bearings should be packed by machine (as shown in *Figure 3-35*) if possible. If a machine is unavailable, packing by hand method is acceptable. The method to pack bearing cones is as follows:

1. Place a quantity of grease onto the palm of your hand. (It is recommended that protective latex surgical gloves be worn during this process.)
2. Press a section of the widest end of bearing into the outer edge of the grease pile closest to the thumb, forcing grease into the interior of the bearing between two adjacent rollers.
3. Repeat this while rotating the bearing from roller to roller.
4. Continue this process until the entire bearing is completely filled with grease.
5. Before reinstalling, apply a light coat of grease onto the bearing cup mating surface.

3-9.3.1.4 Installation/Adjustment

1. Install the inner bearing into the hub and install the rear seal.
2. Slip the assembled hub onto the spindle, taking care not to cause damage to the seal, and install the outer cone and washer into the hub.
3. Tighten the castle nut to approximately 50 ft/lb while spinning the brake hub backward until the hub barely turns. Loosen the castle nut to remove the torque. DO NOT ROTATE THE HUB! Finger tighten the castle nut until just snug. Back the castle nut off to the next slot for the cotter pin to be inserted.
4. Install a new cotter pin through the spindle and bend one leg over the nut, cutting the other leg off flush as shown in *Figure 3-36*. The nut should still have slight movement, held only by the cotter pin.
5. Install the cap. Rotate the hub and check the bearing adjustment. The allowable end play is 0.001 to 0.010 in. (very slight movement).

Figure 3-35 Castle Nut and Cotter Pin



NOTE: Failure to back off the castle nut could cause bearing and axle spindle overheating or damage, which could result in the wheel locking up or coming off during vehicle operation.

3-9.3.1.5 Final Assembly

1. If removed, replace the disc brake caliper.
2. If the wheel and tire are not already in place, install at this time. Torque properly.
3. Lower the RV.
4. See that the lug nuts are properly torqued.

Table 3-4 Troubleshooting Wheel Bearings

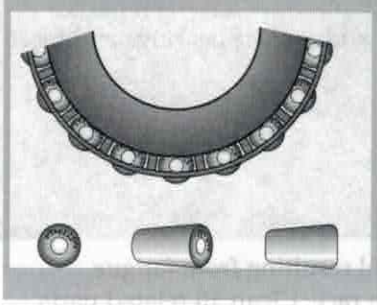
CONDITION		CAUSE & CORRECTION
	GOOD BEARING	
	BENT CAGE	Cage damage due to improper handling or tool usage. Replace bearing and its race.
	BENT CAGE	Cage damage due to improper handling or tool usage. Replace bearing and its race.
	GALLING	Metal smears on roller ends due to overheating or lubricant failure. Replace bearing and its race. Replace seals and check for proper lubrication.

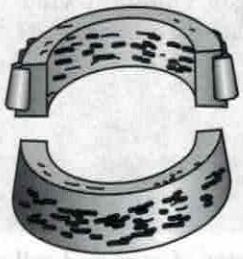
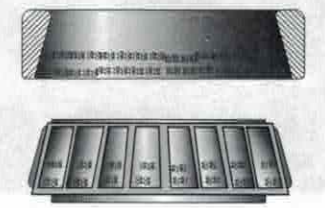
Table 3-4 Troubleshooting Wheel Bearings

CONDITION		CAUSE & CORRECTION
	ABRASIVE STEP WEAR	Pattern on roller ends caused by fine abrasives. Clean all parts and housing. Check seals and bearing and replace if leaking, rough, or noisy.
	ETCHING	Bearing surfaces appear gray or grayish black with etching at roller spacing. Replace bearing. Check seals and check for proper lubrication.
	MISALIGN-MENT	Outer race misalignment due to foreign object. Clean related parts and replace bearing and race. Ensure races are seated.
	INDENTATIONS	Surface depressions on race and rollers caused by hard particles of foreign material. Clean all parts and housing. Replace seals and replace bearings and races if rough or noisy.
	FATIGUE SPALLING	Flaking of surface metal resulting from fatigue. Replace bearing and its race. Clean all related parts.

