CLASS GUIDE

LP SYSTEM KNOW-HOW

With Dave Solberg

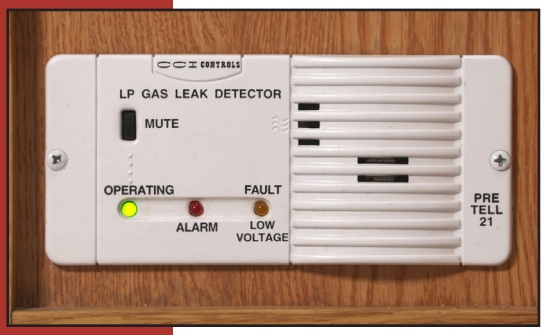
LP SYSTEM KNOW-HOW

LP Overview

Liquid Propane (LP) was discovered in 1910 and is a very important part of residential outdoor grilling and fuel for transportation. It is also an integral part of RV appliance systems. Because it can be stored in a liquid state, it is easy to transfer from bulk storage containers and expands over 270 times in the gas state. In its original state, it has no odor, therefore a chemical called ethyl mercaptan is added to give a rotten egg odor for leak detection.

Two types of containers are used in the storage of LP in an RV: DOT cylinders, which are portable and can be 20-40 lbs., and ASME tanks mounted directly to the frame of a motorhome in a vented compartment. Filling a container must be done by a certified filling distributor and all occupants and pets must be out of the unit away at a safe distance. The distributor will inspect the container for signs of damage and DOT cylinders must be recertified after 10 years.

An Overfill Prevention Device (OPD) was mandated in 1993 and only allows the container to be filled to approximately 80% capacity to allow for expansion of the gas. The liquid turns to a gas and passes through a regulator that contains the pressure to prevent high pressure entering the lines, valves, and appliances. Larger units with several appliances that may need to operate at the same time will have a dual regulator. Both types have a vent and an excess flow valve that shuts down the system if abnormal flow is detected.



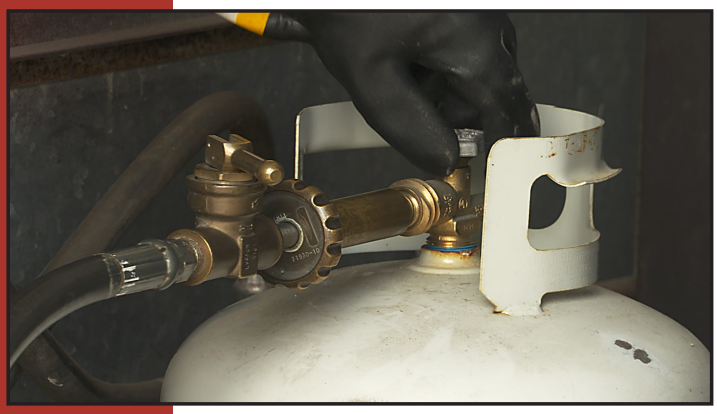
Troubleshooting an LP system starts with an understanding of how the appliance works starting with how 12-volt DC is used through the monitor panel or module board. If an appliance operates on either 120-volt power or LP, verify each mode helps determine if it's an appliance issue or an LP issue. Some models have a gauge or monitor panel to check the LP level, however smaller units must rely on manual verification such as weight scales or a new device that uses ultra sound directly to the side of the tank.

History of Propane

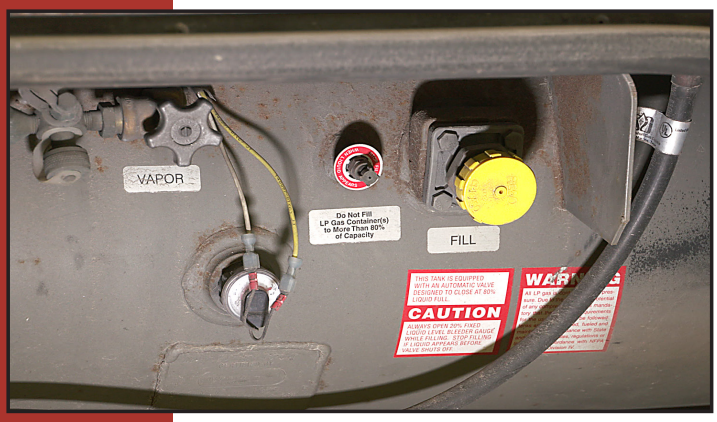
In 1910 a chemist by the name of Dr. Walter Snelling was conducting tests to find out why gasoline was evaporating so rapidly. Using a still to capture the evaporating components, he discovered propane, butane, and other chemicals that would be used for fueling a wide variety of appliances. The first propane gas stove was introduced in 1912 and the first propane fueled vehicle in 1913. By 1927, propane sales reached over 1 million gallons. Today, propane is a $8 billion industry!

