Chapter

5-1 Introduction to RV Propane Systems

- The correct use of tools to maintain the propane system.
- Identification of the proper procedures for the storage and handling of propane.
- Basic practices to enhance safety.
- To leak test the propane system.
- Properties of propane.
- Classification of propane containers.
- To recognize propane odor.

The propane system on a recreation vehicle is the system for storing and conveying propane vapor to the appliances. This system includes the propane containers, regulators, hoses, pipe, tubing, fittings, and the appliances.

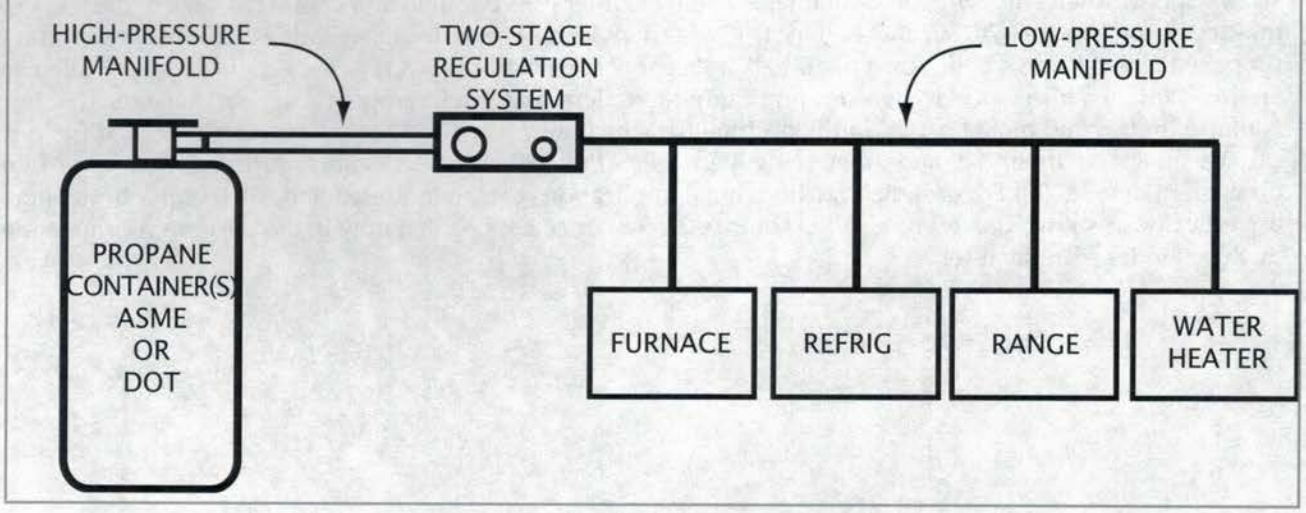
NOTE: In many states or provinces, personnel must be formally trained at an approved facility and licensed to perform some or all of the procedures that are contained in this textbook. Completion of this textbook is not authorization for the student to perform these functions. Check the requirements of the state or province. It is the technician's responsibility to meet local requirements and obtain licenses as required.

5-1.1 The Basic RV Propane System

All recreation vehicles that contain fuel-burning appliances (ranges, ovens, refrigerators, water heaters, furnaces, and fuel-powered lights in older units) use propane as the fuel. Propane is safe, proven, and commonly used in RVs as the source of burning fuel for appliances.

This chapter will discuss how propane is stored on the RV, how it is delivered to the appliances, and the materials and safety devices employed to ensure safe and efficient use. The basic design of most, if not all, propane systems in RVs is depicted in *Figure 5-1*.

Figure 5-1 Typical Basic Propane System



5-1.1.1 Components of the RV Propane System

As *Figure 5-1* shows, the propane system consists of the following:

- A propane container to store the propane
- A two-stage regulator to reduce the pressure of the propane gas to the proper operating pressure for appliance use
- A piping system to deliver the propane gas from the container through the regulator and on to the appliances

Each of these components will be covered in *Chapter 5-2*; however, a brief description of each is given here.

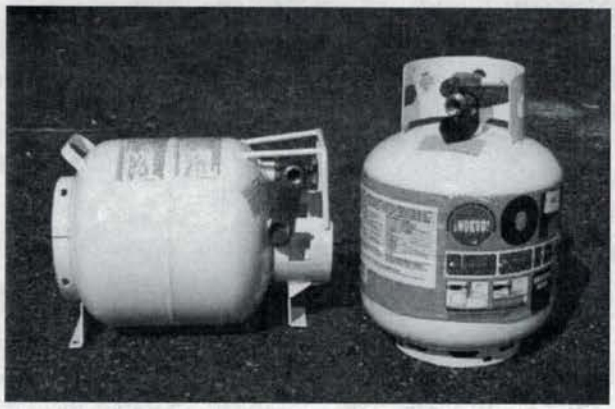
5-1.1.1.1 Containers

Propane for use with recreation vehicles is stored in one of two types of containers. Propane containers used in recreation vehicles are either Department of Transportation (DOT)/Transport Canada (TC) cylinders or American Society of Mechanical Engineers (ASME) tanks. These are shown in *Figures 5-2* and *5-3*, respectively. When referring to DOT/TC cylinders, these will be identified as "cylinders." When referring to ASME tanks, these will be identified as "tanks." When referring to both types collectively, the term "containers" will be used. DOT/TC cylinders are typically used on trailers and truck campers, while ASME tanks are used on motorhomes. Fill containers to 80 percent of their total capacity to allow a vapor space at the top of the container and for liquid expansion. This vapor is the result of the liquefied petroleum (propane) boiling, which will create the vapor under pressure. Both types of containers provide safe and efficient storage but are constructed to different design standards. Because of their designs, some containers are better suited for use on specific types of RVs. However, the type of container does not affect vapor flow. Other factors (such as temperature, Btu/hr demand, and the amount of propane in a container) will affect vapor flow.

DOT/TC Cylinders

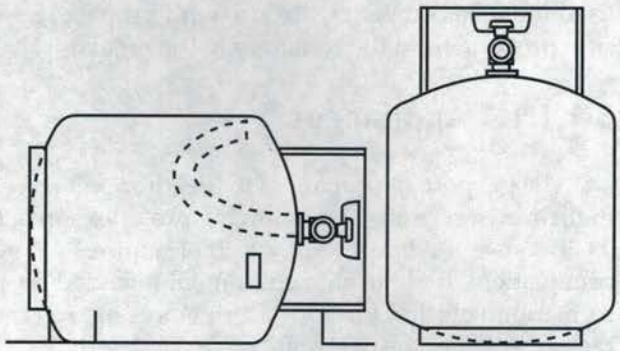
DOT/TC cylinders are constructed to the requirements of the U.S. Department of Transportation's "Specifications for Propane Containers." In Canada, cylinders are constructed to the requirement of Transport Canada's "Specifications for Propane Container." These cylinders are portable and come in a variety of sizes. The most common sizes are 20, 30, and 40 lb (9.1, 13.6, and 18.1 kg). These size designations refer to the amount of propane these cylinders hold when filled to 80 percent of their capacity. DOT/TC cylinders are typically used on travel trailers, fifth wheel trailers, folding camping trailers, and truck campers. They can be vertical or horizontal cylinders and must be used in the position for which they were designed. Cylinders designed for vertical use must be mounted and filled only vertically. Pre-1998 cylinders, not equipped with overfilling prevention devices (OPD), designed for horizontal applications can be mounted and filled either horizontally or vertically, as shown in *Figure 5-2*. OPD equipped cylinders must be filled only in the position recommended by the cylinder manufacturer.

Figure 5-2 DOT/TC Cylinders



DOT(TC) 20 lb. (9.1 kg) cylinder designed for horizontal use, can also be used vertically

Standard vertical 20 lb. (9.1 kg) DOT(TC) Cylinder



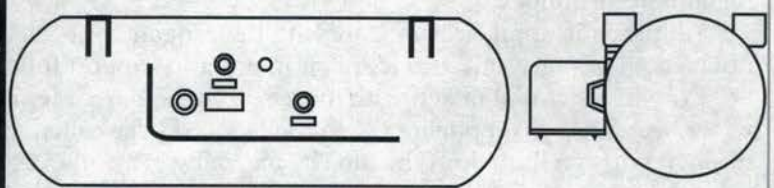
PRE - 1998 DOT(TC) 20 lb. (9.1 kg) cylinder designed for horizontal use, can also be used vertically

Standard vertical 20 lb. (9.1 kg) DOT(TC) Cylinder

ASME Tanks

ASME tanks are constructed to the *American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code*. These tanks are permanently mounted to the recreation vehicles chassis or floor and come in a variety of sizes. Tanks are normally sized by length and diameter. ASME tanks, shown in *Figure 5-3*, are usually used on motorhomes.

Figure 5-3 ASME Horizontal Tank



ASME Horizontal Tank

Side View

5-1.1.1.2 Regulators

Regulators are devices that reduce pressure. System regulators are located just downstream of the container(s) and reduce the high pressure coming from the container to a pressure that is usable by the appliances. The first stage of a two-stage regulator reduces the pressure to approximately 10 lb/in^2 gauge (PSIG) while the second stage reduces the pressure to an appliance operating pressure of 11 in. water column (WC) (approx. 6.25 oz). System regulators today are required to be two-stage configurations that work together to control the system pressure. In addition, there can be regulators at, or internal to, the appliances that also assist in controlling the pressure of propane as it enters these appliances.

5-1.1.1.3 Fuel Piping Systems

Propane vapor is delivered from the containers to the appliances by a variety of materials. These materials may include flexible hoses, iron piping, and copper tubing. Each material has criteria for use, and all materials used must be compatible for use with propane. Specific materials must also be used to deliver the high-pressure propane from the container to the regulator.

5-1.1.1.4 Appliances

The purpose of propane is to fuel the appliances. Whereas the individual appliances are discussed in detail in their own sections, the following provides some general information on appliances.

Because the burning of any fuel requires oxygen, and fuel burning also creates exhaust (or products of combustion), fuel-burning equipment intended for RV use must be specifically listed and approved for use in recreation vehicles. Listed RV appliances are referred to as "sealed combustion, direct vent" appliances, with the exception of the oven and stove. To determine if a particular appliance is acceptable for RV use, look at the appliance's nameplate. A listing agency will have authorized the use of its mark or logo on the appliance, and the actual words "for use in recreation vehicles" will appear right on this data plate or name plate. If these words are not visible, the appliance is not approved for installation in an RV.

Using a "sealed combustion, direct vent" appliance ensures the oxygen or air needed for combustion is drawn into the combustion chamber from the outside of the vehicle, and the exhaust, or products of combustion, are expelled to the outside. Otherwise, the users may be subject to death or serious injury from oxygen depletion, asphyxiation, or carbon monoxide poisoning.

The only exceptions to using "sealed combustion, direct vent" appliances are ranges and refrigerators. Refrigerators are "sealed combustion, direct vent" appliances by their installation. The entire compartment must be sealed to ensure that air for combustion cannot be drawn from the living space of the RV and the exhaust cannot get into the living space.

Because the range is an "attended" appliance, it is not a "sealed combustion, direct vent" appliance and cannot be installed to ensure air/exhaust separation. This is why a label is required to be placed on the range hood or in another location near the range to tell the user to open a window or vent and not to use the range for comfort heating.

All propane appliances mix air with the propane prior to and during combustion. All appliance burners utilize both primary and secondary air in order to support full and complete combustion.

Primary air is that mixed with the gas for main burner ignition and initial combustion. As an example, the water heater has a component called the "J" tube (also called the mixing tube), where primary air is drawn in through ports on the side of the tube by incoming gas as it exits the orifice; a type of venturi action. The air and gas mix in the tube just prior to ignition of the water heater main burner flame. Additionally, the forced air furnace also draws in primary air (mechanically), and mixes it with the propane inside a sealed combustion chamber prior to ignition of the main burner.

Secondary air is that air used to support combustion after ignition. The water heater pilot flame is one type of secondary air; the same with a standing pilot flame on a cooktop. It only uses the air from around the burner flame. Secondary air in a forced air furnace, though drawn in from the outside, still supports main flame combustion after ignition.

Another example of this is a cooktop burner. When the burner valve is opened, gas flows through a burner orifice and into a tube leading to the burner head, drawing in primary air that mixes with the propane. As the combined mixture reaches the burner head, it is ignited (by match, standing pilot or electronic ignition means). After ignition of the burner, combustion remains supported by secondary air. Without primary air mixing with the propane, the appliance would not ignite. Without secondary air supporting combustion during main burner operation, the flame would be extinguished.

5-1.2 Properties of LP-Gas

LP-gas is a petroleum product separated out of natural gas and crude oil in the refining process. It is a true gas and conforms to Boyle's law in that its pressure is related to temperature when the volume is constant, and the volume varies directly with pressure when the temperature is constant. In addition, LP-gas vapor expands as pressure is reduced, so it expands in all directions (Pascal's law), and any air movement from heat, motion, fans, wind, and so forth will move LP-gas around in a space. While LP-gas is heavier than air and, in a perfectly still environment, will settle to the bottom of a space, it will not react like this in real-world conditions. Instead, once propane is mixed with air, the LP-gas will not separate from the air.

The LP in "LP-gas" stands for "liquefied petroleum" and includes both propane and butane. Both propane and butane may be available in the marketplace and, if given a choice for use in a recreation vehicle, choose propane. Propane has a much lower boiling point, which makes it the better choice for RVs, particularly in cold weather, since the propane must "boil" to create the vapor that is supplied by the container for use by the appliances. Commercial butane will not boil when the outside temperature is 15°F (-10°C) or lower. Propane, on the other hand, boils at -44°F (-42°C) and will continue to provide the vapor for fuel. Since butane is not commonly available, this text will focus only on propane.

Table 5-1 provides details on propane properties for troubleshooting and sizing equipment.

Table 5-1 Basic Facts about LP-Gas[1]

Property	Commercial Propane	Commercial Butane
.Lb/US gal at 60°F (16°C)	4.20	4.81
Lb/imp. gal at 60°F (16°C)	5.10	5.80
Kg/L at 60°F (16°C)	0.51	0.58
Specific gravity of vapor at 60°F (16°C)	1.50	2.01
Specific gravity of liquid at 60°F (16°C)	0.504	0.582
Ft^3 gas/US gal liquid at 60°F (16°C)	36.38	31.26
Ft^3 vapor/imp. gal liquid at 60°F (16°C)	44.17	37.95
Ft^3 vapor/lb at 60°F (16°C)	8.66	6.51
Btu/US gal	91,502	102,032
Btu/imp. gal	110,500	125,000
Btu/lb	21,548	21,221
Initial boiling point at 14.7 psi	-44°F (-42°C)	15°F (-10°C)
Vapor pressure in psi at 70°F	127	17
Vapor pressure in psi at 100°F (44°C)	196	37
Vapor pressure in psi at 130°F (55°C)	287	69

1. For additional data see *NFPA 58, Table B.1.2 (a & b), Annex B* and RegO Products *LP-Gas Serviceman's Manual L-545*.

If there is a question as to whether propane or butane is in the container, connect a pressure gauge to the service valve and compare the pressure/temperature relationship to the chart. For example, if at 70°F (21°C) ambient temperature the pressure reading is over 100 psi, there is propane in the container. However, propane is the most common gas in the United States and Canada. Therefore, we refer to LP-gas as propane herein and throughout the textbooks and standards.

NOTE: Treat propane with the same caution as every other flammable gas.

Propane is nearly odorless and colorless as extracted. It looks and acts similar to water except for its boiling point. Water boils at +212°F (100°C) at sea level, whereas propane boils at –44°F (–42°C) at sea level.

The boiling of either water or propane produces vapor. The vapor produced by propane is a colorless, flammable gas. The higher the temperature above the boiling point, the greater the "steam" pressure. Propane gas is compressed 270 times to a liquid state for storage. Thus, 1 US gal of liquid propane produces approximately 36.4 ft^3 of gas vapor at sea level. Each cubic foot of propane contains 2500 Btu/hr and uses about 25 parts of air to 1 part of gas to burn efficiently. Propane gas limits of combustibility are rather narrow. The gas-to-air ratio must be between 2.5 and 9.6 percent to ignite. It requires approximately 1,000°F (540°C) to ignite the mixture, and it can burn at up to 3,500°F (1,925°C) when properly mixed with oxygen.

Ethyl mercaptan is added to propane just after its manufacture as a warning agent. This sulfur compound gives the gas the rotten egg, skunk oil odor. One or more pounds of mercaptan is added to 10,000 gallons of propane; this makes the propane smell in concentrations of one-fifth of the lower limit of combustibility as required by *NFPA 58 The Liquefied Petroleum Gas Code.*

Another important property of propane is the expansion of liquid as it is warmed. Propane's volume increases about 1.5 percent for every 10°F (5.5°C) it is warmed. By increasing propane temperature by 100°F (55°C), the container liquid volume will increase about 15 percent.

NOTE: A properly filled container will not exceed 80 percent of its liquid capacity.

Table 5-2 provides details on cylinder capacities.

Table 5-2 Cylinder Capacities

Property	Lb	Kg	Approx. Btu/hr
2.5 US gal (9.463 L) DOT/TC cylinder	11	5.0	228,750
4.8 US gal (18.168 L) DOT/TC cylinder	20	9.1	439,210
7.2 US gal (27.252 L) DOT/TC cylinder	30	13.6	658,814
9.2 US gal (34.822 L) DOT/TC cylinder	39	18.2	841,818

5-1.2.1 Conversions

Table 5-3 Conversion Formulas

Gallons to Liters (1 US gal = 3.785 L), (1 imp. gal = 4.54 L)
F° to C° [(F° – 32) ÷ 1.8]
11 in. water column (WC) = 6-1/4 oz/in^2 pressure

The Btu/hr demand of a propane appliance is found on the appliance data plate. This information can be used to determine how long a propane supply will last. For example, one gallon of propane contains approxi-

mately 91,502 Btu/hr. If an appliance is rated at 30,000 Btu/hr, then divide the 91,502 by 30,000 to show that the appliance operation time will be approximately 3 hr/gal. The propane capacity of the container is stamped on its data plate or valve guard. For example, a typical travel trailer with two 30-lb propane cylinders can be calculated as shown to determine how long the propane will last:

POUNDS: Multiply 60 lb by 21,548 Btu/hr per pound = 1,292,880, or
GALLONS: Multiply 14.4 gal by 91,502 Btu/hr per gallon = 1,317,629.

A 30,000-Btu/hr per hour appliance is able to operate continuously for 43 hr. For example: 1,290,000 (available Btu/hr) divided by 30,000 (Btu/hr appliance demand) = 43 hr.

NOTE: Most propane RV appliances do not operate continuously.

It is possible to "exceed the rate of vaporization," which is similar to the symptoms of running out of fuel when, in fact, there may be some propane in the container. This is because the fuel has been refrigerated due to vaporization to the point where there is little or no container pressure. This situation is commonly called *container refrigeration*, and it becomes more of a concern as ambient temperatures drop. This means that, for appliances to function in very cold winter climates, full propane containers may be required to maintain sufficient container vapor pressure. In some situations, a propane dealer may need to be contacted to set up a larger propane container to increase vaporization capacity.

As a rule of thumb, when using an RV in cold climates, keep the propane storage in the container above 50 percent full. The liquid must absorb heat from the atmosphere to boil and produce vapor to operate the appliances. The heat transfer occurs primarily through the shell (container walls) wetted by the liquid. The lower the fuel level, the less the wetted surface and the lower the vaporization rate.