Table 3-4 Troubleshooting Wheel Bearings

CONDITION		CAUSE & CORRECTION
	BRINELLING	Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating. Replace bearing and its race if rough or noisy.
	CAGE WEAR	Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication. Replace seals and replace bearings and races.
	ABRASIVE ROLLER WEAR	Pattern on races and rollers caused by fine abrasives. Clean all parts and housing. Replace seals, bearings, and races if leaking, rough, or noisy.
	CRACKED INNER RACE	Race cracked due to improper fit, cocked installation, or bearing seats. Correct problem and replace bearings and race.
	SMEARS	Smears of metal due to slippage. Slippage can be caused by poor fit, improper lubrication, overheating, overloads, or handling problem. Correct problem and replace bearing and race.

Table 3-4 Troubleshooting Wheel Bearings

CONDITION		CAUSE & CORRECTION
	FRETTAGE	Corrosion set up by small related movement of parts with no lubrication. Replace bearing and race, clean related parts. Replace seals and check for proper lubrication.
	HEAT DISCOLORATION	Metal may change color from faint yellow to dark blue, resulting from overloading or incorrect lubricant. Replace bearing and race if overheating damage is indicated. Check seals and other parts.
	STAIN DISCOLORATION	Discoloration can range from light brown to black, caused by incorrect lubricant or moisture. Replace bearing and race, even if stains can be removed by light polishing. Replace seals when seals are removed to check bearings. Check related parts for damage.

3-9 Review

1. Abnormal tread wear on the outside of a tire is an indication of _____.
2. Abnormal wear on the center tread of a tire is an indication of _____.
3. Tire pressures are most accurate if checked when the tire is _____.
4. List three factors that can increase tire pressure by 10 psi.

   A.

   B.

   C.
5. When checking tire tread wear, examine the _____ tread in _____ locations to give an overall reading.
6. Circle which of the following conditions can cause abnormal tire wear.

   A. Misalignment

   B. Bent wheels

   C. Missing valve caps

   D. Worn bushings

   E. Sprung axle housings

   F. Underinflation

   G. Improper camber

   H. Improper synchronization

   I. Faulty or grabbing brakes

   J. Overinflation

   K. Overweight vehicle

   L. Improper weight distribution
7. Never bleed or reduce air pressure when a tire is hot.

   True False
8. Tires should be rotated every 5,000 miles.

   True False
9. Tire pressure should always be checked cold.

   True False
10. Underinflated tires can cause

    A. Poor steering

    B. Abnormal tread wear

    C. Early tire failure

    D. Increased fuel consumption

    E. All the above

11. Do not mix lithium, calcium, sodium, or barium complex greases due to possible incompatibility problems.

    True False

12. Failure to back off the castle nut could cause bearing and axle spindle damage.

    True False

13. Which of the following conditions could indicate the necessity for bearing, race, or seal replacement?

    A. Cage wear
    B. Roller wear
    C. Smears
    D. Galling
    E. All the above

Chapter

3-10 Engine Belts and Hoses

- Interpret and understand manufacturer maintenance requirements.
- Check belts and hoses.

To prevent unexpected breakdowns, it is very important to inspect belts and hoses. Early detection of problems with these components improves the reliability of RVs.

3-10.1 Hose Inspection

Hoses should be inspected for the following defects:

1. Hardness, cracking, and loss of flexibility
2. Bulging due to the softening of hose material
3. Damage due to improper installation

Normal operating temperature variances, plus exposure to the severe under-hood environment, will cause the hoses to dry out and lose their flexibility. To inspect a hose, squeeze it gently to check for pliability while looking for hairline cracks. Cracks in the hose surface expose the inner parts as well as weakening the hose. This may lead to unexpected failure during operation. In addition, this hardening results in a loss of flexibility and transmits more engine vibration to the radiator. Excessive vibration will lead to radiator failure due to metal fatigue.

Another condition to check for is bulges in the hose due to the softening of the hose material. A defective gasket could allow a hose to become covered with engine oil. Petroleum-based engine oil can cause the hose material to break down. This would result in an expansion and softening of the hose material. This will cause a separation of the ply layers of hose, which weakens it and will eventually cause it to fail.