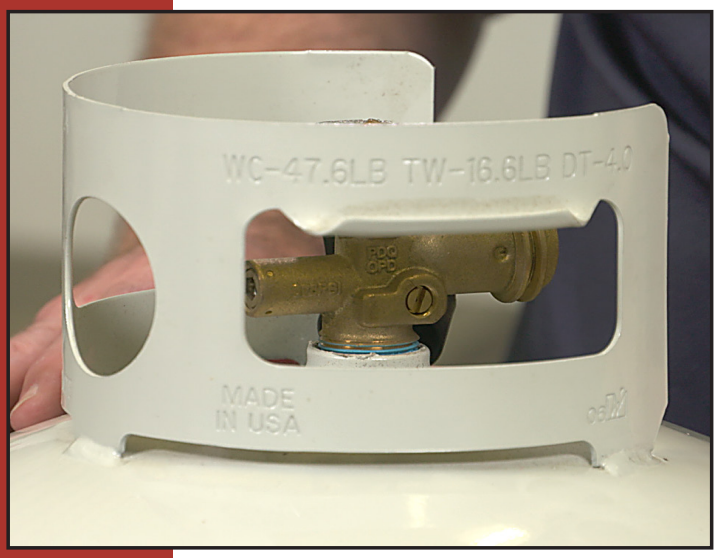
Propane is now used for a wide variety of fueling options from the common residential gas grill to agricultural application such as grain drying. Over 8.1 million homes use it for heating and cooling, fireplaces, and even lighting. As an alternative fuel source, propane powers over 4 million vehicles such as commercial buses, taxis, forklifts, and other industrial vehicles.

Over 90 percent of the propane used in the United States is produced domestically. Seventy percent of international propane usage is produced in Canada and Mexico. Propane is produced from refining equal parts of natural gas and crude oil which makes it readily available and environmentally friendly. According to the National Propane Gas Association (NPGA), propane is an approved alternative clean fuel listed in the 1990 Clean Air Act, as well as the National Energy Policy Act of 1992



Overview of LP Tanks and Cylinders





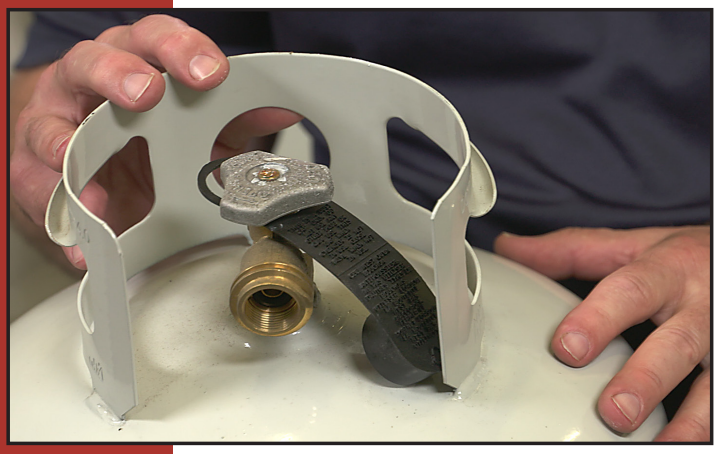
LP is stored in two different containers in the RV Industry. Trailers typically use DOT cylinders which are portable and can be removed and taken to a distributor rather than taking the entire rig. Smaller cylinders such as those used with residential grills are 20 lbs., while larger trailers such as 5th wheels use 40 lb. cylinders and sometimes two, one on each side. These cylinders are built to the specifications of the Department of Transportation (DOT).