Table 5-4 Propane Vaporization Rate Guidelines (Approximate Values)

19-gal (71.9 L) Water Capacity ASME Propane Tank Btu/hr Available at

% Full	+20°F (-7°C)	0°F (-18°C)	-5°F (-21°C)	-10°F (-23°C)	-15°F (-26°C)
60	95,600	47,800	36,000	23,900	12,100
50	86,000	43,000	32,250	21,500	11,750
40	77,000	38,500	29,250	19,250	9,825
30	68,000	34,000	25,500	17,000	8,500
20	58,000	29,000	21,750	14,500	7,250
10	43,200	21,600	16,200	10,800	5,400

20-lb. (9.1 kg) DOT/TC Cylinder[1] Btu/hr Available at

% Full	+20°F (-7°C)	0°F (-18°C)	-5°F (-21°C)	-10°F (-23°C)	-15°F (-26°C)
60	36,000	18,000	12,750	8,500	4,250
50	32,400	16,200	12,150	8,100	4,050
40	28,800	14,400	11,400	7,600	3,800
30	25,200	12,600	10,450	7,300	3,150
20	21,600	10,800	8,100	5,400	2,700

Table 5-4 Propane Vaporization Rate Guidelines (Approximate Values)

10	16,200	8,100	6,075	4,050	2,025

1. For a 30-lb. (13.6 kg) cylinder, multiply x 1.40.

5-1.3 Basic Propane Safety

Safety is above all the most important factor and concern when working with propane systems. Propane is flammable, explosive under pressure, and able to freeze skin. The following are some safety rules that always must be observed when working with RV propane systems. Many of these will be discussed in further detail in other sections of this textbook.

5-1.3.1 Basic Practices to Enhance Safety

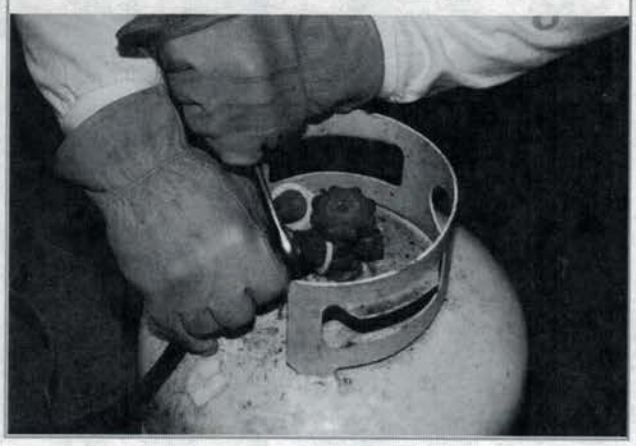
1. **Never allow propane to come into direct contact with skin.** When liquid propane is released, it absorbs surrounding heat to boil. Since it boils at –44°F (–42°C), it absorbs heat, causing anything in contact to freeze. Always wear protective clothing such as gloves (depicted in *Figure 5-4*) and eye protection when the potential for contact with liquid propane is present.

Figure 5-4 Wear Gloves

2. **Never allow a propane container to be filled above the maximum safe level as indicated by the fixed maximum liquid level gauge.** The maximum safe level is 80 percent full, which allows for expansion of propane when it is moved to warmer conditions. Propane volume increases about 1.5 percent for every 10°F (5.5°C) it is warmed. Do not use the liquid level sight gauge for filling—it is only to indicate when to refill the container.

3. **Do not use a wrench or pliers to close the service valve or fixed maximum liquid level gauge on the container.** These valves are designed to be closed leak-tight by hand or screwdriver, as appropriate. If wrenches are necessary to stop a leak, the valve likely needs repair or replacement.

Figure 5-5 Tighten POL with Wrench (Pre-2002)

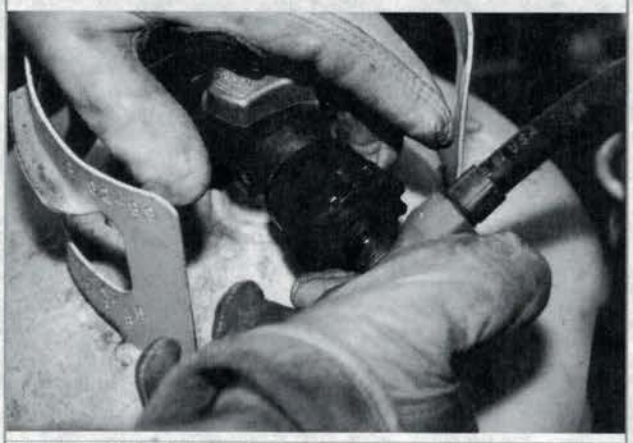


   - **When tightening the Prest-O-Lite (POL) nut (left-hand thread) at the tank's service valve (pre-2002), draw it up snug with a proper wrench (7/8 in. open end or properly used adjustable)** as shown in *Figure 5-5*. This is a machined, male, brass fitting that seats securely against a female seat in the service valve. Pipe sealant is not

permitted on fittings that have metal-to-metal seats. This is similar to a flare fitting, which also has a metal-to-metal seat.

- **Cylinders manufactured after 2002 are equipped with a Type I service valve.** Simply hand tighten the threaded plastic nut until it comes to a complete stop, as shown in *Figure 5-6*. Do not use any type of sealant.

Figure 5-6 Hand-Tighten Plastic Nut (post 2002)

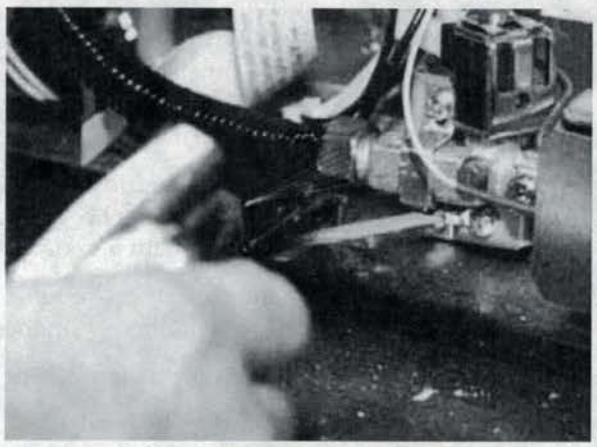


4. **Test for leaks after connecting containers.** To do this, use leak detector solution or an electronic leak detector on the connection at the service valve. Be sure to have turned off all appliance burners and pilot lights. Then open the service valve. Leaks, if present, will be detected by the appearance of bubbles. If bubbles appear with the Compressed Gas Association (CGA) 510 POL, tighten the connector and repeat the leak test. If bubbles appear with the Type I connection, disconnect the Type I nut and check the rubber back-check seal inside the cylinder valve for foreign material or damage. If foreign material is present, clean the rubber back-check seal and reconnect and leak test again. If the connection still leaks, replace the cylinder valve.

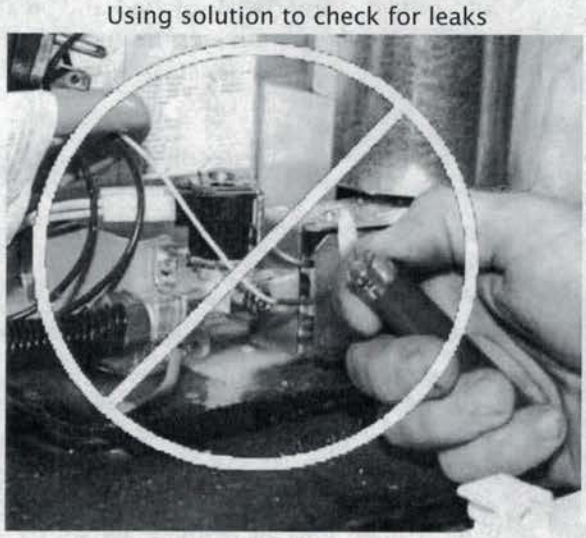
5. **When the propane container is placed into service, open the service valve all the way.** Listen to the regulator for a hiss or hum. This sound is indicative of a large leak. If a hissing or humming is heard, turn off the service valve and look to see that all appliances are off and that an open line does not exist. The source of the leak must be found and fixed. If a "PFFFT" is heard and there is no other noise, the system likely does not have a large leak. The "PFFFT" noise is simply the sound of the gas flowing through the regulator orifice into the downstream part of the system and driving the regulator into its lockup condition.

6. **Test all container and gas line connections periodically, and anytime the system is disconnected, to be sure they are tight.** When testing for leaks, use leak detector solution, as shown in *Figure 5-7*, or an electronic leak detector on each fitting throughout the system to determine if there are leaks. If bubbles appear at the fittings or the electronic leak detector sounds, using two wrenches to prevent twisting the tubing or stripping the fittings, tighten the leaking fitting joint to eliminate the leak. Sometimes, the simple tightening of the fitting will not correct a leak. If this is the case, the joint will need to be taken apart, old sealant removed (a steel brush works well), and new sealant applied. When

Figure 5-7 Testing for Leaks



Using solution to check for leaks



NEVER DO THIS

working with a tubing joint, the fitting assembly will need to be taken apart and inspected. It is possible that the flare is bad, requiring it to be cut off and reflared. DO NOT USE MATCHES, A LIGHTER, OR ANY OPEN FLAME TO TEST FOR LEAKS.

Perform a timed pressure drop test as per *NFPA 1192 Standard for Recreational Vehicles, paragraph 5.3.20.6* (see *Chapter* 5-4), every time a gas fitting has been disconnected. Document the test by writing on the service order the type of test conducted, the date of the test, the pressure(s) used during the testing, the test results, and the full signed name of the service technician. Using just initials in documenting tests is of little value, since more than one technician at a service facility can have the same initials, and no one may remember who the initials stand for if the service technician leaves and test documentation becomes important several years later.

7. **Make certain the container is properly fastened in place.** Ensure that cylinder hold-down brackets and ASME tank mounting bolts are secure. According to *NFPA 1192*, the propane containers are to be installed so they will not become dislodged when a load equal to eight times the container's filled weight is applied to the container's center of gravity in any direction (*NFPA 1192, paragraph 5.2.4.1*).

8. **On dual-cylinder installations, turn the cylinder with the open part of the cylinder guard(s) toward the trailer (travel trailer installation)**. This will provide a little more protection to the valves and regulator(s) against flying rocks and mud that may be thrown by the tow vehicle to the rear on gravel or dirt roads.

9. **Transport cylinders with the valves closed and a plug or dust cap securely fitted to the service valve**. Secure the container against falling or rolling. *NFPA 58 Chapter 6* establishes the requirements for the transportation of propane cylinders. Whenever transporting propane cylinders, secure them in the same horizontal or vertical position in which they are designed to be used.

10. **Purge propane containers before placing them into service.** Uncontaminated propane is noncorrosive, so the inside of the propane container will not rust if it is purged correctly. Keep the outside of the container from rusting with a periodic coat of paint in a heat-reflective color (i.e., white or silver).

11. **Do not store propane containers indoors or in enclosed areas.** Do not expose propane containers to heat. Always store the containers with the service valves closed and plugged or capped.

12. Do not attempt to repair propane containers, valves, or regulators.

13. **Do not fill DOT cylinders beyond 12 years (TC cylinders beyond 10 years) from date of manufacture unless properly recertified and so stamped per DOT or TC regulations.** Technician notes: For additional information on cylinder inspection and recertification, see the propane supplier or write for the *Compressed Gas Association Bulletin C-6*. After initial recertification DOT cylinders must be recertified every 5 years thereafter (10 years in Canada).

NOTE: Some states have requirements for recertification that are more frequent than 12 years. Always check local recertification requirements.

14. **Observe valve information supplied by the appropriate manufacturer.** Measure the dip tubes for proper length when changing DOT/TC cylinder valves. Install the proper relief valves with proper pressure design and volume [375 psi for DOT/TC cylinders, 312.5 psi design pressure (*NFPA 58*, 2-2.2.2) for ASME motorhome tanks].

15. **An overfilling prevention device (OPD) must be installed properly for the valve to operate correctly.** Since overfill devices are located inside the containers, only a device's nut or collar can be seen outside the tank. These nuts or collars have a position indicator to aid in proper installation. Some have a notch that needs to be located straight up, while others may have the word "top" to indicate the proper position. Overfilling prevention devices for cylinders must be replaced with the appropriate valve. Check with the cylinder's manufacturer to ensure that the proper valve is used.

16. **Practice safety at all times.** If questions arise about the operation of an appliance or propane system, contact a supervisor and/or the product's manufacturer.

5-1 Review

1. LP-gas is a petroleum product separated out of natural gas and crude oil in the refining process.

   True False

2. Propane, as extracted, is nearly odorless and colorless.

   True False

3. Propane and water boil at –44°F (–42°C) at sea level.

   True False

4. Ethyl mercaptan is added to the propane as a warning agent.

   True False

5. A gallon of propane weighs 10 lb, 2 oz (4.6 kg) at 60°F (16°C).

   True False

6. Propane contracts as temperature is raised.

   True False

7. A POL nut has a left-hand thread.

   True False

8. Determine the gallon capacity of a 65-lb ASME tank at 60°F (16°C).

9. A 20-lb (9.1 kg) DOT/TC cylinder is half full at –5°F (–21°C). What is the approximate Btu/hr vaporization rate per hour?

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Chapter

5-2 Propane Containers

- Identify types of containers and their components.
- Inspect mounting brackets.
- Identify related terminology.
- Identify reasons for purging.
- Identify system components, their relationship and functions.
- Transfer propane from one container to another.
- Inspect relief valves.
- Purge air from a container.
- Inspect gauges (float mechanisms, sight gauges, and dip tubes).
- Leak test a container (pinhole and thread leaks).
- Inspect stop-fill float devices.
- Identify container markings.
- Inspect automatic stop-fill devices/OPDs.
- Calculate container capacity.
- Inspect service valves.
- Fill containers.
- Inspect excess flow valves.
- Apply appropriate labels.
- Determine if a container is legal to be refilled.
- Inspect containers for dents, rust, and general condition.

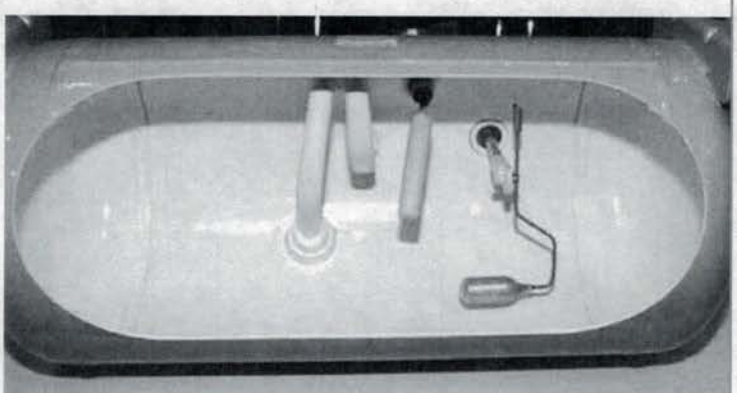
5-2.1 Components: Inspection and Maintenance

There are several components that are common to all propane containers. Become familiar with these components before purging or filling propane containers to ensure safety and prevent accidental leaks.

NOTE: ASME tanks are referred to throughout as "tanks," DOT/TC cylinders are referred to as "cylinders," and when both are discussed, the word "containers" is used.

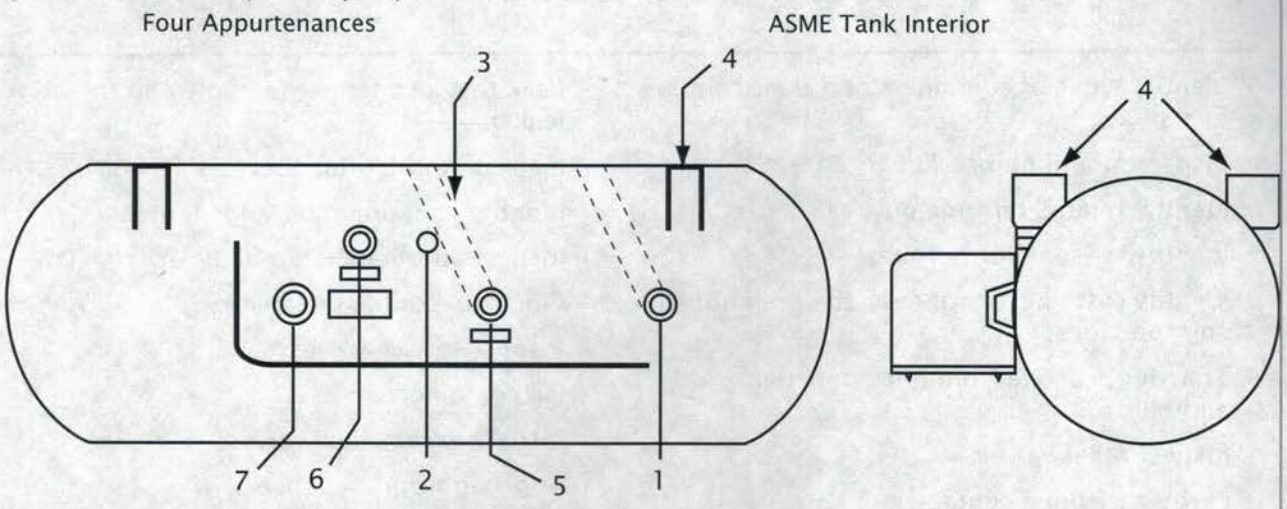
Figure 5-8 Propane Tanks

Four Appurtenances



ASME Tank Interior

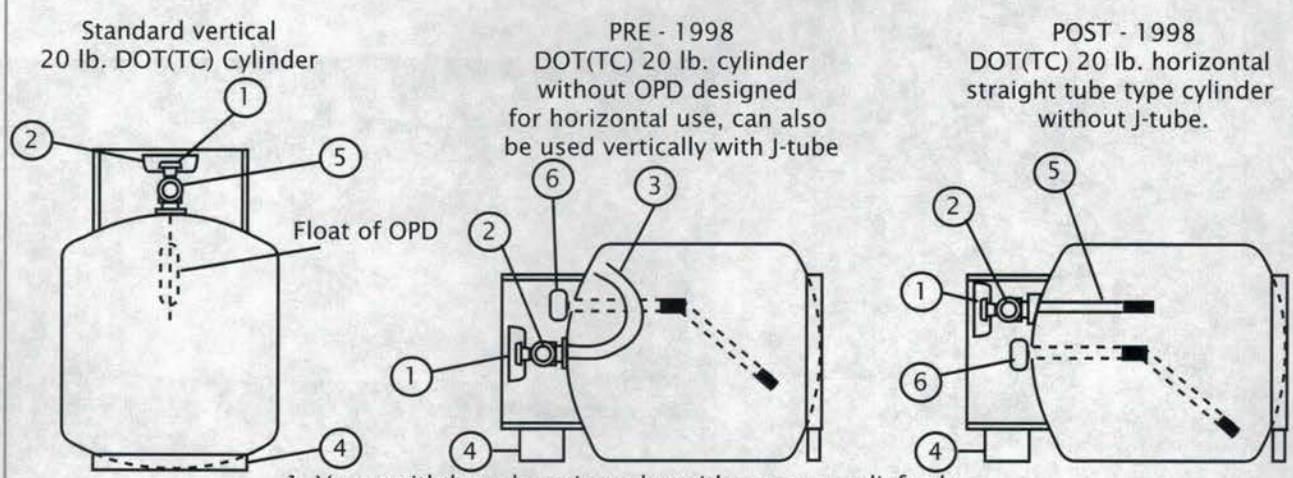
Figure 5-9 Common Components of Propane Tanks



1. Vapor withdrawal service valve with internal excess flow check valve.
2. 20% fixed maximum liquid level gauge or outage valve (sometimes inaccurately called a 10% valve).
3. Vapor withdrawal tube.
4. Mounting brackets.
5. Separate safety relief valve (tanks).
6. Overfilling protection device valve.
7. Visible sight gauge. Available with remote sender.

NOTE: Prior to 1993, service valves on tanks may have incorporated an integral relief valve. This type of valve does not have an internal excess flow check valve.

Figure 5-10 Common Cylinder Components



1. Vapor withdrawal service valve with pressure relief valve.
2. 20% fixed maximum liquid level gauge or outage valve (sometimes inaccurately called a 10% valve).
3. Vapor withdrawal tube or J-tube (used on cylinders where the service valve is not located on top of cylinder due to mounting).
4. Bottom ring, stand legs, or mounting brackets.
5. Overfilling prevention device (OPD) valve.
6. Sight gauge.

5-2.2 Propane Container Components and Installation

All propane appliances for cooking, heating, water heating, and refrigeration are designed to operate on propane vapor only.[1] All propane containers designed for vapor service must be transported, installed, and used in the proper position. Do not transport, install, or use a vertical cylinder (see *Figure 5-11*) in a horizontal or upside-down position. Never use a horizontal cylinder (see *Figure 5-11*) on its improper side. Otherwise, liquid propane could enter the system designed for vapor only, creating a potentially hazardous condition.