Incorrect hose installation could cause hose failure if hose clamps are too tight or if the hose is improperly positioned during installation. Overtightening of hose clamps can cause breakage of the cords of the ply layers, weakening the hose. This condition can be detected if there is a bulge next to the hose clamp. If hoses are allowed to vibrate against engine parts, the hose surface may wear away, causing a leak. Hoses that must contact engine parts should be securely clamped or protected.

3-10.2 Drive Belt Inspection

Most RVs use drive belts to drive the water pump and alternator as well as other engine accessories. Inspection of the belts centers around two basic items: belt condition and tension. The alignment of the pulleys, which house the belts, should also be checked.

The ply layers, or *tensile cords* as they are sometimes called, give the belt its strength and help to maintain its length. These cords are protected by rubber and layers of thin protective fabric. In making a visual inspection, inspect the outer protective fabric layer for signs of fraying and separation. Also turn the belt over to check the underneath side for deterioration. If the under surface of the belt is dried out and brittle, the belt should be replaced. To determine if the crack is minor, rub the surface vigorously with a finger. If the surface is so brittle that it separates, the belts should be replaced. The top surface of the belt around its circumference should also be checked for any cracked areas that indicate a broken tensile cord. If any cracks are visible on the top surface, the belt should be replaced. As on hoses, the protective layers on the drive belt dry out and are prone to cracking and separation. Very small cracks may be acceptable.

It is also very important to have belts tightened properly. This is referred to as *belt tension*. Too loose a tension, and the belt slips, causing eventual permanent belt damage. Too tight, and additional strain is put on the bearings of the driven parts, causing them to wear faster than normally.

NOTE: Adjust and tighten to the manufacturer's specification.

When a drive belt is allowed to slip because it is too loose, it results in heat buildup due to friction. If allowed to continue, this heat will cause hardening of the belt surface, called *glazing*. As a result, the belt loses its ability to grip the pulley, and greater slippage is the result. Once this has occurred, even a correctly tightened belt will slip and squeal. For this reason, it is important to correctly install and maintain belt tension for maximum service life of drive belts.

Figure 3-37 Measuring Drive Belt Tension

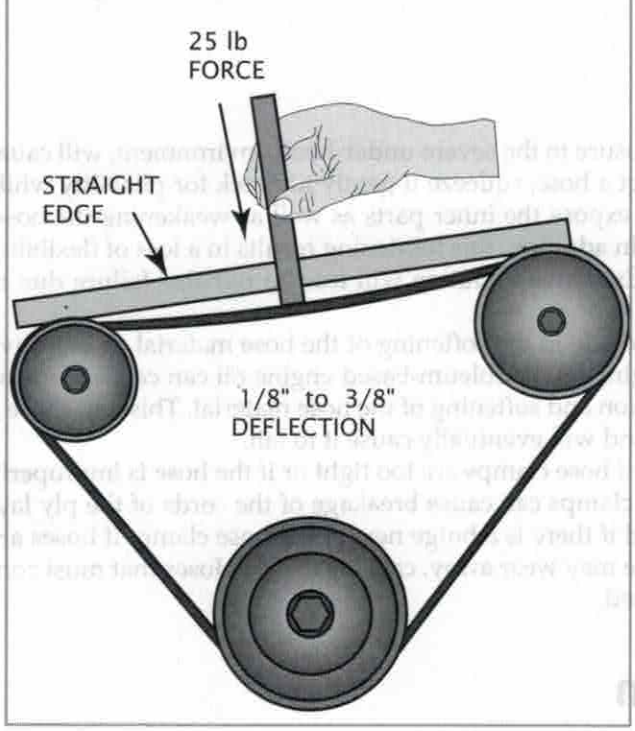
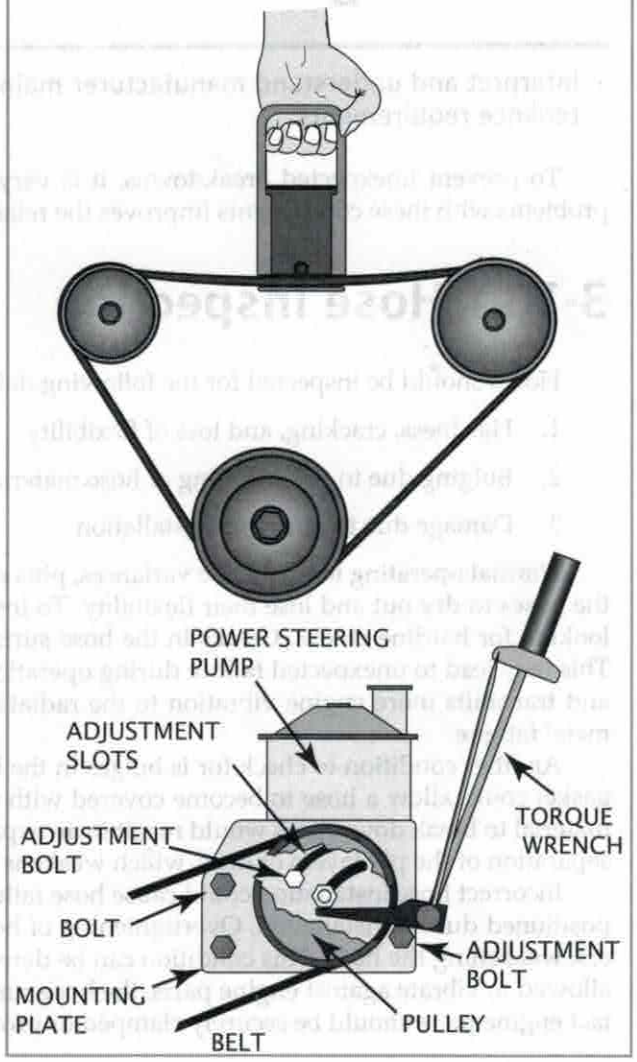