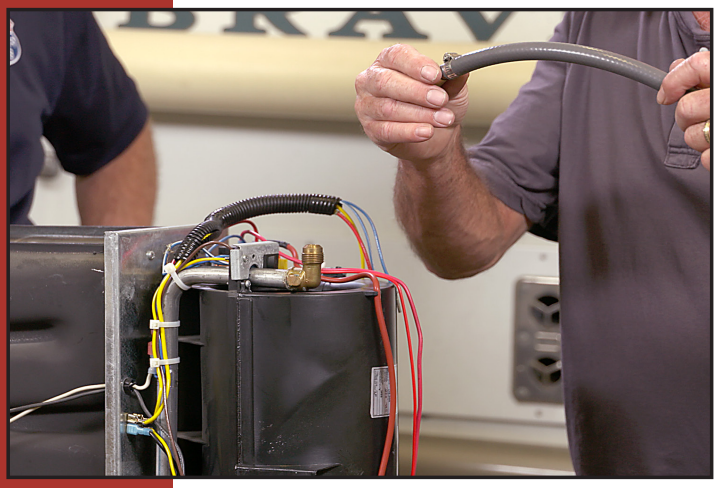
Motorhomes use ASME tanks mounted directly to the chassis in a vented compartment and cannot be removed. In this case the entire rig is taken to the distribution center. ASME Tanks are built to the specification of the American Society of Mechanical Engineers. The difference between the two specifications are the valves, fitting, and brackets may be located on the ends only of the DOT cylinders. The ASME tanks are located on the side in some cases.

Propane container capacity may be designated in either pounds or gallons. Most manufacturers rate them in pounds such as a 20 lb. or 40 lb. DOT cylinder at the 80% fill level. Propane weighs 4.24 lbs. per gallon, so a 20 lb. capacity would be slightly less than five gallons and an 80 lb. ASME Tank would be approximately 19 gallons.

ASME tanks do not require recertification but do need to be inspected by a certified technician for damage and signs of rust or valve issues. DOT cylinders are required to be recertified after 10 years according to the National Gas and Propane Association. After that, a five-year visual inspection is required.

Overview of LP System





As stated earlier, LP is the by-product of crude oil and natural gas distillation and is one of the lightest components, coming from that process as a gas. LP gas is compressed by approximately 270 times by volume to create a liquefied form for convenient storage in containers. Therefore, the DOT cylinders and ASME tanks are made of heavy steel to withstand the pressure.

When the container valve is opened and an appliance calls for fuel, the liquefied gas turns to vapor and passes through a regulator that adjusts the pressure to the specifications for the hoses, valves, and appliances. This pressure is measured in inches of water column which is typically set at 11” of water column for most RV appliances.

Once the valve is open, the LP vapor is available at the line to the appliance. Some appliances require the owner to light a pilot light similar to a residential water heater. This pilot light is a small flame (approximately 1”) that burns constantly next to the burner assembly. When the appliance calls for heat or fuel, the gas valve opens and the vapors pass over the flame and light. These appliances such as a water heater or oven need to be set up prior to operation.

Other appliances have a spark ignitor similar to a push button “Piezo” ignitor on a residential grill. Most stove tops have a red push button spark ignitor that sends a spark from the ignitor to the burner assembly manually operated by the owner.

Other appliances such as the refrigerator, some water heaters, and furnace have a direct spark ignitor commonly referred to as a DSI that automatically sends a spark when the appliance calls for fuel and the gas valve opens. You will hear a clicking or sparking sounds during the lighting sequence. This requires no action from the owner other than setting the thermostat to the desired temperature on a furnace, water heater, or refrigerator.