The label shown in *Figure 5-11* is sometimes placed on cylinders to stress the need of upright positioning during transit.

Propane containers are permanently marked with the word "top" stamped on a tab welded to the tank or "arrows must point up" stamped in the guard or bracket of a cylinder to identify the proper position.

Always use a plug or cap when transporting or storing disconnected cylinders or tanks (full or empty). All propane containers must be securely attached in the proper position for the intended use. Use all brackets provided to ensure proper support and positioning.

Figure 5-12 displays an example of a POL plug for use in a POL service valve [Compressed Gas Association (CGA) 510]. *Figure 5-13* shows a Type I valve and dustcap (CGA No. 791).

NOTE: Never use a POL plug in a Type I (CGA 791) valve. The POL plug may depress the plunger (see *Figure 5-15*) of the Type I valve and create a propane leak. Always use a dustcap.

Figure 5-11 DOT/TC Cylinder Warning/Caution Labels

Figure 5-12 Plastic POL Plug

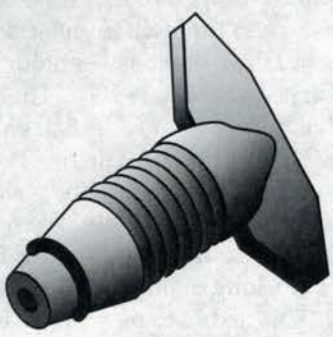
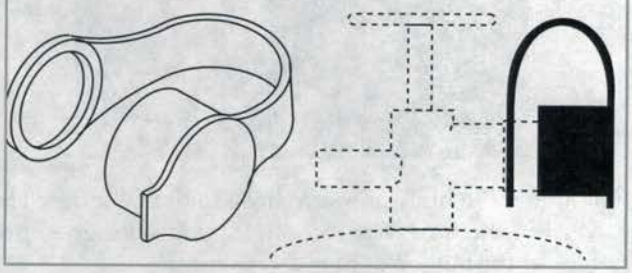


Figure 5-13 Type I Valve Dustcap (CGA No.791)



1. Some propane-powered generator sets may require a liquid supply for proper operation. Special containers or separate container openings may be supplied for this purpose. Liquid withdrawal outlets are so marked.

5-2.3 Propane Container Appurtenances

All containers have appurtenances. The word "appurtenance" is a single term that includes all the fittings and valves on the container. Container appurtenances are items connected to container openings that are needed to make the container a gas-tight entity. Appurtenances include the following items: fill valve, shutoff valve, service valve, fixed maximum liquid level gauge, pressure-relief devices, backflow check valve, excess flow valve, and plugs. While these devices may exist on each container, the types and placement on the containers may vary depending on the type of container (DOT/TC cylinder or an ASME tank) or manufacturer.

5-2.3.1 Service Valves and Service Valve Assemblies

On DOT/TC cylinders, the service valve is the primary valve. The service valve is used for filling the cylinder with liquid, and for vapor withdrawal to supply the system with propane vapor. The service valve is often called the "shutoff valve," because the handle of the service valve is used to turn the cylinder on and off to let gas into and out of the cylinder. The service valve contains an integral relief valve and a fixed maximum liquid level gauge.

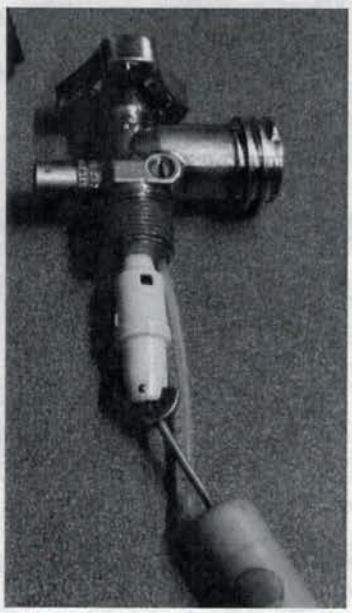
On ASME tanks, the vapor withdrawal service valve is the valve that is opened to allow propane vapor into the system. The handle of this valve is used to turn the gas supply off and on and again. It is sometimes called the "shutoff valve." The fill opening on the ASME tank is separate from the service valve. The fill opening on the ASME tank is only used for filling the tank with liquid propane and has an overfilling prevention device (OPD). Tanks built **prior to 1983** may not have the OPD, as this device was not required by the *NFPA 1192* standard prior to that time.

Figure 5-14 Old Style Valve with POL (CGA 510)

There have been three different service valves used on cylinders, but only one has been qualified for use in the RV industry since May 1, 2002. There is a Type I or CGA 791 valve, a Type II or CGA 810 valve, and the old style POL or CGA 510 valve. The most common service valve used on cylinders for years was the POL type CGA 510 valve (see *Figure 5-14*). They have a five- or six-prong handle. **Cylinders with the POL-type CGA 510 valve are no longer permitted to be refilled after April 1, 2002.** This is due to new safety features that are required by *NFPA 58*. The old POL-type service valves need to be replaced. In the RV industry, the Type I OPD service valve (see *Figure 5-15*), which incorporates an overfilling prevention device (OPD), is now mandatory. This valve has a 1-5/16 in. ACME thread and is referred to as an *OPD service valve* for RV use. Type I OPD service valves have either black or green connector knobs that attach the high-pressure hose to the cylinder. **The color of the connector usually indicates the flow rating.** Most of the time, black connectors are designed primarily for use with a single appliance; green connectors are used for higher-demand systems.

The Type II OPD service valve, which incorporates a quick-disconnect-type fitting, as shown in *Figure 5-16*, is primarily used by the gas barbecue industry. Use of cylinders with a Type II OPD service valve in RVs is not permitted (*NFPA 1192 paragraph 5.2.13.2*). Both Type I and Type II service valves equipped with an OPD will have "OPD" embossed on the body of the service valve in raised letters and a non-removable triangular shaped handle.

Figure 5-15 Type I Valve with OPD, Type I Valve (CGA 791)



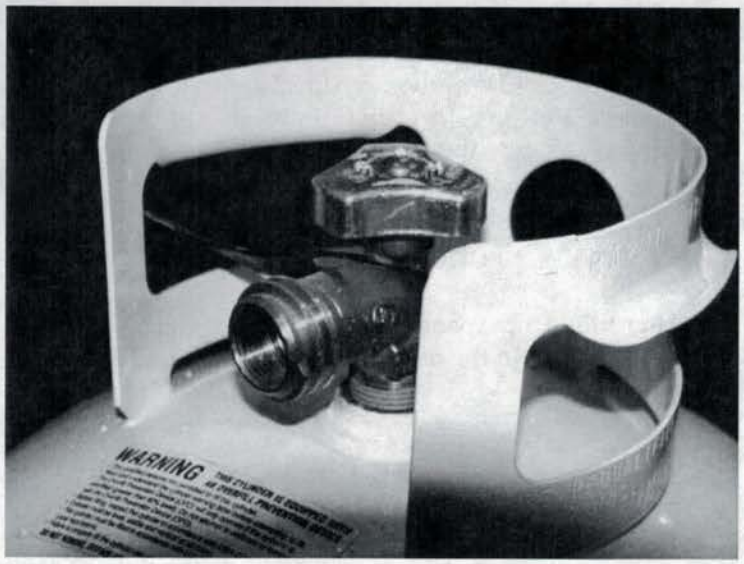
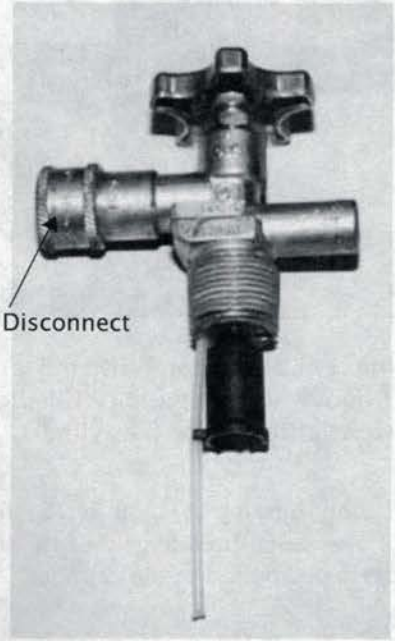


Figure 5-16 Type II Valve (CGA 810)



A Type II or CGA 810 valve uses a quick connect on the valve outlet. The quick-connect type does not require tools or threads to complete the connection. The connection is accomplished by sliding the locking sleeve toward the cylinder's valve body, inserting the mating (BBQ grill side) component of the connection device into the outlet, and releasing the locking sleeve.

Both the Type I and Type II valves incorporate a back-check device that will not allow propane to flow until a positive seal is achieved with the mating connection. The vehicle side of the connection has a thermally sensitive device that forces the back-check valve to close, shutting off the flow of propane, if the connection is exposed to temperatures that exceed 240°F (116°C) under test conditions. Also included is a flow limiting device which, if it senses excess propane flow, will limit the flow of propane to a maximum of 10 standard cubic feet per hour (SCFH). Both Type I and Type II valves incorporate an overfilling prevention device (OPD) to prevent cylinders from being overfilled.

5-2.3.2 Vapor Withdrawal Tubes

Vapor withdrawal tubes are used on both cylinders and tanks and are sometimes referred to as "drop" tubes or "J-tubes." This tube is in direct contact with the vapor space and is used to withdraw propane vapor from the container to the service valve.

Figure 5-17 Horizontal Cylinder Pre-1998 with J-tube

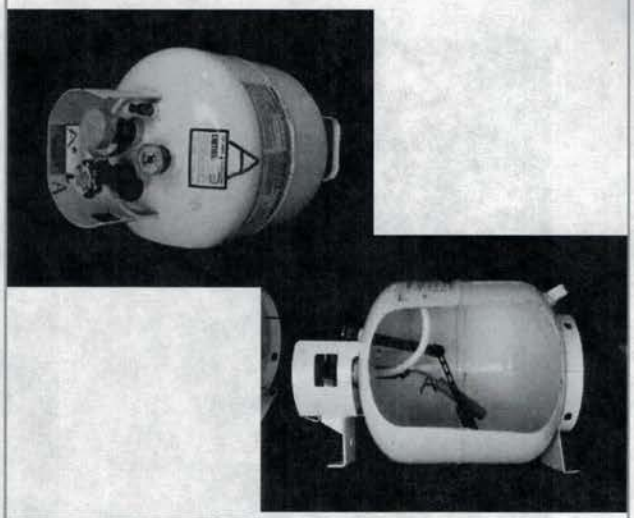
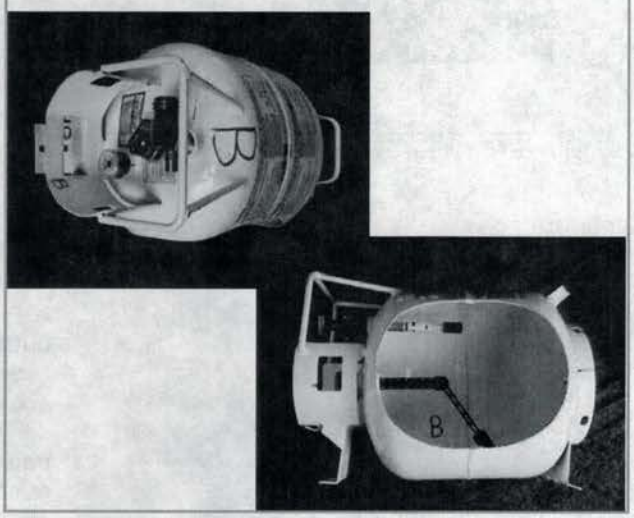


Figure 5-18 Horizontal Cylinder Post-1998 without J-tube



5-2.3.2.1 Testing Vapor Withdrawal Tubes

After filling a propane container, follow this procedure to determine if the dip tube is allowing liquid into the system:

Cylinders

1. When opening the valve on a DOT/TC cylinder, be certain that liquid propane is not released. If present, liquid propane is identified as a white, fog-like substance emitted from the service valve. Liquid propane will freeze upon contact with air, creating a white mist. Only vapor, which is invisible, should be emitted from the valve. To perform this test, simply open the service valve a small amount for a short duration and check the emission. The emission of liquid can be evidence of overfill.
2. Horizontal DOT/TC cylinders manufactured prior to 1998, as shown in *Figure 5-17*, are filled in the horizontal position. Lay the cylinder in its correct position, as indicated by the arrow on the decal and the arrow on the guard pointing up when the cylinder is resting on its feet. Horizontal DOT/TC cylinders manufactured post 1998 do not have a J-tube and therefore are filled in the vertical position.When the service valve is opened slightly, a small amount of white mist (drop of liquid) may be visible. This liquid may be trapped in the withdrawal tube that goes to the vapor space at the top of the cylinder. After a very small discharge of liquid, only vapor should be released.
3. Turn off the service valve and wait for 30 to 60 seconds without moving the cylinder. Perform the procedure again to make sure there is no liquid in the tube. This tests the integrity of the tube to make sure there are no holes or cracks and that the tube is properly positioned in the cylinder.

Tanks

1. The same test used on cylinders can be applied to ASME tanks on motorhomes and camper vans. Generally, tank service valves cannot be observed for liquid, because the fill valve is separate from the service valve and disconnecting the regulator is not recommended. These tanks have an internal vapor withdrawal tube that runs to the upper center of the tank. Any liquid that may enter the service valve is likely the result of splashing during the filling process. The amount of liquid entering the service valve should be minimal and not affect its operation.

2. If there is any doubt, perform the same test again to make certain that only vapor is exiting this tube.

NOTE: The small amount of liquid in the vapor withdrawal tube following the filling process is eliminated by the RV's regulator system.

5-2.3.3 Shutoff Valve Assembly

DOT/TC cylinders use the same port (or opening) for filling and withdrawing gas, so many of the safety features are combined in the valve. The total device is often called the "shutoff valve assembly," as shown in *Figure 5-19*.

NOTE: Use of the valve shown in *Figure 5-19* has not been permitted on cylinders since April 1, 2002.

The components of the shutoff valve assembly, as identified in *Figures 5-19* and *5-20*, are described below:

1. The shutoff valve is the main supply on/off valve for the entire propane system. Open and close this valve by hand only.

2. The dip tube extends into the tank to the 80 percent full level. The length of the dip tube is marked on the protective collar of the cylinder (e.g., "DT 3.5" means the dip tube is 3-1/2 in. long) and on the data plate. The dip tube is connected to the outage valve and together is correctly referred to as the *fixed maximum liquid level gauge*. Less-accepted terms used are *vent stem, spitter valve, bleed valve, vent valve, 10 percent* or *20 percent valve,* and *outage valve*. The length of the dip tube can vary from cylinder to cylinder. Generally speaking, larger cylinder capacity means longer length of the dip tube.

3. Outage port. The fixed maximum liquid level gauge knob (*Figure 5-19*) or screw (*Figure 5-20*) opens and closes the valve. It should be opened during filling and closed at all other times. Fixed maximum liquid level gauge knobs on DOT/TC cylinders, since 1980, use screwdriver slots for this purpose.

4. The valve threads. Inspect these 3/4 in. national pipe taper threads when removing the assembly. If they become damaged, replace the entire unit, as this flaw could lead to gas leaks. Coat the male threads with listed gas thread compound or sealant when installing.

5. Relief valve opening or port. (Do not tamper.) This automatically opens to relieve excessive pressure due to overfilling above 35 psi or heat in excess of approximately 160°F (71°C).

Figure 5-19 Old Style Shutoff Valve Assembly with POL Connection and w/o OPD

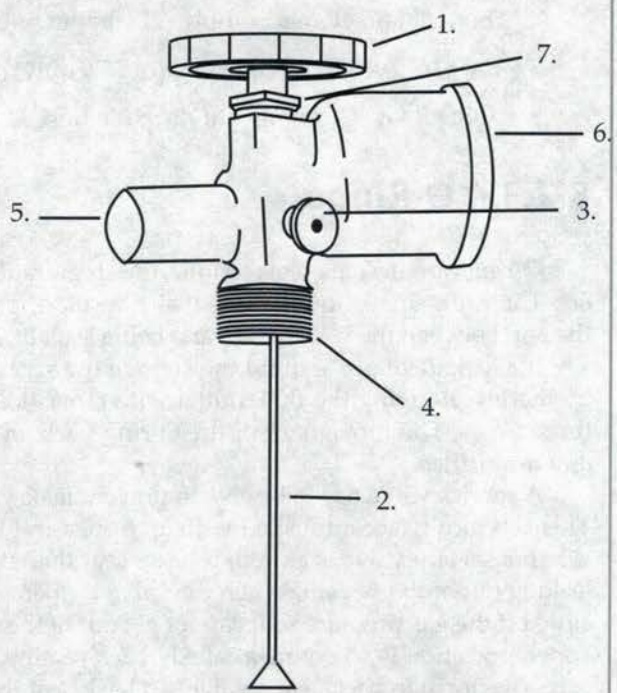
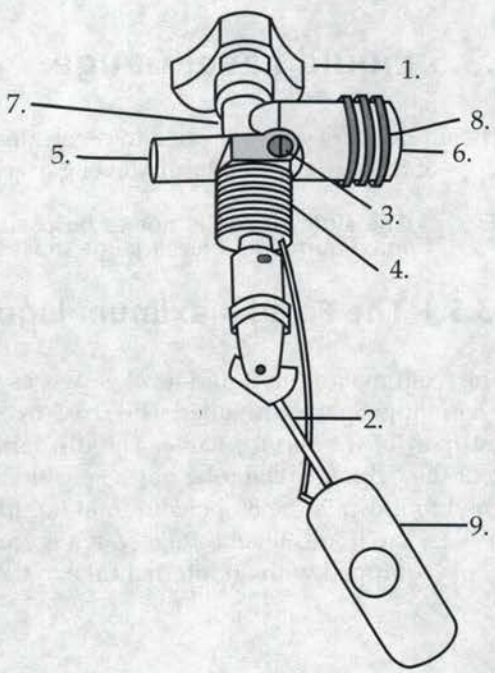


Figure 5-20 Type I Service Valve (CGA 791)



6. A female POL fitting (left-hand thread) has been the standard propane outlet connection for vapor withdrawal on RV cylinders. The Type I (CGA 791) valve is the standard on RVs and has been required since April 1, 2002 (*Figure 5-20*).
7. Bonnet and stem assembly. The bonnet nut has left-hand threads (turn counterclockwise to tighten).
8. 1-5/16" ACME threads (*Figure 5-20* only).
9. OPD float. This will shut propane flow off when it achieves the horizontal position (*Figure 5-20* only).

5-2.3.4 O-Rings

O-rings are used as seals around the stems and working parts of the valves and fittings on propane containers. Their function is to form a seal as a result of pressure by making the rubber O-ring form a slight oval to fill the gap between the two metal parts being sealed. O-rings may not seal well when old, cold, or contaminated.

If a leak develops around the stem of the service valve on either type of container, it often can be corrected by merely plugging the POL outlet with a plastic POL plug and opening and closing the service valve two or three times. The movement of the O-ring back and forth on the seating surface will wipe the surface clean of any impurities.

A service valve has to be able to prevent leakage around the valve stem in either the open or closed position. This is typically accomplished with an upper and lower seat and with an O-ring on the shaft of the valve stem. When a service valve is closed, it has a seat that closes off gas pressure from the container to prevent gas from leaking out of the system. When the valve is opened all the way, the valve stem presses against the upper seat to close off the gas pressure so it cannot get out of the system from around the valve stem. This sealing action at the "open" position is sometimes called "back-seating" and applies to most valves. Do not use any kind of tool or excessive force to back-seat a valve. To back-seat the valve, simply open it all the way. By doing this, the bonnet and stem are protected from a gas leak. The O-ring only has to control the gas leak while in the process of opening or closing the valve. If the O-ring leak cannot be corrected by working the valve back and forth, it will be necessary to replace the valve, because repair or replacement of the O-rings is not generally done.

5-2.3.5 Liquid Level Gauge

The liquid level gauge is used to determine the 80 percent liquid level in a propane container. Two different types of fixed maximum liquid level gauges can be used on propane containers.

NOTE: The sight gauge is not to be used as a "measure" when filling a container, but the fixed maximum liquid level gauge must be used when filling containers.