Figure 3-36 Drive Belt Construction



3-10 Review

1. Bulges in hoses can be caused by overtightening clamps or by oil getting on the hose.

   True False

2. Hoses that must contact engine parts must be securely clamped or protected.

   True False

3. Inspection of belts should cover three areas: tension, belt condition, and pulley alignment.

   True False

4. Glazing is a process of applying the correct amount of lubrication to a belt.

   True False

5. As a rule of thumb, a properly adjusted belt should have 3/8 to 1/4 in. deflection when 25 lb of force is applied to the belt.

   True False

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Chapter

3-11 Storage and Winterizing

- Identify procedures for storage.
- Identify procedures for winterizing the RV.
- Interpret and understand manufacturer maintenance requirements.

3-11.1 Preparing the Vehicle for Storage

Properly preparing the vehicle for storage will lessen the possibility of damage to the vehicle.

1. Turn off the propane container service valve(s).
2. Have the vehicle chassis completely serviced and lubricated. Be sure radiator antifreeze protection level is sufficient for the lowest anticipated temperatures.
3. Fully charge the batteries.
4. Wash and wax the coach.
5. Inspect all seams and seals around the doors, windows, vents, and any other joints. Replace or repair any that are damaged.
6. Close all windows and roof vents. Protect all appliance vent openings from contamination by animals or insects (e.g., bird nests, wasp nests, and so on).
7. Lubricate all door hinges and locks.
8. Clean the interior of the coach. Dirt and stains are more easily removed when fresh.
9. Close shades to protect upholstery from sunlight.
10. Clean and defrost the refrigerator. Place an open box of baking soda inside the refrigerator to help absorb odors.
11. Prop refrigerator door open.
12. Turn the furnace thermostat to OFF.
13. Drain water heater, water tank, and holding tank.
14. Suggest to the owner to give the RV a monthly visual check for any potential problems that may develop during the storage period. (This may include leaks from rain, vents, or windows that worked open from the wind; vent covers that blew off; and so forth.)

NOTE: Batteries must be kept to at least 80 percent charge to keep from freezing or sulfating.

When storing the vehicle through the winter or in cold climates, extra preparations need to be made to protect systems that can be damaged by freezing temperatures.

When storing the vehicle in humid climates, extra preparations need to be made to protect systems from moisture damage.

3-11.2 Cold Weather Storage Procedure (Winterizing)

Clean and dump the holding tanks as follows:

1. Add water to the sewage holding tank by holding the toilet flush lever open with the water pump running. Add water to the wastewater holding tanks by opening the kitchen, shower and lavatory faucets. Tanks should be about one-fourth to one-third full to rinse properly. Driving to a disposal site will normally loosen and rinse any waste material from the sides of the tanks.