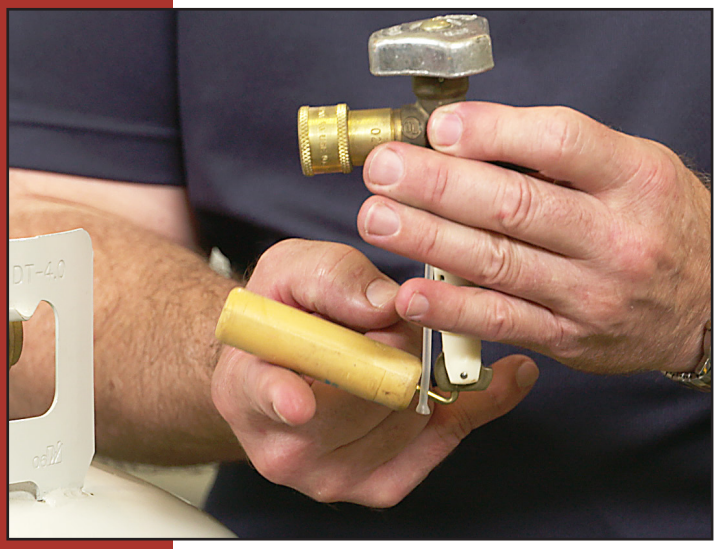
Checking LP Levels

Most LP containers have some type of gauge that shows the level of gas in the propane container. ASME tanks on motorhomes typically have a gauge directly on the tank and another inside as part of a monitor panel. Larger units with DOT cylinders have a gauge at the tank, however smaller units leave it to guess. There are several gauges available to check the level. There are also campground fiction methods which are tested in this chapter.

Several owners claim an Infrared Thermometer will determine the temperature difference as the cool propane inside lowers the temperature of the metal container up to the level. This only works when the system has been used in hot weather, where you can typically see a slight "frost" where the propane is.

Others claim a stud finder will detect the difference in density. Unfortunately these are proven to not be a qualified test for accurate levels. Even the residential method of using a hand-held scale is not as accurate as the Level Check tool by Truma which uses ultrasound to provide an accurate level of propane in a DOT cylinder or ASME tank.

Overfill Prevention Device (OPD)



When LP is transferred from a bulk tank at a certified distribution center to an RV container it is in a liquidized from and usually at a fairly cool temperature. As the outside temperature rises, and heat from driving down the road on blacktop and exhaust system on motorhomes creates a higher temperature underneath the RV, the ambient temperature of the LP container gets higher and the LP volume will expand. Therefore an Overfilling Prevention Device known as an OPD valve has been required, which will limit the fill rate to 80% to allow for the expansion.

According to the National Fire Prevention Association (NFPA) LP Gas Code NFPA0-58 as of April 1, 2002, no container can be filled without an OPD valve. This valve limits the fill level to 80% to allow for the expansion of the LP in the tank during temperature variations. These cylinders can be retrofitted with a new OPD valve, however it's a better option to purchase a new tank as they would also need to be recertified and the price of a new valve and recertification would be much more than a new tank! The new valve can be identified by the triangle handle.

ASME tanks used in motorhomes have had the OPD valve since 1984 and do not have the triangle handle but are safe to fill.

Proper LP Filling of DOT Cylinder

Filling a DOT cylinder is not a DIY job and must be performed at a certified LP filling station. There are several locations across the country that will fill your container, however you need to make sure they are certified and familiar with your type of system. Your job is to educate yourself on the proper procedure and make sure the procedure is correct.

The certified propane dealer will start by purging the tank of air to prevent it from diluting the propane, which could cause excess pressure and poor appliance operation. The dealer will inspect the tank for rust, damage, and check the age of the tank (which is stamped on the handle). The cylinder will then be weighed to determine how much fuel is already in the tank and the approximate amount to fill.

A Tare Weight (TW) will also be stamped on the handle to tell how much the cylinder should weigh when empty. The scale will be set to the desired weight and the dispenser connected to the fill valve. Next, the bleeder valve is opened and the cylinder is ready to fill to the desired weight taking in to account for the OPD Valve at 80%.

Proper LP Filling of ASME Tank

To properly fill an ASME tank permanently mounted to a motorhome chassis, you will need to bring the rig to the propane distributor. Extinguish all appliance pilot lights and shut off anything that could produce a spark such as the refrigerator, water heater, or other appliance with a direct spark ignitor.

Make sure your vehicle is turned off, parking brake is engaged, and all occupants are out of the rig and a safe distance away. The propane dealer should verify this and then inspect the integrity of the tank, looking for corrosion, rust, or even improper modifications. When removing the fill cover, the dealer will look for the O-ring and verify it is in good condition.

Next, they will check the data plate, and even though ASME tanks do not require recertification, he will verify the size and amount of propane that the tank will hold with the OPD Valve. The fill hose is then connected, pump turned on, fill valve opened, and spit valve opened. This will allow the air inside the tank to purge as the propane fills the tank. Once the white mist or vapor is coming out the spit valve, or the OPD Valve shuts down the fill, the spit valve is closed, pump shut off, and fill hose pressure is released and the hose disconnected.