5-2.3.5.1 The Fixed Maximum Liquid Level Gauge

The fixed maximum liquid level gauge, as shown in *Figure 5-21*, is used to determine the 80 percent liquid fill level in a propane container. The fixed maximum liquid level gauge on a DOT/TC cylinder is usually an integral part of the service valve. The dip tube is connected to the service valve and extends into the vapor space of the cylinder. The tube has a specific length determined by the size and shape of the cylinder and is designed to indicate the 80 percent total liquid capacity level of the cylinder. On an ASME tank, as shown in *Figure 5-22*, the liquid level outage valve is located on the body of the tank at the 80 percent liquid capacity level or is equipped with an internal tube to the 80 percent level.

The fixed maximum liquid level gauge has an orifice no larger than the size of a #54 drill, restricting the amount of gas that can be released though the valve. The valve is designed to be opened approximately 1/3 to 1/2 turn during the fill process. The filler will observe the clear propane vapor when the container is below the 80 percent level. When the container is filled above the 80 percent level, the fixed maximum liquid level gauge will emit a white mist. The fixed maximum liquid level gauge will alternate between the clear vapor and the white mist when the liquid level in the container is filled to its maximum permitted fill level (80 percent). If a solid white mist is emitted from the valve, the container is overfilled. Bleed off any excess fuel through the fixed maximum liquid level gauge until the emissions indicate a properly filled container.

Figure 5-21 Fixed Maximum Liquid Level Gauge on DOT/TC cylinder

NOTE: This white mist is actually caused by liquid coming from the fixed maximum liquid level gauge. Exercise caution to avoid liquid contact with exposed skin.

The fixed maximum liquid level gauge is to be used when filling a container, even though the container may have an overfilling prevention device (OPD).

NOTE: Persons filling propane containers are to be trained as required by local jurisdictions.

The Type I valve, or CGA 791 valve, as shown in *Figure 5-23*, is sometimes called a quick closing coupling (QCC) valve. Connection to a Type I valve requires a mating ACME nut, normally plastic, that includes the right-hand 1-5/16 ACME threads for hand tightening the fitting to the service valve of a cylinder.

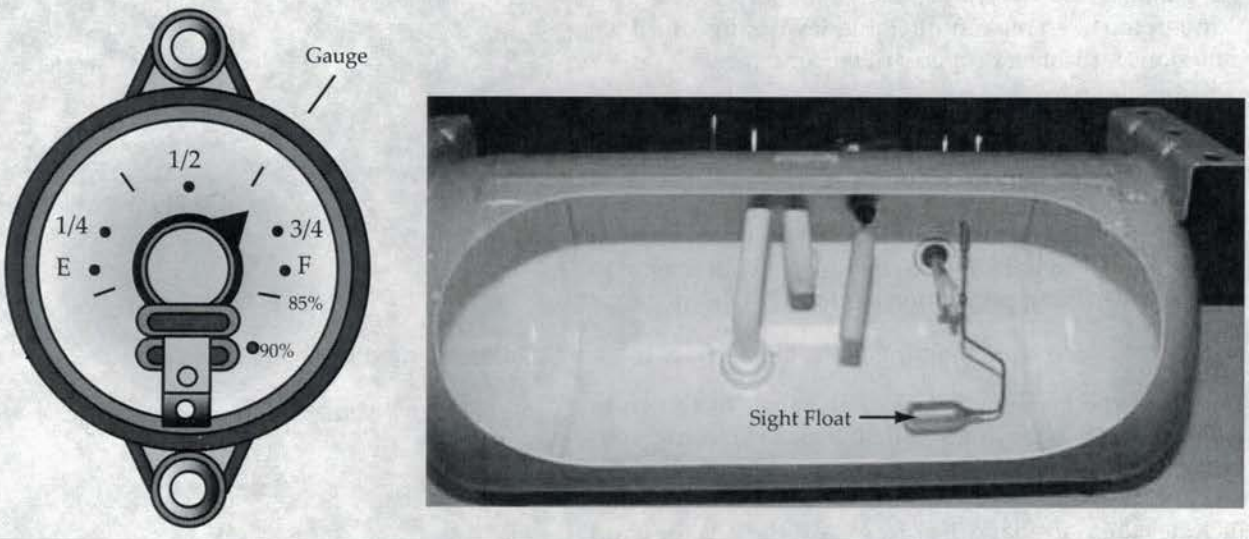
Figure 5-22 Fixed Maximum Liquid Level Gauge on ASME Tank

Figure 5-23 Type I Valve with OPD

5-2.3.5.2 Sight Gauges

On DOT/TC cylinders, the liquid level sight gauge frequently is connected to the service valve. The sight gauge is optional, and only some cylinders are so equipped. Almost all ASME tanks are equipped with liquid level sight gauges to indicate the approximate quantity of propane in the tank, as shown in *Figure 5-24*. The gauge itself is either bolted into the tank with four bolts or, more likely, screwed into the tank through a 1-1/4 in. opening. This device has a float inside the tank that floats at liquid level and operates a shaft through a set of gears that rotate a magnet inside the gauge. There can be either a dial chamber, which must be read by looking at the dial on the tank, or a dial chamber with a remote sender, fastened onto the face of the gauge, that sends an electrical signal to a monitor panel. This is a magnetic tracking dial chamber that follows the internal magnet of the gauge.

Figure 5-24 Sight Gauge and Float



Remote Senders

The dial chamber or remote sender is fastened to the sight gauge itself. Some senders snap onto the gauge, and some use screws. On some chambers, one of the screws is a grounding stud. The other screw is connected to the wire that connects to the coach monitor panel. The receiver is more accurate if it is grounded to a good grounding terminal rather than depending on grounding through frame members of the RV. Over time, poor grounding can result, because a grounding nut screwed into a frame may rust or corrode and not allow proper grounding at the connection. The use of a star washer can help maintain a good ground connection. Also, dielectric compound can be used to help prevent corrosion from occurring at the connections exposed to moisture.

One end of the sender is pointed and one end is flat so that the unit can only be installed in one direction. The pointed end has an arrow that indicates the direction the float moves on gauge.

There are new senders with heat shrink wire connections to protect against corrosion. A magnet can be used to test the new-style gauge without disconnecting the wire. This may require unsnapping the sender from the tank. Be sure to set the dial follower needle back to match the gauge sender magnet when installing this type of sender for the first time or when the sender has been removed (use a magnetic screwdriver or similar tool).

Exercise caution to avoid any possibility of a hot wire touching the sending device, as it could burn out the sender. The senders used in almost all recreation vehicles are rated 0 to 90 ohms (Ω). There are a variety of these ohm resistance devices used by different vehicles. It is important to use the correct ohm resistance sender for the unit to be calibrated accurately. The back of the sender has the resistance inscribed in black letters.

Testing Receiver

On a 0- to 90-Ω sender, an open circuit will cause the receiver to read "full." In fact, it will go beyond the full mark. This indicates that it has a great deal of resistance (no connection) and will read "full." Use the following procedures to test the receiver or the wiring:

1. Disconnect the receiver; it should read "full."
2. Use a jumper or touch the wire from the receiver to ground. It should go to empty, since there would now be 0 Ω resistance (if the ground is good).

The same type of gauge/sender/receiver is used on some RVs. If these two wires are touched together, the gauge will go from full to empty if the wiring and receiver are working properly. If this works and the gauge does not operate properly, then the trouble would be in the sender or the gauge.

Check Float Gauge for Sticking

1. Remove the sender from the gauge by removing the stud and Phillips screw, and connect the ground wire to the outside of the sender.
2. Reconnect the sender wire that runs from the receiver to the brass stud in the middle of the sender.
3. Operate the needle by use of a magnetic screwdriver. If this makes the receiver work properly, it is an indication that the internal gauge float is stuck or has somehow failed.

Figure 5-25 Rochester Sight Gauges

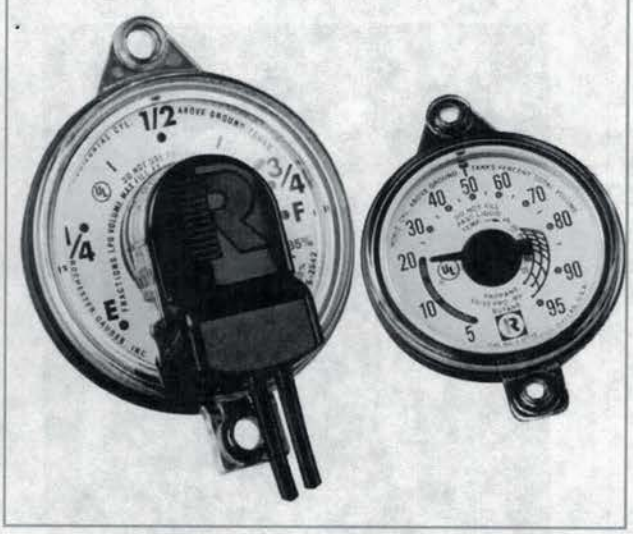
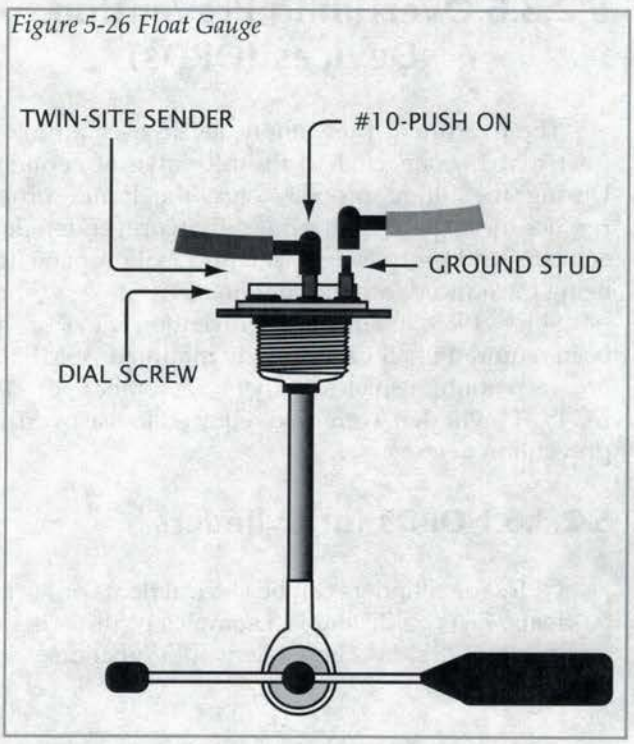


Figure 5-26 Float Gauge



Removing the Gauge from an ASME Tank

In the event the gauge needs to be removed from an ASME motorhome tank, the tank must dropped and removed from the vehicle. It will be necessary to remove the propane and pressure from the tank to remove the valve. Information on evacuating the propane is found in this text under *"Emptying Containers" on page 5-40*. Remember that when transferring the propane to another container, the receiving container(s) must be large enough to contain the fuel. After the tank is evacuated, remove the gauge with the gauge in the vertical position. If trying to remove the gauge from the tank in its mounted position, the float will likely catch on some internal tubes and destroy the gauge assembly.

NOTE: When removing a gauge or valve from an RV tank, be sure all pressure is exhausted from the tank. Ignition sources need to be eliminated for 25 ft (7.6 m) around the tank in all directions.

Remote Gauge—DOT/TC

When using the remote gauge, as on 40-lb DOT/TC cylinders, it is important to check the timing location of the float. The arrow on the sender must point away from the service valve. Since the float is installed in a coupling that is on a 7° angle, the center of the bottom of the float is in the quadrant of the cylinder underneath the service valve. The float needs to have room to move without touching the side of the cylinder. Thus, the arrow must point toward the side of the cylinder away from the service valve. If it points toward the service valve, the float will bump the cylinder side next to the service valve. This can often be corrected by tightening the gauge one-half turn. Contact the manufacturer's service department to return the cylinder and receive one with the gauge installed correctly.

5-2.3.6 Overfilling Prevention Devices (OPDs)

The overfilling prevention device uses an internal float that is connected to the fill valve of containers. During the filling process, once the liquid propane reaches the 80 percent, the overfilling prevention device activates and protects against additional propane liquid being introduced into the container.

Since 1983, overfilling prevention devices have been required in all permanently mounted ASME tanks on recreation vehicles. Since September of 1998, DOT/TC cylinders were also required to use overfilling prevention devices.

5-2.3.6.1 OPDs for Cylinders

OPDs for cylinders can be vertical floats or horizontal floats. *Figure 5-27* shows examples of these devices, and *Figure 5-28* shows how one would function.

Figure 5-27 Vertical and Horizontal OPDs for Vertical Cylinders

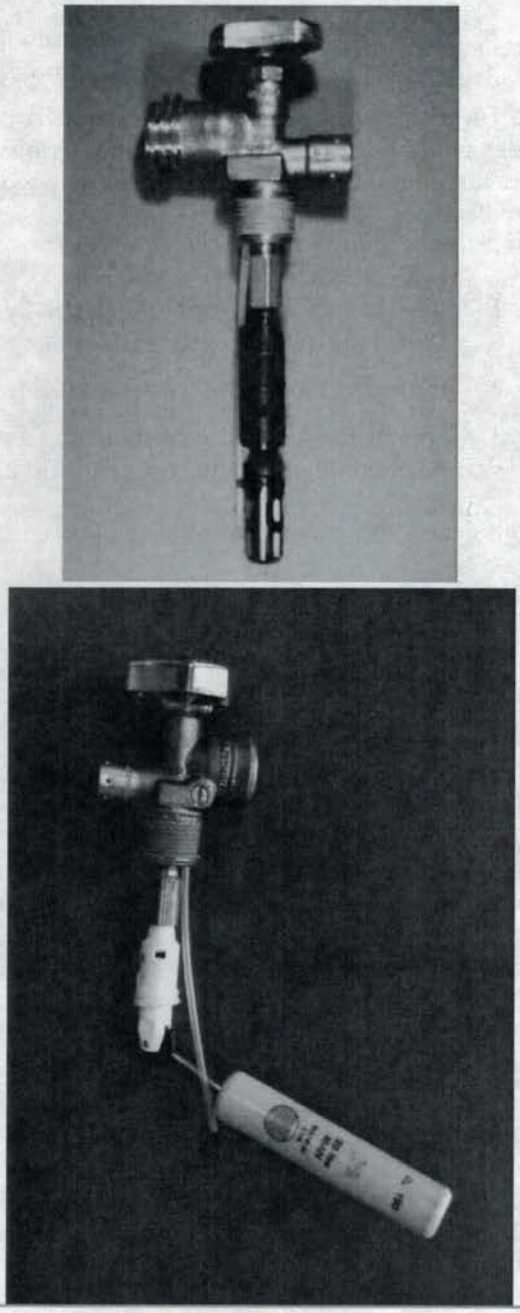
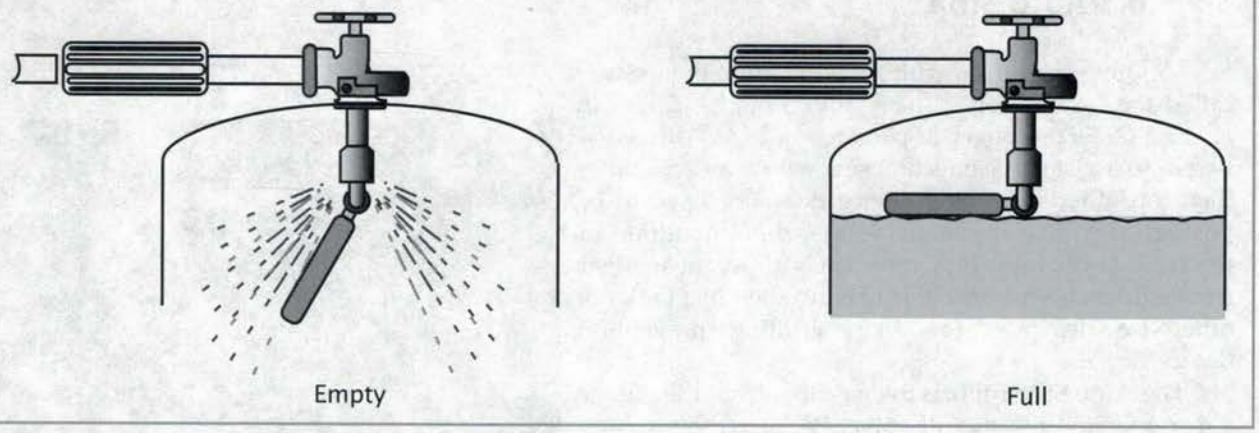


Figure 5-28 Propane OPD Operation



5-2.3.6.2 Float-Type OPDs for Tanks

The float-type OPD is shown in *Figure 5-29*. This type of fitting is used when the fill fitting is in the upper 45° quadrant of the tank.

There is a piston-and-valve assembly that restricts the inlet flow rate to keep the float from bouncing due to the rapid injection of propane. The fill rate is roughly 7 to 9 US gal (26.5 to 34.1 L) per minute.

These devices are occasionally troublesome when filling a new or empty tank. This is because the fill rate is so rapid that the gas flying around inside the tank moves the float upward. Since liquid propane weighs half as much as water, it acts like water in zero gravity, and it moves around in the tank quite freely. It can therefore prematurely flip up the float. The current OPD models being used in motorhome tanks have a restricted fill rate.

Even when using an overfilling prevention device, it is still required that the fixed maximum liquid level gauge (outage valve) be opened and that it remain open during the entire transfer of liquid into the tank. In the event that the 80 percent overfilling prevention device does not work, the technician would be aware that the tank is full when liquid appears at the fixed maximum liquid level gauge opening.

Figure 5-29 Float-Type OPD for Propane Tanks

One important consideration when checking any of the OPD float devices that may be malfunctioning is to make certain that the fill valve is installed so the word "top" is pointing upward. It must be in this position for the device to function correctly. The word "top" is stamped into the metal of the fill valve in the correct position. On a motorhome, this will not always be easy to see and will probably require a flashlight and a mirror to check. A small groove may also be cut into the face of the brass fill valve that points to the top to show correct valve positioning.

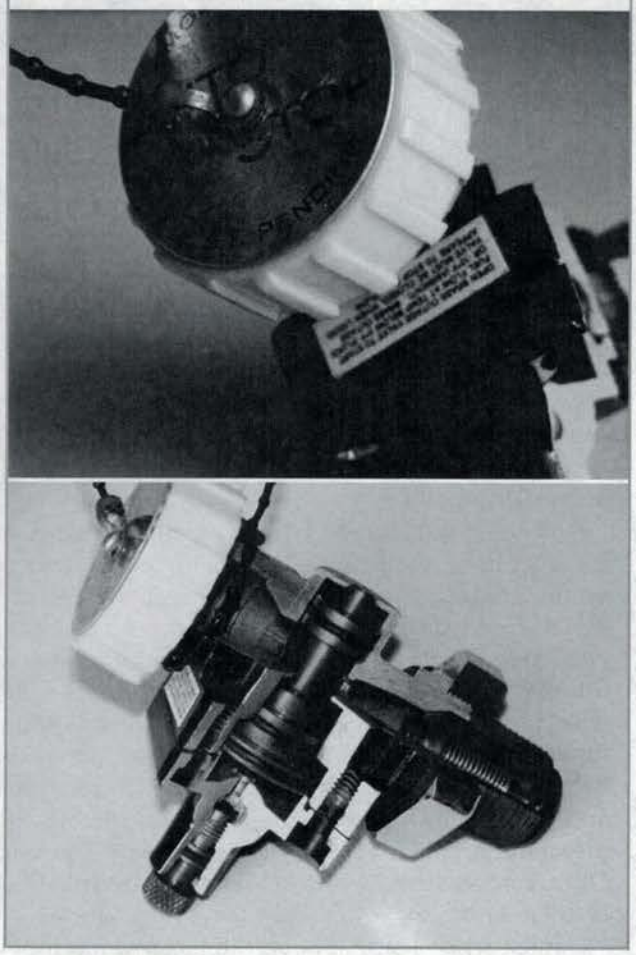
All fill valves must be kept free of foreign material while filling, and the dust cover must be replaced after every filling. Failure to observe this precaution may result in improper operation of the valve, requiring replacement.

Replacing any overfilling prevention device with something other than an overfilling prevention device is a violation of the national standards and must not be permitted.