2. Completely drain the sewage and wastewater holding tanks at an approved waste disposal site. Drain the sewage tank first so the wastewater that follows can rinse any solids from the dump outlet and sewer hose.
3. Close dump valves to prevent valve shafts from rusting and to prevent entry by rodents and insects. Refit the dust cap onto the drain outlet.
4. Add 1/2 to 1 gal of antifreeze to each holding tank to prevent water remaining in the tanks from freezing. This "antifreeze" does not need to be "nontoxic," since it is not in contact with the potable water system. In fact, windshield washer fluid can be used, as it is cheap, is readily available, and does not adversely affect plastic or rubber seals.

Level the vehicle and drain the entire plumbing system as described in the following steps:

1. If the coach is equipped with a water purifier system, remove the filter and follow manufacturer's winterizing procedure.
2. Open all drain valves. (Reference the vehicle owner's manual for the water system drain valve locations on a particular model.)
3. Turn the water pump switch ON to allow it to operate until all faucets and toilet are completely drained.
4. Open all faucets and shower-head valves, including exterior shower.
5. Operate the toilet flush lever and hold until water stops flowing in the toilet. Then turn the water pump switch OFF.
6. Turn off the water heater power and drain the water heater tank to avoid damage to the heating element.
7. Drain the water heater by removing the plug from the base of the water heater tank, accessible from the outside of the coach. (This requires a socket and ratchet.) Also open the pressure-temperature (PT) relief valve at the top right portion of the tank to prevent air-locking in the tank while draining.
8. After water has stopped draining at all faucets and drain valves, connect a **"blow-out"** plug to the city water connection on the coach. Then use a hand pump or air compressor regulated to 30 psi or less to force air through the system.

NOTE: Limit air pressure to 30 psi to avoid damage to pump or water lines.

NOTE: DO NOT burst air into the system. This can damage the water pump. It is better to let air in slowly.

9. Let air flow for five minutes until water is completely drained out of faucets and drain valves. Close faucets one at a time.
10. Operate and hold toilet flush level until water is completely drained from toilet.
11. Turn off air pressure and disconnect the water purge adapters. Recap the city water connection to avoid contamination by dirt or insects.
12. Leave all the line valves and faucets open to allow for expansion, because some water will likely remain in the system. However, reinstall the water heater drain plug and close the PT relief valve.
13. Open the ice maker's valve and drain it. Also, drain the hot and cold water lines and valves at the clothes washing machine.
14. Pour about one cup of nontoxic RV antifreeze into the kitchen sink drain, bathroom sink drain, and shower drain. This prevents any holding tank odors from entering the coach during storage. It is not necessary to add RV antifreeze to the toilet, since the flush valve will be closed.

NOTE: NEVER use automotive antifreeze/coolant in the RV water system. Auto antifreeze contains ethylene glycol which, if ingested, can cause blindness and can be fatal.

Do not add automotive antifreeze or caustic chemicals such as bleach or laundry detergents into the toilet bowl or holding tanks. Although these products may have a deodorizing effect, they may damage plastic and rubber parts in the system.

NOTE: As an alternative to totally draining the plumbing system, the tanks and lines may be winterized by pumping nontoxic RV antifreeze through the system. This product is available from a supplier/dealer. Follow directions on the container to determine the correct amount to use for the coach.

3-11.3 Removal from Storage

1. Completely air out the RV.
2. Check the propane system.
3. Check window operation.
4. Check cabinet door hinges and catches and drawer slides.
5. Check plumbing systems.
6. Sanitize the water system as outlined in *Chapter 3-7*.
7. Check around all appliances for obstructions and ensure that all vent openings are clear.
8. Start all appliances and check for proper operation.
9. Check batteries and charge as necessary. Check electrical systems to make sure all lights and electrical components operate. Change generator oil and replace all filters; remove tape from tailpipe; lube throttle pivot points; clean plugs, reinstall; clean generator exterior; test fire unit; and apply A/C load.
10. Check tires for proper cold inflation pressure. Check lug nuts for proper torque.
11. Carefully inspect the seams and sealants for separation or cracks that may have appeared around the window frames, vents and any other joints. Also inspect weather seals around doors and other locations. Replace as necessary.