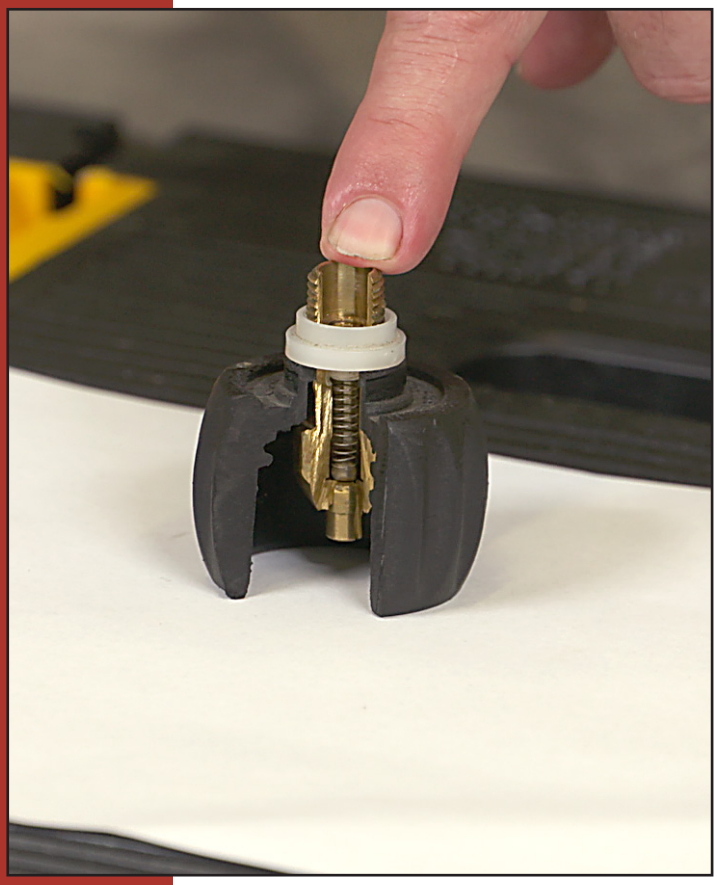
LP Regulators

As the propane gas turns to vapor, the pressure could exceed 300 psi and must be reduced and regulated to approximately 11 inches of water column for the appliances to operate properly. The regulator is located within the supply line, very close to the cylinder or tank. It has a vent located on the bottom to prevent moisture from entering and is usually protected with a plastic cover. Units with small tanks typically have a single stage regulator that is designed to run only one appliance at a time and can handle only approximately 75,000 Btu.

However, units with larger tanks and more appliances that may require three times the Btus would have a dual or two-stage regulator. The regulator has a rubber diaphragm and spring inside that adjusts the pressure as appliances demand fuel. The regulator requires very little maintenance other than a visual inspection and ensuring the vent is open and clean. When disconnecting the regulator to fill a DOT cylinder always check for leaks when reconnecting the valve and regulator.

The NFPA recommends replacing a regulator after 15 years as the rubber diaphragm can get dried out and the spring weaken. The only way to detect a defective diaphragm is to use a water column tester or manometer to determine the pressure coming out of the regulator. One indicator that it might be getting weak is to turn on the stove top and watch the flame. Then turn on the furnace or water heater as they have a higher fuel demand. If the flame drops drastically and stays low on the stove top, the diaphragm is not adjusting properly and should be checked and/or changed.