5-2.3.6.3 Auto Stop®

Another type of overfilling prevention device was called the "Auto Stop®." The Auto Stop, as shown in *Figure 5-30*, is no longer in production but is discussed herein to assist service technicians who may encounter them on older RVs. This device does not have to be positioned so that its float is in the upper quadrant of the tank. It operates in a completely different manner from a float system, and it can be installed in a tank not otherwise designed for an overfilling prevention device.

Figure 5-30 Auto Stop Cap and Cutaway view



The Auto Stop utilizes the gas flow from the outage valve opening into the fill valve. Because the viscosity of gas vapor is different from that of gas liquid, the liquid does not escape through an outlet orifice as rapidly as vapor, and it will automatically cause a piston to close, shutting off the filling process.

There is only one moving part—the piston. It has three O-rings that perform seal functions between the different cavities in this valve. As previously mentioned, O-rings occasionally have to be seated. When an Auto Stop is used, it is important that the operator open and close the outage valves several times during the first filling to cause the piston to move back and forth and spread the lubricant along the walls of the valve to make the O-rings seal properly.

It is also important to know that, on this particular valve, when the outage valve is opened, it must be opened all the way. It does not screw out of the valve. It will open about two and one-half turns. It must be open all the way to allow the internally installed orifice to do the measuring to make the valve function properly. If the outage valve is only open part of the way, the flow rate is in effect changed, and the valve may not open to allow the tank to fill. It is also important to purge the air from the tank. Purging is discussed in *"Purging Containers" on page 5-35*. Air flows at a different rate from gas vapor, and this will frequently shut off the filling at about the 60 percent mark. The fact that liquid fills the lower 60 percent indicates that any of the unpurged air into the top of the tank is now compressed. This will cause the air to flow through the orifices, causing the valve to shut off prematurely.

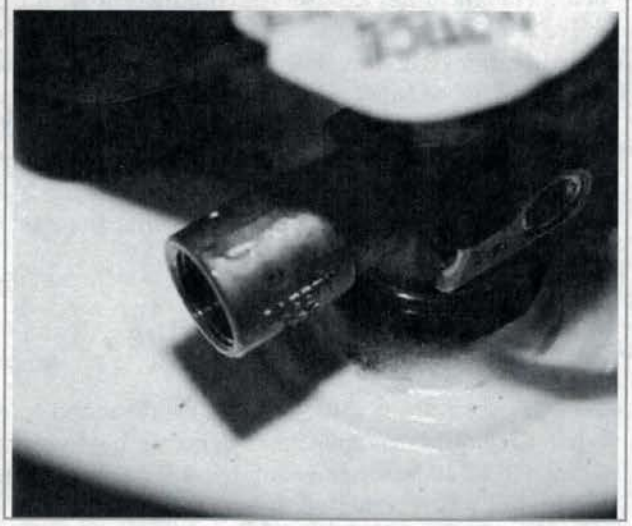
One of the advantages of the Auto Stop valve is that the valve can be serviced without emptying the fuel from the tank. The double back-check device that is screwed into the tank keeps fuel from escaping out of the tank and into the area of the piston. If service personnel have been properly trained and understand the device, it can be disassembled and worked on by plugging off the line from the outage coupling and performing service functions. Do not attempt to work on a tank containing fuel if not instructed in this procedure.

5-2.3.7 Pressure Relief Valves

All propane containers have an integral pressure relief valve. This valve is designed to open at a specific high pressure to prevent the container from being damaged or rupturing.

There are many types of pressure relief valves used in the propane industry. One characteristic common to all is they are not to be adjusted by service personnel. A pressure relief valve that malfunctions or is believed to be not working properly must be replaced. The following types of pressure relief valves are commonly used on RVs:

Figure 5-31 Pressure Relief Valve for Cylinder



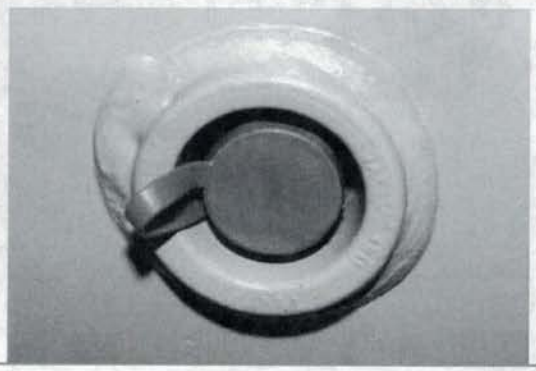
A. A pressure relief valve is integral with the DOT/TC cylinder service valves, as shown in *Figure 5-31*, for cylinders of 40 lb (18.1 kg) capacity or smaller. The pressure setting of this relief valve is 375 psi, with an orifice size of 0.019 in. This pressure relief valve/service valve combination is commonly referred to as a *compact valve*. The pressure relief valve on the service valve is the large opening on the back of the service valve, usually opposite from the fill side of the valve. The words "safety relief valve" are stamped on the shroud of this pressure relief valve. This type of service valve also incorporates the fixed maximum liquid level gauge on the body of the service valve.

B. The ASME tank uses two types of relief valves. They are:

1. On older model tanks (pre-1993), some high-flow service valves with integral relief valves were used. The pressure relief valve was an integral part of the service valve and located outside the tank. This service valve is different from DOT/TC cylinder valves in that the pressure relief setting is 312.5 psi. Further, there is no liquid level gauge opening on the service valve of the ASME tank. The pressure relief valve of the cylinder valve has a relief setting of 375 psi. Finally, ASME pressure relief valves are required to have a flow rating of at least 626 ft^3 (17.7 m^3) per minute (CFM), and DOT/TC pressure relief valves will not meet this requirement.

2. Beginning in 1993, an internal pressure relief valve was required for use on all ASME tanks. This required the use of a separate opening into the tank, as the pressure relief valve was no longer an integral part of the service valve, as shown in *Figure 5-32*. These internal relief valves are 3/4 or 1 in. pipe size and are protected from contamination by plastic dust caps. *NFPA 1192 paragraph 5.2.17.2* requires that ASME tanks to specifically employ a separate full internal or flush-type full internal pressure relief valve. It also requires a 312.5-lb (141.75-kg) working pressure for ASME tanks.

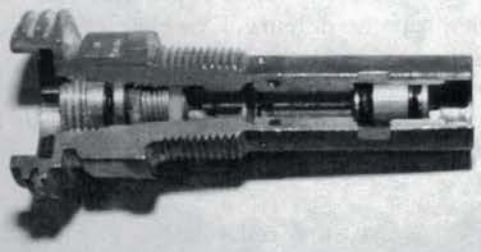
Figure 5-32 Relief Valve ASME Tank



5-2.3.8 Backflow Check Valve

The backflow check valve, as shown in *Figure 5-33*, is a mechanical device used in conjunction with the fill valve that permits the flow of vapor or liquid in only one direction. Backflow check valves are used primarily when filling ASME tanks. They are internal and were added to prevent propane escaping from the tank into the atmosphere after the tank is filled. In the event the fill valve is sheared off a propane tank during a collision, the backflow check valve prevents the gas from escaping into the atmosphere.

Figure 5-33 Cutaway of an AMSE Fill Valve with Double Back-Check (Backflow Check Valve)



5-2.3.9 Excess Flow Valves

An excess flow valve is a device designed to close when the liquid or vapor passing through it exceeds the prescribed flow rate. An excess flow valve is required for use in all RV propane containers. The excess flow valve will not stop propane from flowing out of the container, but when activated due to an opened or broken line, it will limit the flow.

On ASME tanks, the excess flow valve is installed as an integral component of the service valve, sometimes called the "vapor withdrawal valve." On DOT/TC cylinders, the excess flow valve is located in the POL or Type I fitting that attaches to the outlet of the service valve. This means the excess flow valve may be in the fitting of the regulator or in the fitting of the high-pressure flexible hose connection, sometimes called the "pigtail."

The excess flow valve can be seen in a POL fitting. Before connecting the POL fitting into the container and hooking it back up to the recreation vehicle's propane system, notice that inside the hole of the POL fitting is a square piece of material. This square piece of material is an excess flow check valve. POL fittings for use other than in recreation vehicle service typically do not have an excess flow check valve. The excess flow valve for the Type I or CGA 791 valve appears in the end of the fitting that connects to the cylinder valve, but it is not readily visible.

Figure 5-34 shows a POL fitting, including the front view displaying the square piece.

Figure 5-34 Excess Flow Male POL Fitting

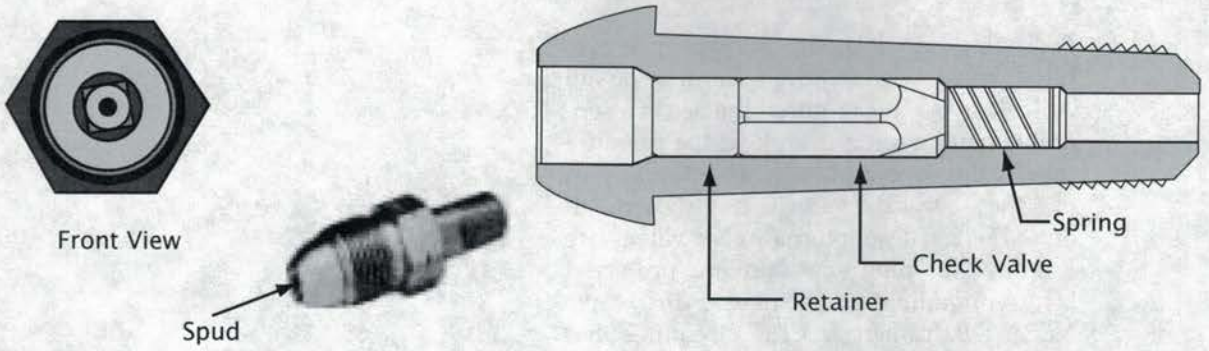
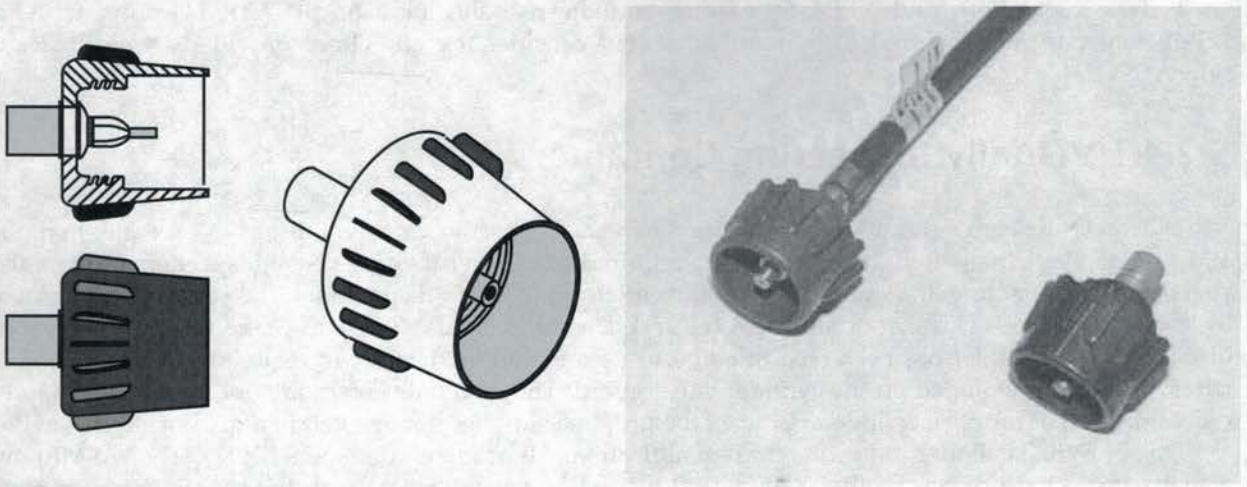


Figure 5-35 Type I Valve Fitting



The excess flow valve restricts gas flow when the flow through the valve exceeds the set point of 200 cubic feet per hour (CFH). Should the need arise to replace any of these parts in the field, repairs must comply with national RV standards and replace them with parts that contain the correct excess flow check valve.

Excess flow check valves are required by *NFPA 1192, paragraph 5.2.16.1* and also by the Canadian RV Standard *CSA Z240* paragraph 7-3. Every RV is required to have at least one excess flow valve at the container service valve. With DOT/TC cylinders, the excess flow check valve is typically installed in the mating vehicle side fitting. This is because cylinders are removable and can be exchanged with another cylinder when they become empty. If the excess flow valve is installed as an integral component of the service valve, the required protection could be lost when the cylinders are exchanged. However, with ASME tanks (after 1993) that are permanently mounted, the excess flow check valve will be located in the inlet of the tank's service valve (*NFPA 1192, paragraph 5.2.16.1* and *CSA Z240 paragraph 7-3*).

The excess flow check valve protects the propane system on the high-pressure side of the regulator. The excess flow check valve may not shut off low-pressure leaks.

5-2.3.10 Quick-Disconnect Devices

Some recreation vehicles use quick-disconnect devices within the propane system. Quick-disconnect devices are hand-operated devices that provide a means for connecting and disconnecting an appliance or an appliance connector to a gas supply. *NFPA 1192, paragraph 5.3.14* directs that quick-disconnect devices used downstream of the propane main regulator need to be listed for use with propane and listed for the specific environment (indoor, outdoor, or both), and they cannot be capable of connection to the cylinder portion of a cylinder connection device. *NFPA 1192, paragraph 5.3.15* requires that a quick-disconnect device, when installed indoors, must have an approved manual shutoff valve with a nondisplaceable valve member (rotors) installed upstream from the quick-disconnect device. This requirement may be met by using two individual components or by using one device that incorporates both functions. Each interior location containing a quick-disconnect device must be so equipped. Interior locations also include below-floor storage compartments. Quick-disconnect devices used outside the recreation vehicle do not require the use of the manual shutoff valves and may be used at the manufacturer's discretion (*RVIA A Guide to 1192 Handbook, paragraph 5.3.14*).

5-2.4 Examining the Containers

Federal regulations and *NFPA 58* require periodic requalification of all DOT/TC propane cylinders. ASME tanks are not required to be requalified, but consider the guidelines provided herein to maximize safety.

5-2.4.1 Visually Inspecting Containers

DOT cylinders are required to be recertified by visual inspection at intervals of 12 years after manufacture and every 5 years thereafter. TC cylinders are required to be recertified by visual inspection at intervals of 10 years after manufacture and every 10 years thereafter. To recertify the cylinder, the person must be qualified by the Department of Transportation (DOT) or Transport Canada (TC) and make records of the cylinder inspection. If a cylinder has been recertified by visual inspection, the date of requalification, followed by the letter "E," will be stamped on the cylinder valve guard. The materials herein are not intended as a guide for requalification of propane cylinders. Contact the propane supplier if interested in requalification of cylinders.

Do not refill a cylinder if it is due for requalification. All propane containers (DOT/TC or ASME) must be visually inspected prior to refilling. The visual inspection needs to start with the container's data plate and must also include the container surface, valve guard, and foot ring.

5-2.4.2 DOT/TC Cylinder Markings

DOT/TC requires that certain information, such as the design manufacturing code, be permanently marked on the cylinder. Normally, this information is stamped on the outside of the valve guard or on the cylinder body itself (see *Figure 5-36*). In some cases, the information is stamped on a metal plate, and the plate is attached to the cylinder.

The DOT/TC marking is the "ID card" for the cylinder. This information can easily be used to distinguish between cylinders. In addition, the information can be used in selecting valves and determining when the cylinder needs reinspection. Whenever working with a DOT/TC cylinder, be sure that all of the required information is clear and easy to read. Never place a cylinder into service or fill it with propane when any of the DOT/TC information is missing or unreadable. Contact the container manufacturer if questions arise.

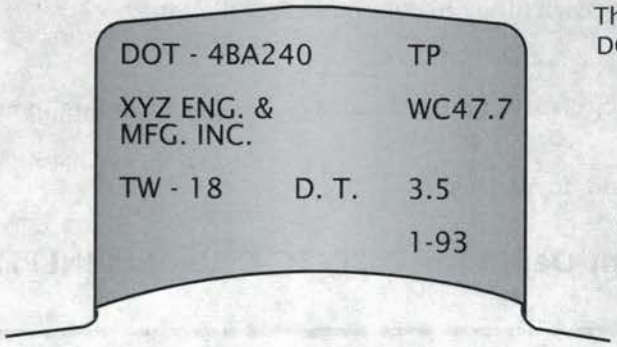
5-2.4.3 Design Manufacturing Code

Cylinders for any type of service can be built under several design codes. DOT/TC design code markings normally consist of two basic parts: the design code and the service pressure. *Table 5-5* shows detailed design codes.

Table 5-5 Cylinder Design Codes

Specification Number Marking and Material		Method of Fabrication
4B-240	Steel	2-pc. welded and brazed
4BA-240	Alloy steel	2-pc. welded and brazed
4E-240	Aluminum	Welded and brazed
4BW-240	Steel	3-pc. welded and brazed

Figure 5-36 Cylinder Markings



The picture shows the following markings.
DOT - 4BA240 TP - (Initials of Inspector)

welded alloy steel — service pressure

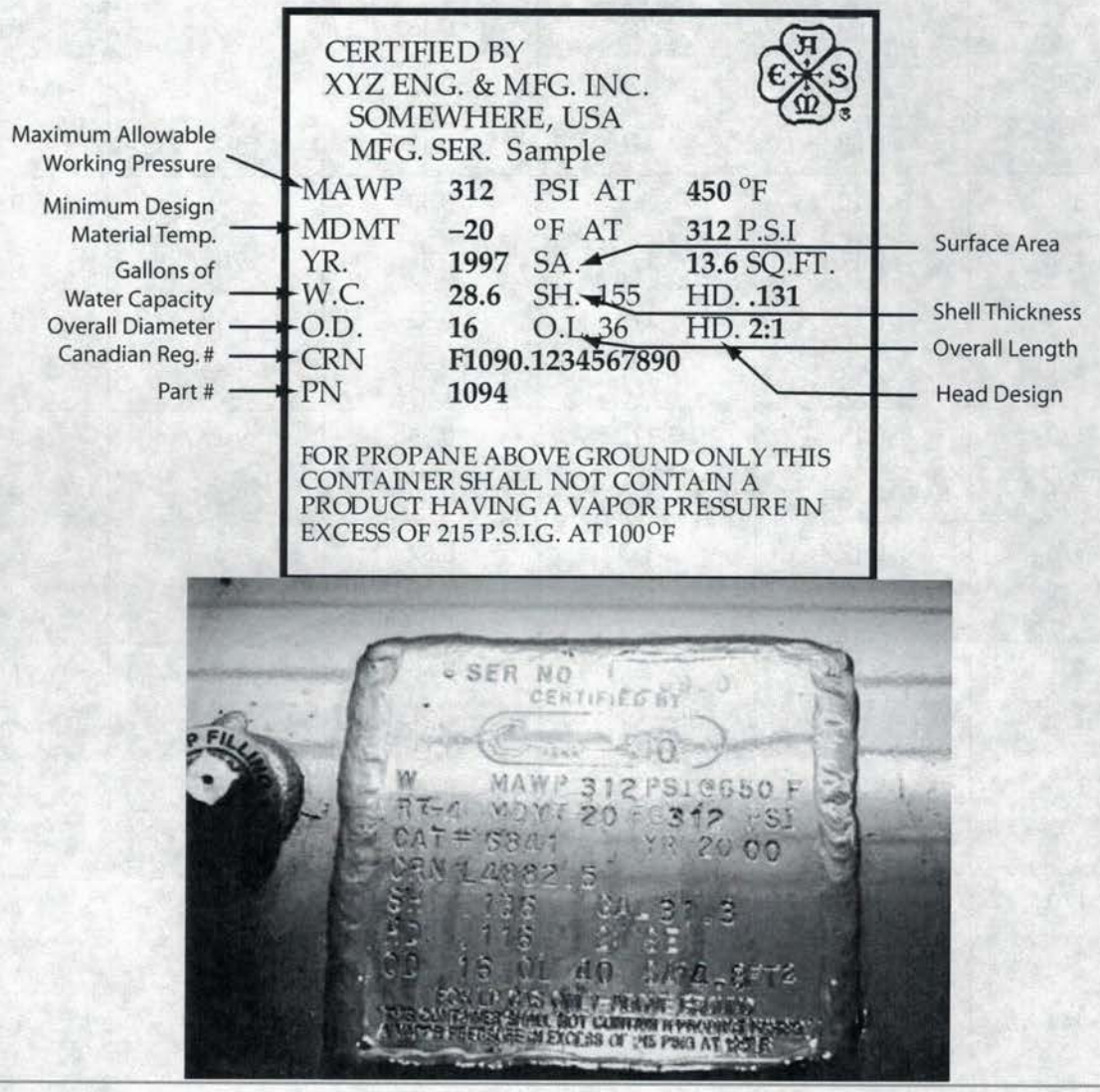
XYZ ENG. (manufacturer) — WC 47.7 (water capacity in pounds)

TW -18 - (tare weight, weight of empty cylinder, in pounds)

D. T. 3.5 - (Dip Tube Length)

1-93 - (Date of Manufacture. Retest date is optional.)