NOTE: Thoroughly inspect water system for all appliances, devices, filters, and so forth included in winterization process.

NOTE: There is no review for this chapter.

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3 Answer Keys

Chapter 3-1

There is no review for this chapter.

Chapter 3-2

1. True *(page 3-3)*
2. True *(page 3-3)*
3. True *(page 3-3)*
4. True *(page 3-5)*
5. True *(page 3-5)*
6. Directly to the ground; within 45° *(page 3-4)*
7. A. Operating pressure test *(page 3-5)*
   B. Pressure drop test *(page 3-7)*
   C. Lock-up pressure test *(page 3-5)*
8. A. Regulator adjustment as necessary *(page 3-5)*
   B. Leak testing the regulator *(page 3-6)*
   C. Leak testing the piping system *(page 3-7)*
9. True *(page 3-7)*
10. C *(page 3-5)*
11. A. Electronic leak detector *(page 3-7)*
    B. Leak detector solution *(page 3-7)*
12. True *(page 3-12)*
13. Plug the propane line with a brass cap *(page 3-12)*
14. Incomplete combustion, which can be caused by an obstruction in the air intake vent or main burner *(page 3-13)*
15. Carbon monoxide *(page 3-13)*
16. C *(page 3-14)*
17. D *(page 3-14)*
18. A *(page 3-15)*
19. B *(page 3-17)*

Chapter 3-3

1. C *(page 3-21)*
2. A *(page 3-22)*
3. False *(page 3-22)*
4. True *(page 3-22)*
5. C *(page 3-22)*
6. False—continuity test *(page 3-22)*
7. True *(page 3-22)*

Chapter 3-4

1. 12 VDC chassis system; 12 VDC house system *(page 3-25)*
2. Isolator/solenoid *(page 3-25)*
3. Regular baking soda *(page 3-25)*
4. False—sulfuric acid and distilled water *(page 3-25)*
5. False—temperature compensated hydrometer *(page 3-26)*
6. False—open-circuit voltage test *(page 3-26)*
7. True *(page 3-26)*

Chapter 3-5

There is no review for this chapter.

Chapter 3-6

1. False—should be checked when the engine is cold *(page 3-31)*
2. Ethylene glycol (permanent antifreeze) *(page 3-31)*
3. C *(page 3-31)*
4. C *(page 3-31)*
5. B *(page 3-31)*
6. True *(page 3-31)*
7. True *(page 3-32)*
8. True *(page 3-33)*
9. False—3 minutes on a level surface *(page 3-34)*
10. False—different transmission fluids NOT COMPATIBLE *(page 3-35)*
11. True *(page 3-35)*

Chapter 3-7

OIL CHANGING

F Additives *(page 3-37)*
D Detergent *(page 3-38)*
B Dispersant *(page 3-38)*
H Lubricate *(page 3-37)*
I Multigrade *(page 3-38)*
E Oil filter *(page 3-40)*
C SAE *(page 3-38)*

H Sealing *(page 3-37)*

G Synthetic oil *(page 3-38)*

A Viscosity *(page 3-38)*

COOLANT FLUSHING

1. Poisonous *(page 3-41)*
2. Thermostat *(page 3-41)*
3. 20 psi MAXIMUM *(page 3-41)*
4. Correct amount of antifreeze *(page 3-42)*
5. Separately *(page 3-41)*

Chapter 3-8

1. A. When the RV is first put into service *(page 3-47)*

   B. Anytime the RV has not been used for a long period of time *(page 3-47)*

   C. When contamination is suspected. (Never assume contamination has not occurred. Suspicion is enough to warrant sanitization.) *(page 3-47)*
2. D *(page 3-47)*
3. True *(page 3-47)*
4. False—consult the manufacturer instructions for proper servicing procedure. *(page 3-48)*
5. False—they should be lubricated to ensure ease of operation. However, special drain valve lubricant should be used. *(page 3-48)*
6. A. Clean or replace filters *(page 3-49)*