Excess Flow Valve

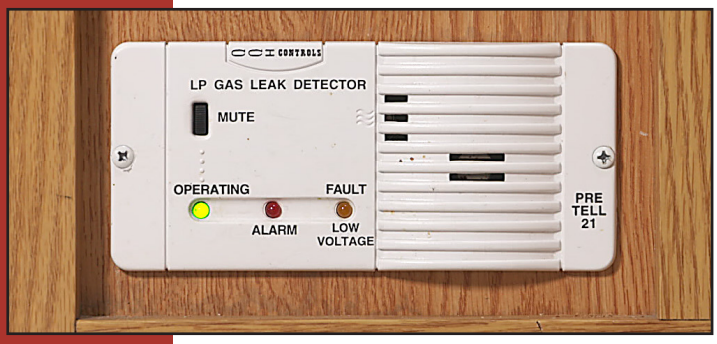


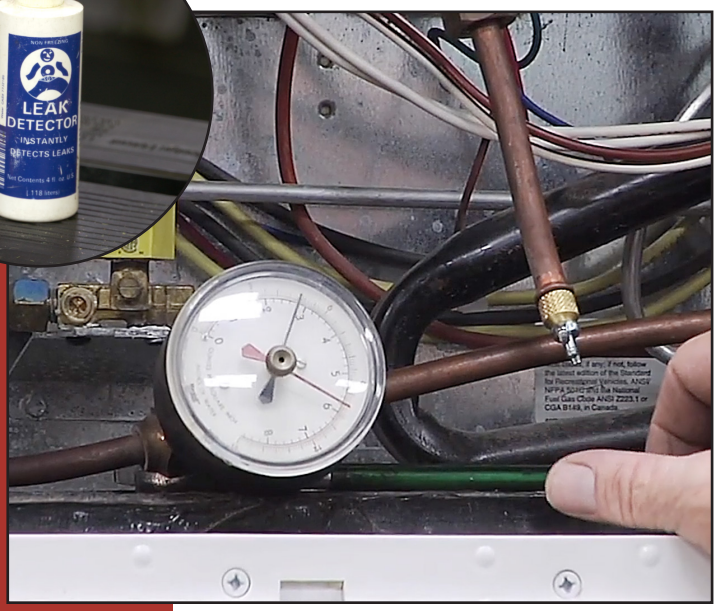
A ball bearing and spring engineered inside the connecting valve is called an excess flow valve and is designed to recognize when the flow of vapor is in excess of typical operation, which would indicate a ruptured line or loose valve. The pressure of the vapor pushes the spring and ultimately the ball bearing which seats in the valve to restrict flow.

Just about any time a tank is opened quickly, this safety device will push the ball bearing to reduce the flow, however it still allows a small amount of vapor pressure to pass which circulates through the LP system. If all appliances are off and there are no leaks, this pressure makes its way back to the valve and creates enough back pressure to push the ball bearing and spring back to normal operation and provides proper vapor pressure to the appliance. This all happens in less than 10 seconds so most owners do not notice it.

However, if a valve is open on an appliance like the stove top, or an owner tries to light a gas grill connected to the system before the back pressure pushes the excess flow valve back, the valve will stay partially closed and there will only be a small amount of vapor pressure. The stove top might light with the small amount of vapor flowing, but will become starved when another appliance calls for fuel. If this happens, shut the entire system down, make sure all appliances and grills are shut off, let the unit sit for a minute or two, then open the valve “SLOWLY”!

LP Leak Detection



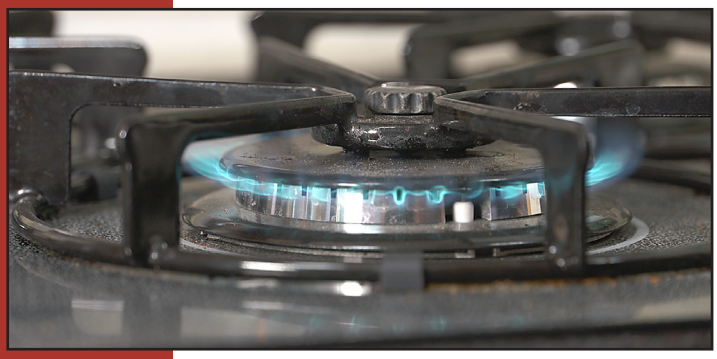


There are several ways to determine if you have a leak in your LP system, the first being the distinct rotten egg odor! Propane is typically odorless so the chemical ethyl mercaptan is added to give owner's a signal that something is wrong. RVs built today are required to have an LP Leak Detector installed by RVIA code, which is normally located in the kitchen or living room area. Since LP is heavier than air, if there is a leak it will drop to the floor, therefore LP Leak Detectors are located in the lower section of the cabinetry.