Figure 5-37 Tank Markings



5-2.5 Container Inspection

Tanks and cylinders must be inspected before each filling to determine the following:

- That their valve guards are in place and securely attached
- That the container has not been subjected to physical damage, scraping, denting, gouging (see *Table 5-6*), excessive rusting, or fire
- That fittings are working properly and do not leak

Table 5-6 Maximum Allowable Dent Depth for DOT/TC Cylinders (NLPFA #4003, Table C)

Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches	Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches	Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches
1/2	0.05	4-1/2	0.45	8-1/2	0.85
5/8	0.06	4-5/8	0.46	8-5/8	0.86
3/4	0.07	4-3/4	0.47	8-3/4	0.87
7/8	0.09	4-7/8	0.49	8-7/8	0.89
1	0.10	5	0.50	9	0.90
1-1/8	0.11	5-1/8	0.51	9-1/8	0.91
1-1/4	0.12	5-1/4	0.52	9-1/4	0.92
1-3/8	0.14	5-3/8	0.54	9-3/8	0.94
1-1/2	0.15	5-1/2	0.55	9-1/2	0.95
1-5/8	0.16	5-5/8	0.56	9-5/8	0.96
1-3/4	0.17	5-3/4	0.57	9-3/4	0.97
1-7/8	0.19	5-7/8	0.59	9-7/8	0.99
2	0.20	6	0.60	10	1.00
2-1/8	0.21	6-1/8	0.61	10-1/8	1.01
2-1/4	0.22	6-1/4	0.62	10-1/4	1.02
2-3/8	0.24	6-3/8	0.64	10-3/8	1.04
2-1/2	0.25	6-1/2	0.64	10-1/2	1.05
2-5/8	0.26	6-5/8	0.66	10-5/8	1.06
2-3/4	0.27	6-3/4	0.67	10-3/4	1.07

Table 5-6 Maximum Allowable Dent Depth for DOT/TC Cylinders (NLPFA #4003, Table C) (Continued)

Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches	Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches	Average Dent Diameter, Inches	Maximum Allowable Dent Depth, Inches
2-7/8	0.29	6-7/8	0.69	10-7/8	1.09
3	0.30	7	0.70	11	1.10
3-1/8	0.31	7-1/8	0.71	11-1/8	1.11
3-1/4	0.32	7-1/4	0.72	11-1/4	1.12
3-3/8	0.34	7-3/8	0.74	11-3/8	1.14
3-1/2	0.35	7-1/2	0.75	11-1/2	1.15
3-5/8	0.36	7-5/8	0.76	11-5/8	1.16
3-3/4	0.37	7-3/4	0.77	11-3/4	1.17
3-7/8	0.39	7-7/8	0.79	11-7/8	1.19
4	0.40	8	0.80	12	1.20
4-1/8	0.41	8-1/8	0.81	12-1/8	1.21
4-1/4	0.42	8-1/4	0.82	12-1/4	1.22
4-3/8	0.44	8-3/8	0.84	12-3/8	1.24

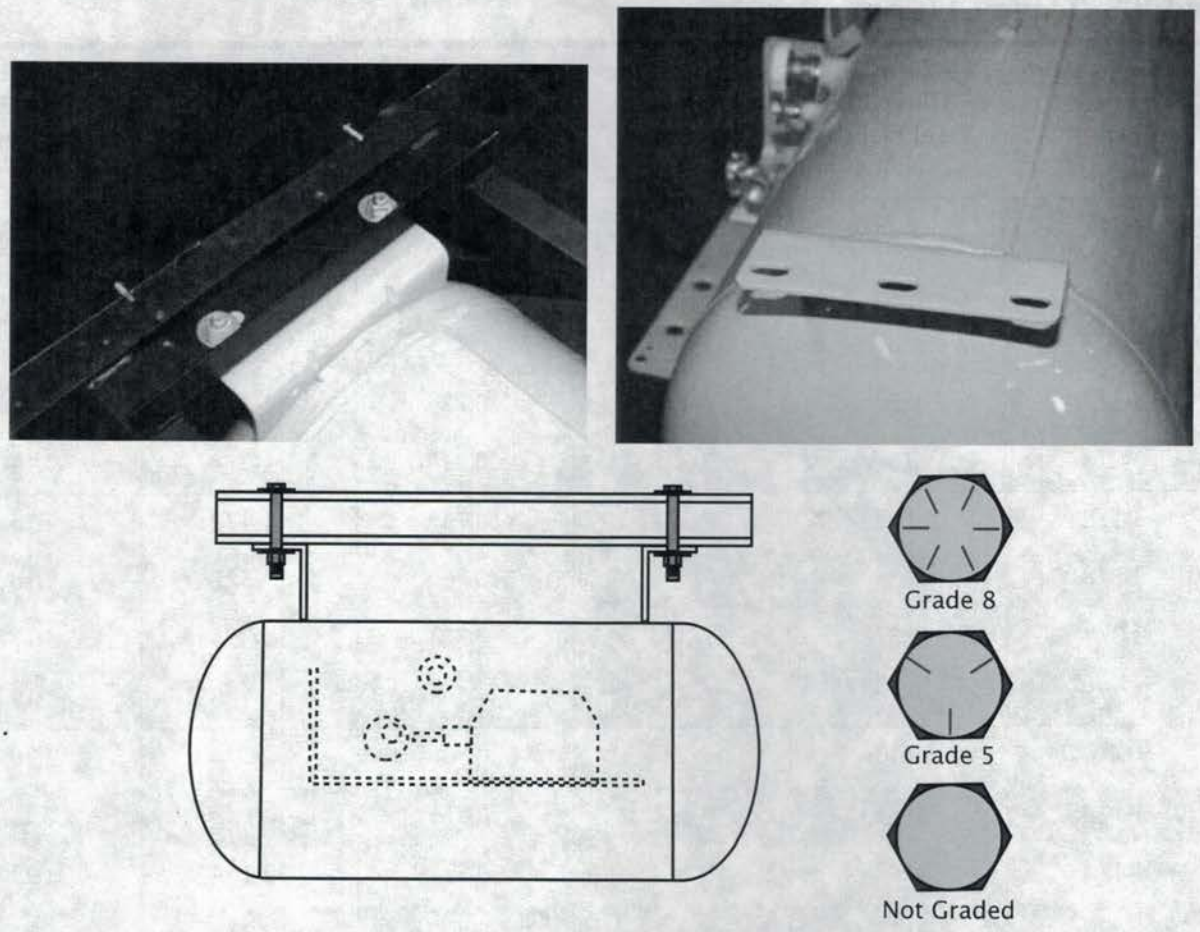
To measure a dent in a container, use a straight edge (ruler or tape measure) to measure the diameter of the dent (the straight line distance from one side of the dent to the other through the center of the dent). Place a straight edge across the dent and, using another ruler or tape measure, measure the distance from the bottom of the dent to the bottom of the crossing straight edge.

5-2.5.1 Inspect/Install Mountings and Brackets

Propane containers need to be secured to the recreation vehicle so they will not become dislodged when a load equal to eight times the container's filled weight is applied to its 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 all brackets are secure and all bolts are tight and in place. Tighten all bolts and replace missing ones with bolts of equal size and strength. If any washers and lock washers were used, be sure these items are reinstalled. Bolt strength is often indicated by markings on the head. These bolt head markings can be numbers or symbols. *Figure 5-38* shows an example and brackets of a propane mounting. If in doubt, contact the container manufacturer to determine the correct bolts to use.

Figure 5-38 Propane Container Mounting



NOTE: Grades of bolts are designated by numbers where increasing numbers represent increasing tensile strength. See *SAE J429*.

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.

Figures 5-39 and *5-40* show a double cylinder assembly and mounting bracket.

Figure 5-41 shows a cylinder assembly with an adjustable strap.

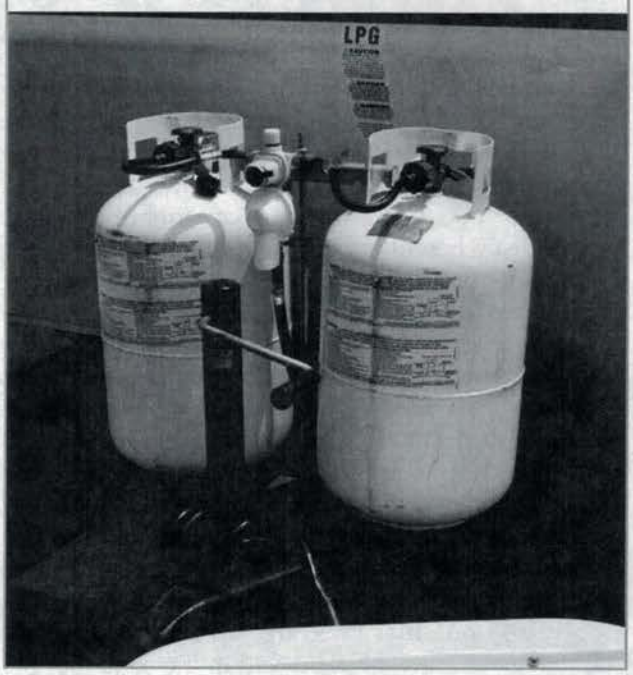
Figure 5-39 Rear Facing Service Valves and Regulator

5-2.6 Container Replacement

DOT/TC cylinders are generally replaced by the same type already mounted. For example, a 20 lb (9.1 kg) cylinder replaces a 20 lb (9.1 kg) cylinder, and so on. However, larger cylinders can be used as replacements if the owner desires to increase the capacity of the onboard supply, especially on an RV with externally mounted cylinders. While this does not pose a problem from a cylinder standpoint, it could affect the weight-carrying and weight-distribution capability of the RV. Replacing dual 20 lb (9.1 kg) cylinders with dual 40 lb (18.1 kg) cylinders will impact the hitch weight.

Replace ASME tanks with the same type as removed. The necessary information required for replacement can be found on the data plate of the tank (*Figure 5-37*). To order a new tank, the technician or parts department personnel would give the data plate information to the distributor. ASME tanks are seldom ordered directly from the manufacturer. If the data plate is missing, the technician should measure the diameter and length of the tank. Distributors may ask for additional information such as location of mounting brackets, location of appurtenances, and so forth. Different tank manufacturers make different size tanks, so this information is important to ensure that the replacement tank will fit the RV.

Figure 5-40 Forward-Facing Service Valves and Regulatory with Secondary Lever



5-2.7 Purging Containers

All new containers and some used containers, particularly those that have their service valves left open, may contain water, air, or other contaminants. It is essential that these be removed before filling the container and putting it into service. The process of removing these contaminants is called "purging."

Purging a propane container is necessary to ensure that the propane supplied into the RV system will be at the correct pressure and that there is no unwanted air in the propane that could cause poor or unsafe appliance operation. Purging is necessary for brand-new containers and other containers that have been contaminated with air. Used containers can become contaminated with air due to valve removal or empty containers that inadvertently had their valves left open. This is one reason to always check for the service valve being closed before removing the plug or cap.

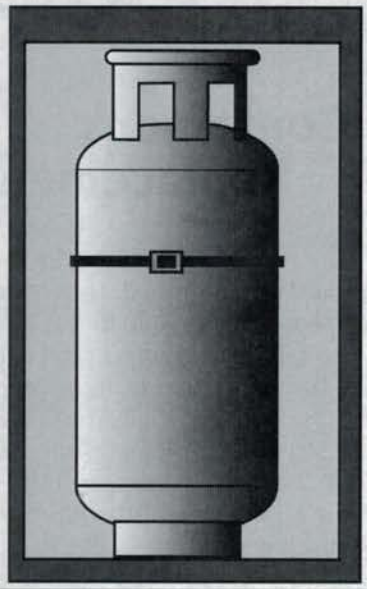
Brand-new containers, never before filled with propane, contain dehydrated air inserted by the propane container manufacturer.

Dehydrated air is inserted for the following reasons:

- To make certain that the container contains no moisture that could start an internal rusting process.
- To use as a safety clue; if a container is opened and no air pressure is found inside, be particularly attentive to leak testing that container. An empty container could indicate a defect in the container that allowed the pressurized air to escape.

NOTE: It is possible for a new container to be totally empty. This could be caused by a valve opened during shipping.

Figure 5-41 Cylinder Assembly with Adjustable Strap



Additionally, unpurged containers could cause several other related problems.

Air or moisture in a propane container is considered a contaminant. Air can contain water and oxygen. These are not suitable to be in a propane container. Chemical reactions such as rust or high container pressure can have potentially harmful results. Moisture in certain conditions can have a plugging effect in regulator orifices (freeze-up). Methyl alcohol may be used to free up a severe moisture blockage in the propane system.

Both oxygen and moisture in propane containers are thought to lead to "odor fade." Air contains oxygen, and oxidation is a process that removes the odorant (usually ethyl mercaptan) that has been added to the propane. Over a period of time, the moisture in the air in an unpurged propane container could lead to rusting, and the oxygen could reduce the odor level of the propane in that container. It is a good idea not to assume that everyone knows the smell of odorized gas, natural or propane. Allow customers to observe the smell and document that they can identify the odor. A "sniff test" to verify the presence of the odorant is a good idea when filling propane containers.

Appliance burner problems. The false high pressure and the higher air-to-gas mixture from an unpurged cylinder will result in appliance burner tuning problems. Water heaters will roar, furnaces may bang or not even light, and if the air mix for the propane/air mixture found in the unpurged container is adjusted, a too-rich burner condition will result once the concentrated propane fuels the appliance. This can cause a condition in which excess carbon or carbon monoxide is produced. The additional service to retune the appliances is costly to the industry, the customers are inconvenienced, and the warranty claims are a problem for the dealer as well as for the appliance manufacturer. Tests indicate that the propane is "off spec" for about half the first fill in a container that is not purged.

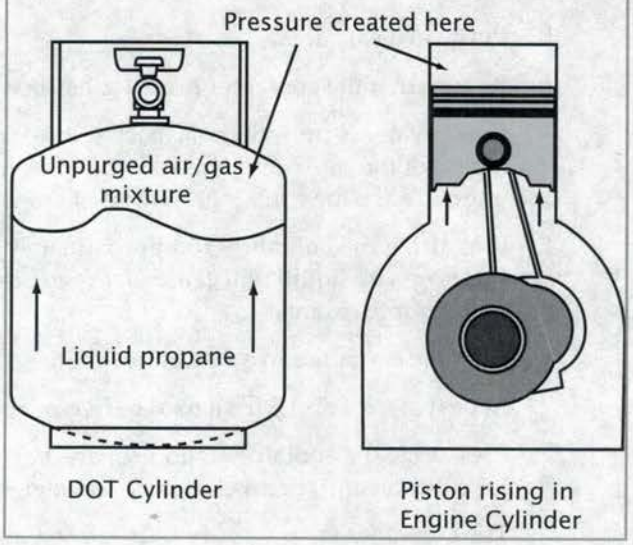
Air in a container can slow down or stop the fill process. Propane dispenser pumps use a differential pressure to fill a container. If the container to be filled has a higher pressure than the dispenser storage container plus the pump's differential pressure, then the fill process can be slowed down or even stalled.

False Container Pressure. An abnormally high pressure can be observed in a propane container that was not purged. If any air is present in the container before it is filled with liquid propane to its proper fill density of 80 percent, it will compress and trap any air inside the container between the top of the tank and the propane liquid. This trapped air can be pressurized five times the atmospheric pressure, creating the situation called *false container pressure. Figure 5-42* displays the creation of pressure in a cylinder.

Propane vapor under sufficient pressure will condense into a liquid. The pressure will be relative to the temperature of the propane. Air, on the other hand, will be compressed by the piston (liquid propane) to the top of the cylinder. The more compression, the higher the pressure. Remember that air can be compressed, but liquid cannot be compressed.

NOTE: *High pressure can be dangerous!* Warm weather, heat, or fire could bring pressures in a propane cylinder to a higher level. The relief valve will function if the pressure of the compressed air is added to the pressure of the propane and the resulting pressure meets or exceeds the relief valve setting (375 psi = 165˚F (75˚C) propane approx.). This could result in a release of gas at a much lower temperature than expected. This could be a hazardous condition.

Figure 5-42 Creation of Pressure in a Cylinder



5-2.7.1 Why Purge?

1. Reduces moisture
2. Removes oxygen
   A. Minimizes odor fade
   B. Avoids improper appliance operation
   C. Eliminates slow filling
   D. Eliminates false container pressure

5-2.7.2 Purging

Check to see if the container is filled with gas or air. If the container does not contain propane (as determined by smell, although the presence of a factory purge sticker is a clue), disconnect the regulator from the container's service valve, open it up, and let the compressed dehydrated air blow out. ASME tanks on motorhomes have an excess flow valve that may "slug" if the air volume escaping the tank exceeds the design of the valve. If that occurs, simply close the valve for about two seconds and slowly reopen the valve. Type I valves (shown in *Figure 5-20*) require an adapter (full-flow POL) to allow the air to escape through the service valve, although the liquid level gauge (bleed or outage) screw can be used to bleed the air though the #54 drill-sized orifice in the outage valve.

NOTE: After the air is released or emptied, keep in mind that, at sea level, there is still 14.7 psi (atmospheric pressure) in the tank.

5-2.7.2.1 Safety Considerations for Purging with Propane

The purging procedure requires a minimum of 25 ft (7.6 m) in every direction between the container and any source of ignition when releasing the air/gas mixture.

The use of a vent stack approximately 10 ft (3 m) or higher will greatly improve fire safety. Propane can be torched with a vent stack designed for the purpose and located according to code 25 ft (7.6 m) from the dispenser). If a vent stack is not used, then it is recommended that the release of propane be restricted to the volume of a #54 drill-sized orifice.

Wear clothes and safety gear that are designed for dispenser operation. Examples include protective eye wear, heavy gloves, protective footwear, coveralls, and head protection (see *"Fuel Transfer Safety" on page 5-41*).

5-2.7.2.2 Purge Procedures[1]

1. Purge in a safe area.
2. Be sure that the container pressure has been released.
3. If free water is present or suspected to be in the container, contact the propane supplier for a determination of the cause and effect. Some cases may require mechanical or chemical drying or, in the case of internal rust, the container may need more attention or replacement.
4. Pressurize the container to approximately 15 psi with the propane vapor. Never purge with liquid. Purging with liquid will cause any moisture in the tank to condense and/or freeze and not be expelled in the purge exhaust.
5. Vent the container to a safe atmosphere.
6. Repeat steps 4 and 5 for a total of five purgings.[2]
7. Pressurize the container with propane vapor and perform leak tests on the container using leak detector solution and/or an electronic leak detector.
8. The container is now ready to be placed into service. Remove the factory purge sticker and install the appropriate DOT/TC and/or OSHA decals.

5-2.7.2.3 Alternative Method to Vapor Purge Utilizing a Vacuum Pump

Twenty-six inches of mercury vacuum has been found to be an acceptable alternative to vapor purging in new containers only. However, the investment in equipment and training can be higher. Do not apply a vacuum, for purging, to containers that have or may have contained propane.

5-2.8 Leak Testing Containers

Use liquid leak detector solution or a mixture of liquid soap and water.

NOTE: Do not use any liquid soap containing ammonia or chlorine, because it will damage the brass fittings of the propane system.

NOTE: Never use a match to check for gas leaks.

For cold-weather areas, name-brand leak detecting solutions are available through wholesale propane industry supply houses that are designed for leak detection use in temperatures below freezing.

Examine the container carefully, particularly at the fitting threads, using leak detection methods at the threads.