   B. Inspect and clean evaporator *(page 3-49)*

   C. Inspect and clean condenser assemblies *(page 3-49)*
7. A—1 minute or 60 seconds *(page 3-50)*
8. False—this means the detector is working properly. The warning of carbon monoxide buildup is a continuous beeping and flashing of the red LED. *(page 3-50)*
9. A. Replacing the battery annually or more often as needed *(page 3-51)*

   B. Testing by depressing the test button on the face of the detector *(page 3-51)*

   C. Once a month gently vacuuming or dusting the face of the cover *(page 3-51)*
10. False—never partially discharge a fire extinguisher to test it. *(page 3-51)*

Chapter 3-9

1. Underinflation *(page 3-53)*
2. Overinflation *(page 3-54)*
3. Cold *(page 3-53)*
4. A. Heavy loads *(page 3-54)*

   B. High-speed driving *(page 3-54)*

   C. High road-surface temperatures *(page 3-54)*
5. Center groove; three different *(page 3-55)*
6. All but C and H can cause abnormal tire wear. *(page 3-55)*
7. True *(page 3-54)*
8. False—The rule of thumb is every 6,000 to 8,000 miles, but this will vary based on manufacturer and type of tire (steel, steel-belted radial, ply, etc.). Always check the owner's manual for the rotation sequence and interval. *(page 3-57)*
9. True *(page 3-53)*
10. E. All of the above *(page 3-53)*
11. True *(page 3-60)*
12. True *(page 3-60)*
13. E. All of the above *(page 3-61)*

Chapter 3-10

1. True *(page 3-67)*
2. True *(page 3-67)*
3. True *(page 3-67)*
4. False—glazing is the hardening of the under surface of the belt, caused by heat, due to improper belt tension. *(page 3-68)*
5. False—1/8 to 3/8 in. *(page 3-68)*

Chapter 3-11

There is no review for this chapter.

3 Glossary of Preventive Maintenance Terms

Anti-scuff Additives Oil additives designed to polish the engine's moving parts. They are especially helpful for engines running at extremely high temperatures caused by high RPM or heavy load.

ASME American Society of Mechanical Engineers.

ASME Tank A container constructed in accordance with the ASME Code (NFPA 58).

ATF Automatic transmission fluid. There are several types:

Type F: Meets Ford Motor Company Specification M2C33-F
Mercron: Meets all other Ford Motor company specifications
Dexron, Dexron II, Dexron IIE, and Dexron III: Meet General Motor specifications
Dexron III/Mercron: Meets all GM and Ford specifications except for Type F

Bail A hoop-like handle that provides pressure on a lid to keep it closed when slipped or pulled over the top of the lid.

Bellow Seal A seal with folds, similar to a bellows, found in a brake master cylinder, that moves up and down with the fluid level while sealing out air.

Black Water Holding Tank The name commonly applied to the body waste holding tank on an RV.

Body Waste The discharge from any fixture, appliance, or appurtenance containing fecal matter or urine.

Brinelling The creation of surface indentations caused by one metal pressing onto another under heavy pressure.

Carbon Monoxide (CO) A colorless, odorless gas resulting from incomplete oxidation of carbon found in automobile exhaust.

Camber (camber angle) The inclination from the vertical of the steerable wheels of an automobile.

Chlorine Water A clear, yellowish liquid used as a deodorizer, antiseptic, and disinfectant.

Continuity Continuous path for current; reading of zero ohms with an ohmmeter.

Corrosion Inhibitors Oil additives designed to neutralize the harmful effects of acids and water produced in the combustion process.

Detergents & Dispersant Oil additives designed to (a) keep contaminants suspended in the oil so they can be removed from the oil as it passes through the oil filter and (b) clean the engine parts.

Disc Brake A brake system in which a disc attached to a wheel is slowed by the friction of the brake pads being pressed against the disc.

Drum Brake A brake system in which brake linings are pressed against the underside of a drum to cause friction, thereby slowing down and stopping the rotation of the wheel.

Electrolyte A substance used in dry and wet cells in which conduction of electricity is accompanied by chemical action.

Electronic Leak Detector An electronic device, usually hand held and battery operated, that detects propane leaks using a special sensor.

Ethylene glycol (Glycol) A colorless dihydroxy alcohol used as an antifreeze, in hydraulic fluids, and in the manufacture of dynamites and resins.