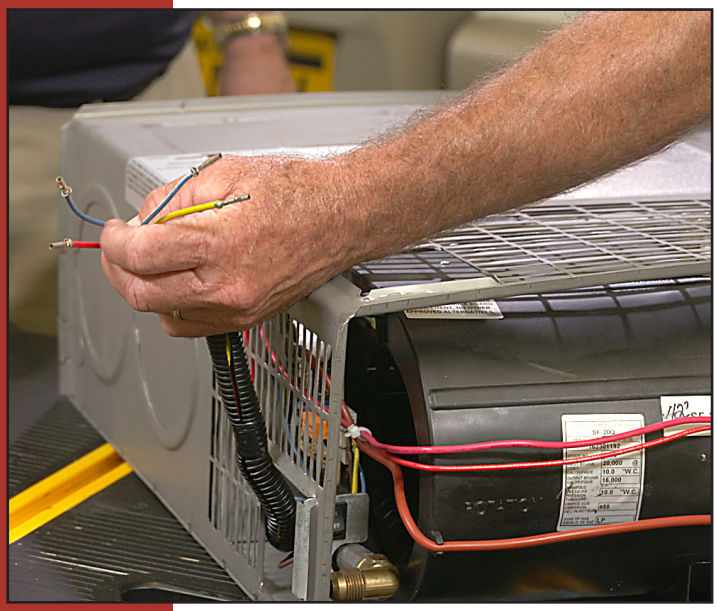
Other leak detection devices are available such as an in-line manometer or even hand held device. The manometer will show a drop in pressure when all appliances are shut off, indicating a leak. A leak detection solution can be applied to valves and fitting. A bubbling of the liquid indicates a leak.

According to the Propane Education and Research Council, if you smell propane or discover a propane leak, immediately put out all smoking materials, pilot lights, open flames, and anything that would create a spark such as direct spark ignitors for the refrigerator, water heater and others. Do not operate lights, cell phones, or appliance as a spark from these devices could cause an explosion or fire. If you can safely reach the containers, shut off the valve to the DOT cylinder or ASME tank. Open all doors, windows and vents. Immediately leave the area and call 911 or the local fire department. Do not re-enter the RV or try to move it before a certified technician inspects the rig.

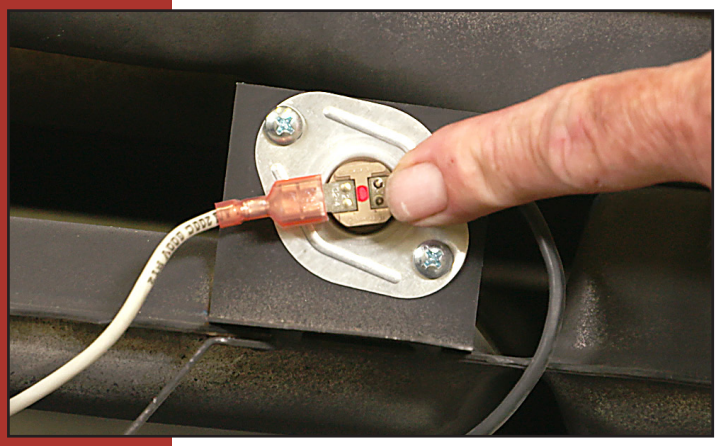
Troubleshooting LP Appliances



To properly troubleshoot a defective LP appliance it is important to understand how it operates, what power sources are involved, and what check valves or devices might restrict the operation. Most appliances require at least 10.5-volt DC power to light and stay operational. You can also verify proper LP pressure by turning on the stove top and watching the flame as another appliance is operated. If the flame drops and stays low, there is limited pressure and the regulator should be tested.