Examine all welded surfaces. On larger tanks and cylinders, there is a longitudinal weld that joins the shell together and two circumference welds that fasten the heads to the shell. On smaller cylinders, there may only be the circumference weld between the top and bottom halves.

On DOT/TC cylinders, there are also welds at the foot ring and the valve guard, and a welded coupling where the service valve fitting is installed, as shown in *Figure 5-43*. On ASME tanks, there are welds that connect the brackets and at fittings that hold the valve guard in place. Check these for possible pinhole leaks.

NOTE: If this is the first time the container has been filled with propane, remember that propane can flow out of a leak where air will not escape in sufficient quantities to be detected.

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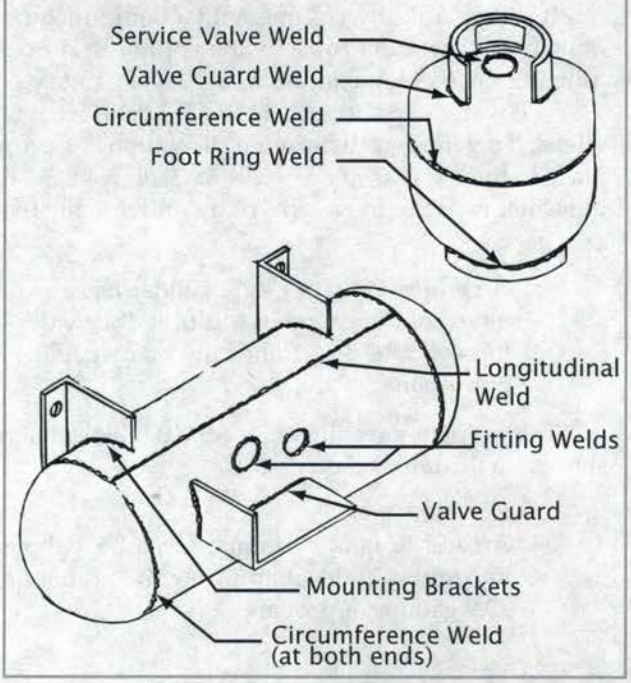
1. Proper purging based on NPGA Safety Bulletin #133.
2. Purging with 30 psi three times or 45 psi twice will result in an acceptable propane-to-air mixture that has been measured to be approximately 93.75 percent pure.

Due to advanced detection techniques at the container manufacturer, fewer pinhole leaks will get into the marketplace. This is because of the container manufacturers' more thorough quality assurance checks. However, the service technician provides the final quality control test.

Pinhole leaks are not normally hazardous but will leave an oily spot that can be detected after the container has been in use for a while. Pinhole leaks can cause a depletion of the propane supply, since the leak is constant. But in most instances, they will not sustain a flame. However, pinhole leaks may be detected by the odor, as the odorant is designed to be detectable by smell in concentrations of one-fifth the lower limit of flammability.

ASME tanks and DOT/TC cylinders are warranted through the manufacturer. On an ASME tank, the date of manufacture is stamped on the nameplate. On a DOT/TC cylinder, it is stamped on the valve guard. These dates of manufacture will be used as the date of warranty unless the container manufacturer is provided with a bill of sale showing a later date.

Figure 5-43 Welds on Containers



An electronic leak detector may be substituted for the leak detector solution procedure. This device may find leaks faster and more easily than the use of soapy water or leak detector solution. Electronic leak detectors come in a variety of styles, but all have a sensing device (usually on a cable or flexible tube) that beeps when propane is detected. The device can be held in one hand while the probe is passed around the container or fittings with the other hand.

5-2.9 Filling Containers

Supervisors should check frequently on their personnel filling propane containers to determine if the correct procedures are being followed. National codes and some state and provincial laws require that the filling personnel are properly trained and that documentation of their training is on file. Refillers are sometimes required to carry cards documenting their qualifications.

5-2.9.1 Calculating DOT/TC Cylinder Fill Weight

Fill cylinders (and tanks) to the 80 percent level only. If using a scale (the weight system), DOT/TC cylinders typically used on recreation vehicles hold 20, 30, or 40 lb of propane in weight. They are sometimes incorrectly called 5, 7, and 10 gal (18.9, 26.5, and 37.9 L) cylinders. These are convenient references only and do not allude to the actual capacity of these cylinders. The propane capacity in pounds is 0.42 times the water capacity stamped on the collar. When filling cylinders by weight, refer to the T.W. number stamped on the guard (e.g., T.W. 19). This is the *tare weight,* or the weight of the empty cylinder before propane is added. Add the 19 lb (8.6 kg) cylinder weight (T.W.) to the 20 lb (9.1 kg) propane capacity and fill the cylinder to 39 lb (17.7 kg).

NOTE: Cylinders should not be filled by liquid meters as the only indication of volume. They are filled by weight or by the volumetric method using the fixed maximum liquid level gauge. The weight of filling connections and hoses, if attached to the cylinder, need to be added to the tare weight for an accurate fill weight.

5-2.9.2 Filling Containers by Volume

If filling tanks by volume with a liquid meter, read the water capacity stamped on the ASME tank. Determine from that water capacity the volume of propane necessary to fill the container. The tank must be filled by utilizing the fixed maximum liquid level gauge.

The water capacity of a DOT/TC cylinder is shown in pounds on the cylinder or on the cylinder's valve guard. Therefore, to determine the gallons of propane a DOT/TC cylinder will hold, move the decimal one place to the left (based on *NFPA 58 Table 7.4.2.2*). The cylinders, however, must be filled by weight (0.42 times the water capacity in weight) or by utilizing the fixed maximum liquid level gauge.

Example 1:
An empty 20 lb (9.1 kg) cylinder has a water capacity of approximately 48 lb as specified on the valve guard of the cylinder. Multiply this water weight by 0.10 or simply move the decimal point one place to the left to determine how many gallons of propane it can hold. In this case, it will be 4.8 US gallons of propane.

The propane capacity of an ASME tank is determined by taking 80 percent of the water capacity in gallons shown on the tank's data plate.

Example 2:
An ASME tank is stamped 28.6 US gallons of water capacity. To be properly filled to the 80 percent maximum fill level, multiply the number of gallons (28.6 water capacity) times 0.8. This would equal 22.9 gallons of propane.

5-2.9.3 Avoid Overfilling

To avoid overfilling the container, always use the fixed maximum liquid level gauge (outage valve). This means the fixed maximum liquid level gauge must be opened during the filling process. Stop filling the container immediately when the white fog-like liquid is emitted from the fixed maximum liquid level gauge opening. Open the fixed maximum liquid level gauge in a well ventilated area and keep open. This bleeding process ensures that any liquid in the container above the 80 percent level will be emitted from the container. This is accomplished when the white liquid stops. In most containers, the dip tube is fastened to the service valve. In some cases, the dip tube is located at a separate opening of the container. But in every case, the dip tube extends to the 80 percent level of the container, and the liquid level of propane must not rise above the end of this dip tube.

Reinstall the DOT/TC cylinder on the trailer as soon as possible. If it is not to be reinstalled, or if the refilled cylinder is loaded in the customer's automobile to be transported to a travel trailer at another location, a plastic POL plug must be inserted into the service valve opening unless it is a Type I valve. This is a mandated safety procedure to guard against the accidental release of propane or dirt contamination. Type I valves require the use of a dust cap. The cylinder also needs to be secured for transport in an upright position. Read the manufacturer's caution label before transporting or storing cylinders. A caution label is shown in *Figure 5-44.*

Figure 5-44 Caution Label

CAUTION!

USE, TRANSPORT & FILL THIS PROPANE CYLINDER WITH VALVE IN A VERTICAL POSITION ONLY. DO NOT OVERFILL. CHECK AFTER EACH FILLING BY OPENING SMALL OUTAGE VALVE AND BLEED GAS IN A WELL VENTED AREA UNTIL WHITE LIQUID STOPS. OVER-FILLING IS HAZARDOUS. INSTALLATION & FUELING PROCEDURES MUST CONFORM TO NFPA NO. 58 AND 1192 OR OTHER STATE OR LOCAL CODES WHERE APPLICABLE. PERMANENT. DO NOT REMOVE.

5-2.9.4 Emptying Containers

The propane must be removed from a tank or cylinder to perform valve repair/replacement or to return the container to the manufacturer for warranty repairs. It is required by law that the container be shipped

empty of propane and the valves plugged or capped. Containers may be emptied by either propane transfer or using a torch to burn off the vapor. Follow the container manufacturer's instructions when shipping.

5-2.10 Fuel Transfer Safety

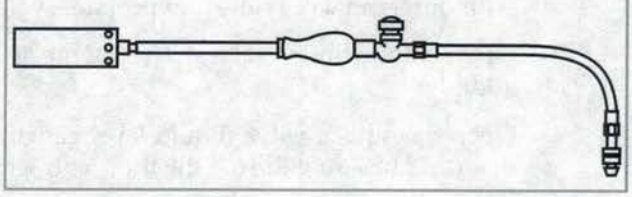
In the interest of safety, all persons employed in the handling of propane need to be trained in proper handling and operating procedures. Refresher training needs to be provided at least every three years. All training is to be documented (*NFPA 58, 4.4*).

1. Wear protective clothes/gear (*NPGA #4001*):
   - Protective footwear such as steel reinforced safety shoes.
   - Coveralls or full coverage garments with consideration as to fire resistance. Cotton or cotton blends are less likely to melt in a flash fire.
   - Heavy gloves such as vinyl safety gloves.
   - Vinyl gloves during liquid transfer.
   - Head protection such as bump caps and safety hard hats.
   - Protective eyewear such as goggles, safety glasses, or face shields.
2. Prepare the transfer area:
   - 18 B:C rated fire extinguisher or better. A water hose nearby and ready can be helpful if conditions permit.
   - Remove sources of ignition for 25 ft (7.6 m).
   - Internal combustion engines within 15 ft (4.6 m) of a point of transfer need to be shut down during transfer.
   - Use wind direction for safety advantage.

5-2.10.1 Torching-Off a Container

Torching is used to reduce container pressure to atmospheric pressure. *NFPA 58* allows venting to the atmosphere through an orifice no larger than a #54 drill size. Avoid releasing unburned propane vapor into the atmosphere. A torch up to 500,000 Btu/hr is typically used to burn off the remaining propane vapor from the container. It is recommended that the torch be located at least 10 ft (3 m) from the RV. *Figure 5-45* displays a sample torch.

Figure 5-45 Torch



When torching-off a container to burn propane, container refrigeration will occur. Identify container refrigeration by moisture/frost forming on the outside of the container where the liquid level of the propane touches the metal. When this occurs, it slows the vaporization process until the flame extinguishes. Wait until the frost melts, then repeat the burn-off procedure as many times as necessary to empty the container.

NOTE: The larger the drill number, the smaller the hole size.

NOTE: Follow the torch manufacturer's specific instructions for correct torch operation procedures.

5-2.10.2 Opening Container Valves

Use the following procedures to open container valves:

1. Make sure that all appliance valves are off.
2. Fully open the Type I cylinder valve. The excess flow check valve, a component of the Type I connector, will activate when initially pressurizing the piping system. Wait a minimum of three minutes for the entire piping system to pressurize before turning on any appliance valves. An activated excess flow valve will allow a limited amount of propane to flow downstream and pressurize the system.

The seats of an excess flow check valve have a metal-to-metal "seat" and are not designed to have a total seal. Therefore, some pressure can get through the valve and into the system. If an appliance is opened before the reset, the excess flow valve will not reopen and will cause only a small amount of propane to flow through the piping system. If the excess flow valve does not fully open, this is an indication that there is a leak in the piping system or all the appliance valves were not closed before opening the Type I cylinder service valve.

NOTE: Piping systems using automatic changeover regulators do not require three minutes to reset the excess flow valve if the supply cylinder is open and operational with the changeover lever pointing to the supply cylinder. Reconnecting the filled reserve cylinder and opening its cylinder valve will not require time to reset the excess flow valve. The system pressure from the supply cylinder will reset the reserve cylinder excess flow valve very quickly.

5-2.10.3 Propane Transfer to Another Container

5-2.10.3.1 Gravity/Pressure Differential Propane Transfer—Vertical Cylinders

1. Connect the "filled" cylinder to an empty purged cylinder (of the same or larger size) using a hose connection with full-flow POL fittings on both ends (do not use excess flow-check or restricted-flow POLs).

NOTE: The cylinder that is receiving the propane should be colder than the filled cylinder. Liquid propane gas pressure is relative to temperature. Be sure that the receiving cylinder does not contain air, as the false container pressure will slow down the propane transfer. Purge the container following the instructions contained in *"Purging Containers" on page 5-35.*

2. Place the filled cylinder upside down and, if possible, at a higher level so that the liquid can transfer with differential pressure and propane weight.
3. Open both cylinder valves. The sound of the propane transferring into the empty cylinder will be audible.
4. Open the outage valve (liquid level gauge) on the receiving cylinder and allow this valve to remain open and bleeding during the transfer operation.
5. The transfer process is complete when a transfer hose fitting can be "cracked" (slightly loosened) and the liquid propane gas emitted from the fitting is clear vapor. If liquid propane is being transferred, a white mist will be observed.
6. Once the liquid transfer is complete, the container will still contain high-pressure vapor. To reduce the container to atmospheric pressure, the container needs to be "torched-off" (see *"Torching-Off a Container" on page 5-41*).

NOTE: Depending on temperature, hose length, and diameter, the transfer of approximately 7 gal (26.5 L) of gas in a 30 lb (13.6 kg) cylinder takes between 5 and 10 minutes. Pressure differential propane transfer by bleeding vapor from the #54 drill size orifice of the outage valve limits propane loss to the atmosphere to a minimum. This controlled propane outage is for fire safety and national code compliance. OPD-equipped cylinders can slow the transfer process.

5-2.10.3.2 Gravity/Pressure Differential Propane Transfer—Tanks and Horizontal Cylinders

When a tank or horizontal cylinder has to be emptied, the propane can be transferred to another container as described above. Containers with vapor withdrawal tubes need to be turned upside down for the withdraw tube to be in the liquid space.

NOTE: Injection of compressed oxygen, or any oxidizing gas, into containers to transfer propane is prohibited (*NFPA 58, 7.2.2.3*).

5-2 Review

1. Whenever transporting or storing disconnected propane containers, always use a _____.
2. Use a POL plug in a _____ valve.
   A. Type I (CGA 791)
   B. Type II (CGA 810)
   C. CGA 510
   D. None of the above
3. Which of the following is NOT a propane container "appurtenance?"
   A. Fill valve
   B. High-pressure pigtail
   C. Liquid level gauge
   D. Service valve
4. Which of the following valves is the primary valve on a DOT/TC cylinder?
   A. Excess-flow valve
   B. Fixed maximum liquid level gauge
   C. Service valve
   D. Gate valve
5. A _____ is used to withdraw propane vapor to the service valve on both cylinders and tanks.
6. A properly sized and installed dip tube will extend into a propane container to the _____ level.
7. The length of a dip tube can be found:
   A. In the service manual
   B. On the cylinder guard
   C. On the shipping invoice
   D. On the tank data plate
8. Pressure relief valves are adjusted by the technician as part of the leak test.
   True False
9. The pressure setting for a pressure relief valve for a DOT cylinder, 40 lb (18.1 kg) capacity or smaller, is _____ psig.
   A. 3.75
   B. 37.5
   C. 375
   D. 3750

10. The proper setting for a pressure relief valve on a ASME tank is _____ psi.

    A. 312.5

    B. 31.25

    C. 3.125

    D. None of the above

11. The _____ will severely restrict the propane flow when a propane line ahead of a regulator is broken or opened.

12. DOT/TC cylinders are required to be recertified at intervals of _____ years after their manufacture and every _____ years thereafter.

13. Purging is necessary only when placing a new propane container into service.

    True False

14. Correct purging procedures require a minimum of _____ feet (meters) clearance from any source of ignition.

15. Proper purging procedures are contained in:

    A. The owner's manual

    B. NFPA 1192

    C. NFPA Bulletin 110-A

    D. NPGA Safety Bulletin #133

16. Pinhole leaks can usually be detected by the _____ that forms after the container has been in use for a while.

17. List the two methods that can be used to determine the amount of propane to be added to a container when filling.

    A.

    B.

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Chapter

5-3 Regulators

- Identify related terminology.
- Adjust regulator outlet pressure.
- Identify regulator components, their relationship and functions.
- The operation of regulators and their components (including automatic changeover).
- Identify high- and low-pressure flex hoses.
- Identify the reasons regulators fail.
- Identify vapor flow.
- Remove and replace a regulator.
- Use appropriate test equipment.
- Install and protect a regulator.
- Conduct regulator lockup test.
- Conduct operating pressure test.
- Determine serviceability of hoses (high- and low-pressure).
- Conduct leak test (using electronic leak tester, leak detection solution, etc.).
- Troubleshoot regulators.

5-3.1 Purpose, Function, and Design

Regulators have often been called the "heart" of the RV propane system. If the "heart" of the system is functioning improperly or not at all, the appliances will not work properly, either. The regulator is responsible for reducing the container's variable high pressure that is created by the "boiling" of propane liquid to a low pressure usable by the individual appliances.

To ensure that the propane system has the correct working pressure, regulators are required. The primary system regulator, located at the container(s), is required to be a two-stage regulator. This two-stage regulator can be an individual device that incorporates both regulators or two separate components.

The first-stage regulator reduces container pressure to about 10 psig. The second-stage regulator reduces the 10 psig to a little over 6 oz of pressure (10 to 14 in. WC). The addition of the two-stage regulator enabled more consistent pressure control and eliminated system problems previously seen with single-stage regulators. If single-stage regulators are present, RV owners should be encouraged to upgrade to a two-stage system.

A regulator works by using atmospheric pressure and a spring. These two influences control the diaphragm inside the regulator. The diaphragm moves up and down, working the lever. The lever has seats that open and close as the lever and diaphragm move. These movements are based on the atmospheric pressure and the tension on the spring, controlling the flow of propane. The seat is used to control the flow of propane, allowing the proper amount of propane to achieve the correct pressure. *Figures 5-46* and *5-47* show the flow of propane through single-stage and two-stage regulators.