Foam Inhibitors Oil additives that reduce oil foaming caused by a mixture of heat, agitation, air, and oil.

Frettage Corrosion caused by the related movement of unlubricated parts.

GAWR (Gross Axle Weight Rating) The maximum safe load-carrying capacity of a single-axle system as measured at the tire/ground interfaces. It is calculated by determining the capacities of the following: (1) axle rating, (2) suspension rating, (3) tires, (4) wheels. The load on each axle should not exceed the GAWR specified on the safety certification label, nor should the total on both axles exceed GVWR.

GFCI (Ground Fault Circuit Interrupter) An extremely sensitive circuit breaker connected to exterior, bath, and kitchen outlets. The GFCI helps to protect against severe electrical shock if a ground fault develops. If such a condition occurs, the GFCI will break (open) the circuit by turning off the power to the protected outlet.

Glazing The hardening of a belt surface caused by excessive heat buildup due to friction.

Gray Water Holding Tank The name commonly applied to the liquid waste holding tank on an RV.

Hydraulic Brakes A brake operated by fluid pressures in cylinders and connecting tubular lines.

Hydrometer A float-type instrument used to determine the state of charge of a battery by measuring the specific gravity of the electrolyte (the concentration of sulfuric acid in the electrolyte).

Hygroscopic Absorbing or attracting moisture from the air.

Kilopascals (kPa) Combination of the word *kilo,* for 1,000, and pascal, a unit of pressure equal to the pressure resulting from a force acting uniformly over 1 m^2.

Liquid Waste The discharge from any fixture, appliance, area, or appurtenance that does not contain body waste.

Lock-Up Test A pressure test conducted on the propane regulator to determine the amount of pressure required to press against the regulator diaphragm, overcome the spring, and completely seat the lever seat assembly in the regulator so that no gas flows through the regulator when the appliances are turned off. The pressure should not be more than 14 in. WC.

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

Master Cylinder: A cylinder in the brake system that contains the brake fluid necessary for operation of hydraulic brakes.

Miscible Capable of being mixed without changing properties of the mixed elements.

NFPA 1192 *Standard on Recreational Vehicles.* Published by the American National Standards Institute (ANSI) establishing fire and life safety standards for RV vehicles.

Operating Pressure Test A test on the propane system to determine what pressure the system regulator is providing to the system when appliances are functioning.

Polarity The property of a physical system that has two points with different (usually opposite) characteristics, such as one that has opposite charges or electric potentials.

Oxidation Inhibitors Oil additives that neutralize the harmful effects of sludge and varnish.

Pour-Point Inhibitors A viscosity index improver that improves oil fluidity at low temperatures, reducing cranking efforts in cold weather and improving lubrication during cold-weather warm-ups.

SAE 5W-10 A cold-weather oil.

SAE 10W-30 An all-weather oil.

SAE 10W-40 An all-weather oil.

SAE 20W-30 A high-temperature (hot-weather or high-RPM), anti-wear oil.

SAE 15W-50 A high-temperature (hot-weather or high-RPM) oil.

Society of Automotive Engineers (SAE) A network of engineers, business executives, educators, and students that establishes and publishes more than 6,000 standards developed by more than 600 committees on every facet of the mobility industry.

Solenoid An electrically energized coil of insulated wire that produces a magnetic field within the coil.

Spalling The flaking of surface metal resulting from metal fatigue or pressure/explosion.

Sludge Sludge is a thick oily substance resulting as a by-product of engine combustion.

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

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

Timed Pressure Drop Test A test conducted on the propane system using a manometer to determine whether a leak exists within the system. It measures the drop in propane pressure over a predetermined period of time.

Varnish A substance that forms on engine surfaces when sludge is cooked by high engine temperatures.

V.I.N. Vehicle identification number.

Viscosity The characteristic of a fluid that resists the force tending to cause the fluid to flow; the ability of oil to flow under a variety of temperatures.

Viscosity Index The established scale for lubricating oils that indicates the extent of the variation in viscosity with variation of temperature.

Viscosity Index Improvers Oil additives that (1) improve the oil body by giving it more body at high temperatures and (2) improve the oil's ability to flow at low temperatures.

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3 Index

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