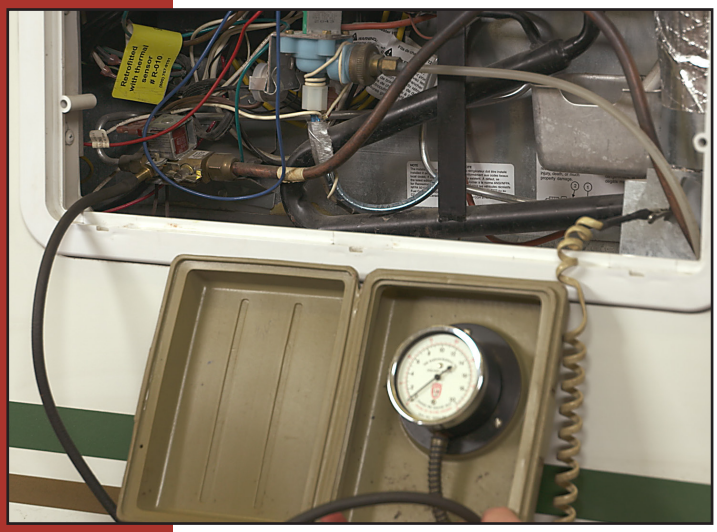


When the thermostat calls for heat, the blower motor kicks on and lifts a sail switch in the front, verifying there is enough fan speed for the unit to operate. Once the sail switch is raised, it creates a closed system that tells the module board to open the gas valve and light the burner assembly. As the hot air passes through the burner chamber, a limit switch on the back-side measures airflow and temperature. If there is a blocked vent or supply tube inside the rig, it will overheat and the limit switch will shut the unit down.



With any LP appliance, once you verify proper LP pressure, use a multimeter or simple test light to verify 12-volt power at the control module. Some appliances have a fuse on the module board, however all have a 12-volt automotive style fuse at the distribution panel. Verify 12-volt power from the distribution center through the fuse and to the module board.

Troubleshooting LP Refrigerator Operation

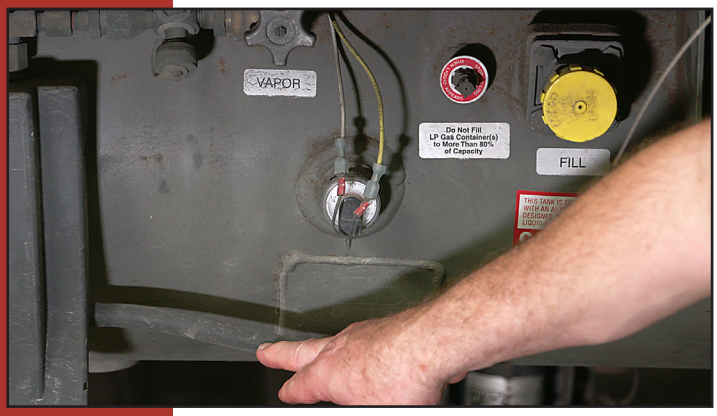


The absorption refrigerator used in most RV applications runs on either 120-volt AC power or LP. Some also operate on 12vVolt DC house batteries. The absorption refrigerator has no moving parts, can handle temperature changes throughout the year, can tolerate road vibration and bumps, and can be used in a dry camping situation when 120-volt power is not available.

To troubleshoot an absorption refrigerator not working on the LP mode, first verify if it cools in the 120-volt mode. If it does, then you have eliminated the cooling unit, inside control module, and thermistor as the problem. Now you can concentrate your troubleshooting efforts to the LP operation. First, verify the system has proper LP pressure which you can do inside by turning on the stove top. Turn on all three to make sure there is not reduced pressure when more than one appliance is being used. If pressure is good, check 12-volt power from the distribution center to the module board in the back of the refrigerator. There is an in-line fuse that also needs to be verified. If power is good, turn the unit on LP Mode and listen for the gas valve to click open and the spark ignitor trying to light. If neither happens, there is an issue at the module board.

This class will help walk you through the process of determining if the spark ignitor is defective, has a cracked insulator, known as carbon tracking, or even if the flame lights but goes out in a few seconds, which would indicate a defective thermocouple.

Traveling With Propane



While not illegal, traveling with the propane system on and appliance running is not a safe method of driving down the road. Propane lines are made of very thin soft copper and a mishap with a road sign or construction zone can easily rupture a line. In addition, all the fittings and connections take quite a bit of abuse on today's bumpy roads. If a gas leak were to occur, it could fill the lower portion of an RV and the attempted spark from a refrigerator, water heater, or furnace could ignite it. If you do choose to travel with propane, make sure you shut all appliances and anything that can create a spark off before entering a fueling station.

So how do you keep your refrigerator cold? We conducted a test of both Norcold and Dometic, bringing the inside temperature of the unit down to 34 degrees. The unit was shut off and the temperature checked remotely every hour. Six hours later the inside temperature was still at a safe level of 40 degrees, so the refrigerator can keep food cold and frozen for over six hours! There are a few tricks, such as having something to absorb the cold in the freezer – we used a 5 lb. bag of ice. It is also important to check the door gasket to make sure no warm moist air enters the refrigerator box.

Thank You!

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My Notes