Figure 5-46 Single-Stage Regulator (Lever Arm at Angle and Propane Flowing)

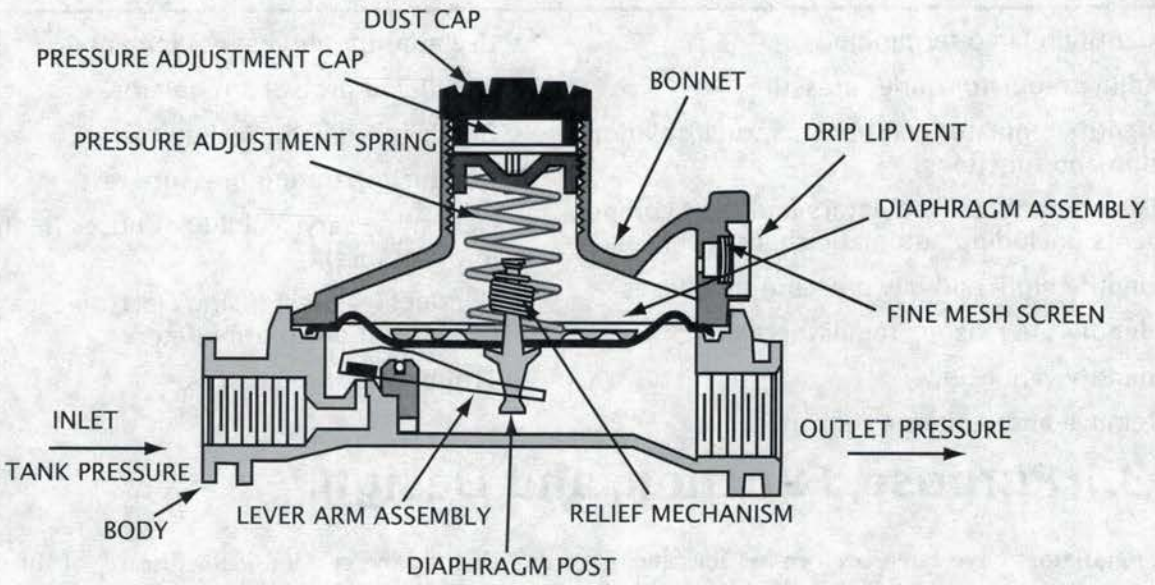
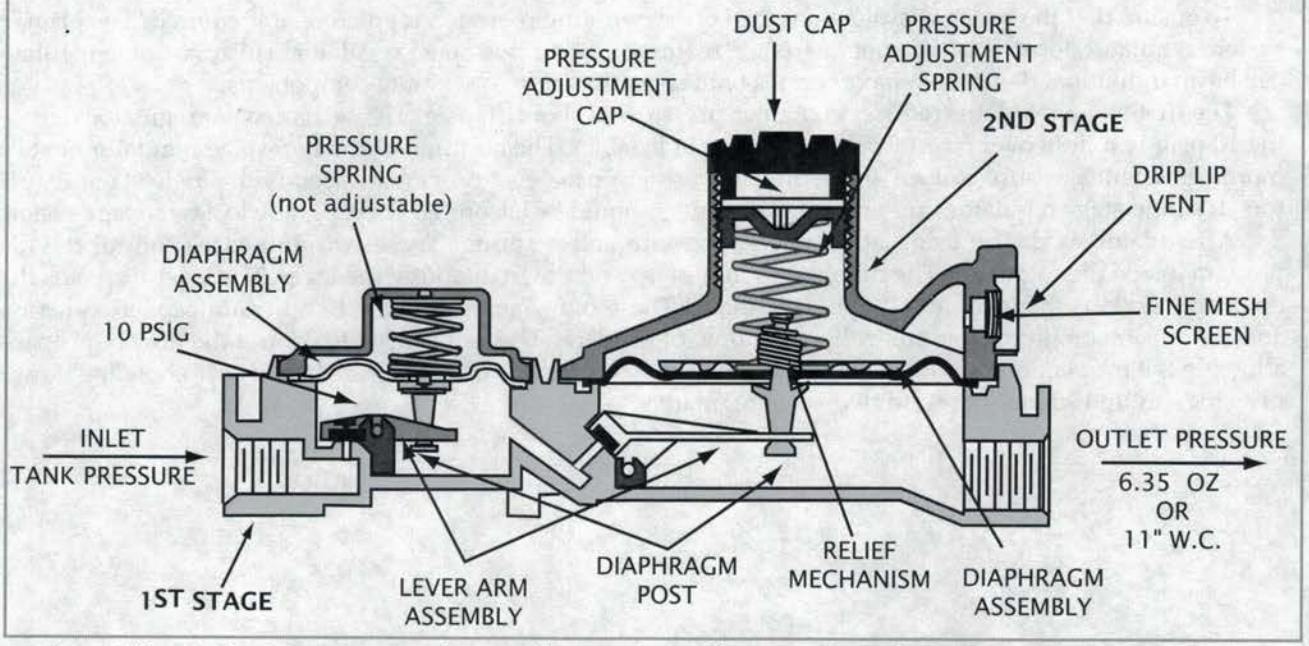


Figure 5-47 Two-Stage Regulator (Lever Arms Horizontal with Ports Closed – Regulator in Lockup State)



In addition to the two-stage regulator at the containers, furnaces, water heaters, and cooktops/ovens have their own integral regulator.

NOTE: Direct spark ignition (DSI) appliances have solenoid gas valves. These gas valves are devices that prevents the flow of propane in the absence of an electric current required to provide ignition. The solenoid gas valve is in a normally closed position, preventing the flow of propane. It requires electrical current to open the valve and keep it open, allowing the flow of propane.

5-3.2 Automatic Changeover Regulator

An automatic changeover regulator as shown in *Figure 5-48* is a two-stage regulator designed for use with two propane cylinders. The input side of the regulator permits two pigtails to be connected to the regulator at the same time. When using an automatic changeover regulator, both cylinder valves should be in the open position. An automatic changeover regulator typically has a changeover knob with an indicator, such as an arrow, to show which cylinder is in use. In addition, there is a pressure indicator (see *Figure 5-49*) that shows there is propane flow in the system.

The following procedure outlines how to operate the automatic changeover device.

Figure 5-48 Propane Automatic Changeover

Figure 5-49 Automatic Changeover Regulator Indicator

To Turn the Gas System On

1. Make sure all appliances and pilot lights are turned off.
2. Have gas in both cylinders.
3. Have both pigtails connected to the cylinder valves.
4. Rotate the cylinder selector mechanism all the way toward the cylinder to be used first; this is the "service" cylinder. The other cylinder is the "reserve" cylinder.
5. Open both cylinder valves and wait until the indicator turns green before attempting to light an appliance or pilot light. If an appliance is lit before the pressure indicator has turned green, low gas pressure will feed the appliances.

NOTE: On systems that have one cylinder mounted next to the regulator and the other cylinder mounted on the opposite side of the coach, or systems that have long high-pressure lines, wait an additional minute or more.

To Disconnect the Empty Cylinder

1. Once it has been determined that the selected service cylinder is empty (the pressure indicator turns red and stays red with no demand on the system), rotate the cylinder selector mechanism 180° toward the reserve cylinder. This becomes the new service cylinder. The pressure indicator should immediately turn green.
2. Once the indicator turns green, close the empty cylinder valve. Disconnect the pigtail from the empty cylinder. There should be no gas leaking out of the disconnected pigtail. ***Do not disconnect a cylinder if the pressure indicator is red.***
3. Remove the empty cylinder, reinstall the plastic cap over the cylinder valve thread, and have the cylinder refilled. Reinstall the full cylinder on the RV, reconnect the pigtail to the cylinder valve, and open the cylinder valve. Use a leak detector solution to check the pigtail to cylinder valve connection. If a leak is found, close the cylinder valve and troubleshoot, locate, and repair all leaks.

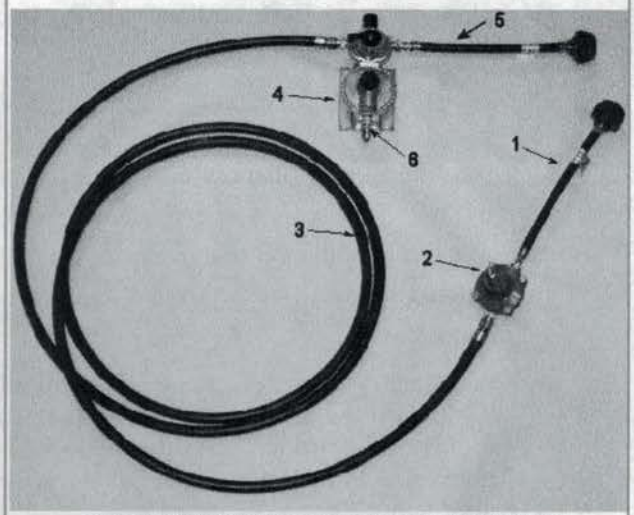
NOTE: Beginning in 2005, *NFPA 1192* required a back check to prevent inadvertent gas escape when changing cylinders. Be sure back checks are in the replacement components. Propane will discharge from the disconnected pigtail on older models if the changeover selector mechanism arrow is not pointing to the cylinder in service.

5-3.2.1 Leak Test Using Automatic Changeover Regulators

If an automatic changeover regulator on a multicylinder configuration is installed, it can be used to perform an "informal" leak test. The indicator, as shown in *Figure 5-49*, is nothing more than a pressure gauge. Turn on the supply at the cylinder and then turn it off (with all the gas valves in the RV closed off). Wait a minimum of three minutes to make sure the red signal indicating the cylinder is empty does not appear. If it does appear, the system has lost pressure, indicating that there is a leak.

If this leak-testing method is not familiar, set up a known-size leak by turning on the cooktop or oven pilot valve, but do not light it. Observe the red indicator. In a system with only the top burner pilot or the oven pilot leaking, the high-pressure gases in the pigtails and automatic changeover portion will provide propane to this leak for about three to four minutes or less. With a known leak such as this, make certain the amount of time it takes for the red flag to indicate on the automatic changeover regulator is noted. This will help the technician understand the system as a leak test device. This test is not a substitute for the documented leak test required when checking a new coach or after a gas line has been opened or otherwise disconnected.

Figure 5-50 Fifth Wheel Remote Cylinder System



DESCRIPTION OF SPLIT CYLINDER SYSTEM

1. CGA 791 (TYPE-1) HIGH PRESSURE HOSE CONNECTOR. (A BACKFLOW CHECK VALVE NEEDS TO BE PROVIDED SOMEWHERE FROM THE CYLINDER OUTLET TO THE AUTOMATIC CHANGE OVER REGULATOR INLET)
2. HIGH PRESSURE REGULATOR. (THIS REGULATOR SHALL REDUCE THE CONTAINER PRESSURE TO 30 PSI OR LESS.)
3. CROSSOVER PIPING
4. MOUNTING BRACKETS
5. CGA 791 (TYPE-1) HIGH PRESSURE HOSE CONNECTOR. (A BACKFLOW CHECK VALVE NEEDS TO BE PROVIDED SOMEWHERE FROM THE CYLINDER OUTLET OT THE AUTOMATIC CHANGE OVER REGULATOR INLET.)
6. AUTOMATICE CHANGEOVER REGULATOR

5-3.2.2 Remote Cylinder Regulators

Remote cylinder or split cylinder applications, as shown in *Figure 5-50*, are used to mount a cylinder on each side of a towable RV. The propane system pressure must be regulated so as not to exceed 30 psi or less within 60 in. of the container outlet from either cylinder, according to *NFPA 1192 paragraph 5.3.11.2*. Manufacturers use remote cylinders to provide more flexibility with regard to space allocation when designing their units.

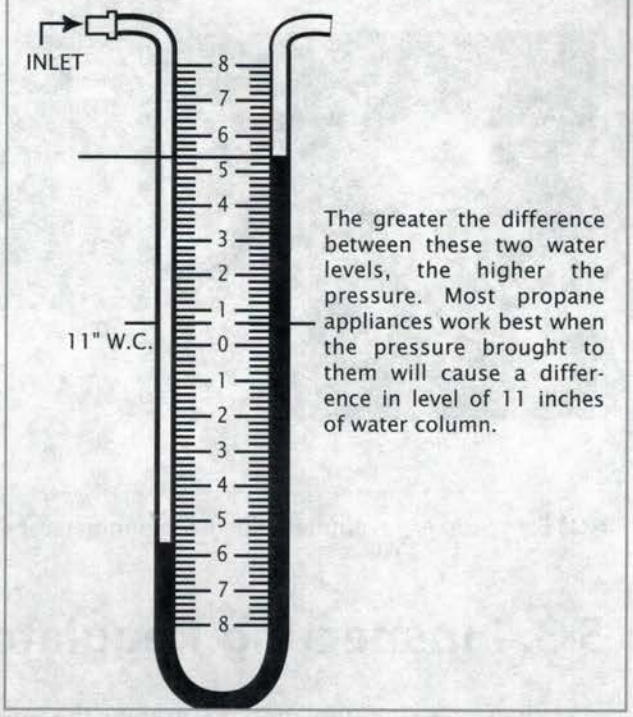
5-3.3 Propane Pressure Facts

- The system functions at a working pressure of 11 in. WC.
- The maximum allowable lockup pressure for a regulator is 14 in. WC.
- The first-stage regulator reduces container pressure to approximately 10 psi.
- The second-stage regulator reduces the pressure of 10 psig to 11 in. WC or 6.3 oz per square inch.

- Appliance regulators are set to approximately 10 to 10.5 in. WC.

Figure 5-51 displays an example of a U-tube manometer.

Figure 5-51 U-Tube Manometer



5-3.3.1 Manometers

The manometer is used to measure low pressure in inches of WC. This device is available in dial, digital, and water-tube types as shown in *Figure 5-52*. There are two types of water tube manometers: a U-tube type and a straight tube. The water type is recommended by all manufacturers of propane appliances because it is extremely accurate; however, most technicians prefer the dial type. The dial type (gauge) does not function as accurately, especially at low pressures, and is susceptible to getting out of calibration. A dial manometer should be calibrated against a water manometer. Calibrate according to the manufacturer's recommendation.

NOTE: Simply stated, pressure is the force exerted by a gas or liquid attempting to escape from a container. It is useful to know how strong this "attempt to escape" is. Pressure can be measured with a manometer or with a pressure gauge. At the lower levels, it is expressed in "inches of water column," i.e., 11 in. WC. Higher pressures are expressed in terms of the force exerted against a square inch of area. For example, "125 pounds per square inch" (125 psi).

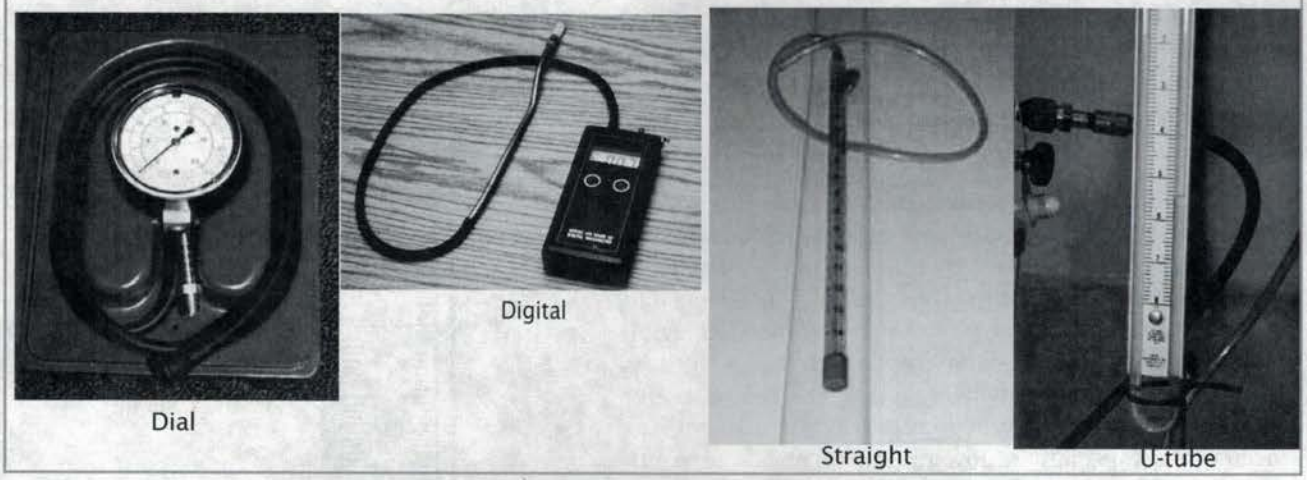
Table 5-7 Pressure Equivalents

1 in. WC	equals	0.58 oz/in^2
11 in. WC	equals	6.45 oz/in^2
11 in. WC	equals	0.4 lb/in^2
1 lb/in^2	equals	27.71 in. WC
1 lb/in^2	equals	0.04 in. mercury
1: mercury	equals	0.49 lb/in^2
1 in. std. atmosphere	equals	14.7 lb/in^2

A dial-type shows the pressure of the system using a needle that points to number indicators. The higher the number, the higher the pressure. Some gauges show inches of water column, ounces per square inch, and kilopascals.

The water manometer uses a clear tube filled with water. A linear scale marked off in inches is located between the two legs of the loop or "U." The water-type instrument must be vertical for accurate readings. The amount of pressure is determined by adding the numbers together that correspond to the level of water in each leg. By using manometers, the propane system can be checked for leaks and proper operating settings of the regulator.

Figure 5-52 Manometer Examples

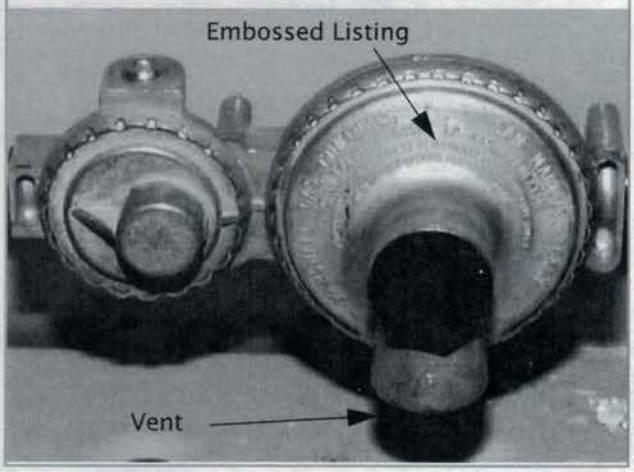


NOTE: It is recommended the manometer be calibrated in minimum increments of 1/2 oz or 1 in. WC.

5-3.4 Inspecting Regulators

When checking the propane system, be sure to inspect the regulator. Look to be sure it is secure to the vehicle or container, and make sure the regulator is not encrusted with dirt, mud, or ice. Insects or dirt that may plug 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 possibilities create substantial safety problems.

Figure 5-53 Two-stage Regulators



Another source of vent clog is ice that can form quickly in freezing rain. Documented tests show that vent openings that point to the ground and have a drip-lip construction are unlikely to freeze completely closed. *NFPA 1192* requires the regulator's vent to be pointing directly to the ground or within 45° of the downward 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 the use of a 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 toward 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. *Figure 5-53* shows the vent location of two-stage regulators.

Most regulators have a fine-mesh screen 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 the screen is in place and nothing is blocking the regulator vent.

It has been suggested that DOT/TC cylinders not in compartments or under housings could 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 help 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. All regulator covers are to be correctly installed.

5-3.5 Replacement of Propane Regulators

In the event that a regulator must be replaced, the technician should ensure that the replacement regulator is the correct one. *NFPA 1192 paragraph 5.2.15.2* and *CSA Z240 paragraph 7.1.1* require that RV propane regulators be a listed two-stage regulator system or an integral two-stage regulator. To determine if a regulator is listed, look at the top of the regulator. The listing should be embossed on it as shown in *Figure 5-53*.

The replacement regulator must have a capacity that is not less than the total input of all propane appliances installed in the RV. The appliance input should be on the individual appliance data plates, and this is simply a matter of addition.

The regulator must be able to be installed with the pressure relief vent opening pointing downward within 45° of vertical to allow drainage of any moisture collected on the diaphragm of the regulator. Installation instructions should come with the replacement regulator. Contact the manufacturer or distributor for installation instructions.

5-3.6 Storage and Installation of Regulators

Regulators should be stored in a clean area, with the inlet and outlet plugged to prevent dirt, debris, insects, and so on from entering the regulator's openings.

When installing fittings into the regulator, care should be taken to ensure that no pipe compound, Teflon® tape, or foreign material gets into the regulator. To prevent this problem, be sure pipe joint compound or Teflon tape is only installed on the male threads, and is not applied to the first three threads. Never apply pipe joint compound or Teflon tape to female threads, as this would result in the sealant ending up inside the joint. Be sure the sealant used is approved for use with propane.

Some pigtails have ends that are inverted flares. As with all flare joints, no pipe joint compounds of any type should be used. Other pigtails are tapered pipe threads (NPT) and must be installed using thread compounds approved for use with propane. Refer to *Figures 5-46* and *5-47* to view cutaway diagrams of regulators.

5-3.6.1 Adjusting Regulators

To adjust the system regulator, an operating pressure test and a lockup pressure test must be conducted.

The operating test is used to determine what pressure the system regulator is delivering when at least 50 percent of the appliance load is functioning. The lockup 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 approximately 11 in. WC, and the lockup pressure must never exceed 14 in. WC.

5-3.6.1.1 Making a Test Apparatus

Obtain or build this testing device (this apparatus is shown in *Figures 5-54* and *5-55*). Equipment needed is listed below.

A. Brass 1/4 in. female pipe cross

B. A low-pressure flex hose connector (short length 6 in., 3/8 in. female flare one end, 1/4 in. male pipe other end)

C. Male half-union 1/4 in. pipe × 3/8 in. male flare

D. Gas cock 1/4 in. male pipe × 1/4 in. female pipe

E. 1/4 in. pipe plug drilled with a #41 orifice drill or 3/32 in. standard drill (75,000 Btu/hr)

F. 1/4 in. male pipe × 5/16 in. hose barb fitting (for manometer hose hookup NOT SHOWN), (*Figure 5-54* only)

G. Dial manometer with 1/4 in. male pipe thread (*Figure 5-55* only)

Figure 5-54 Test Apparatus

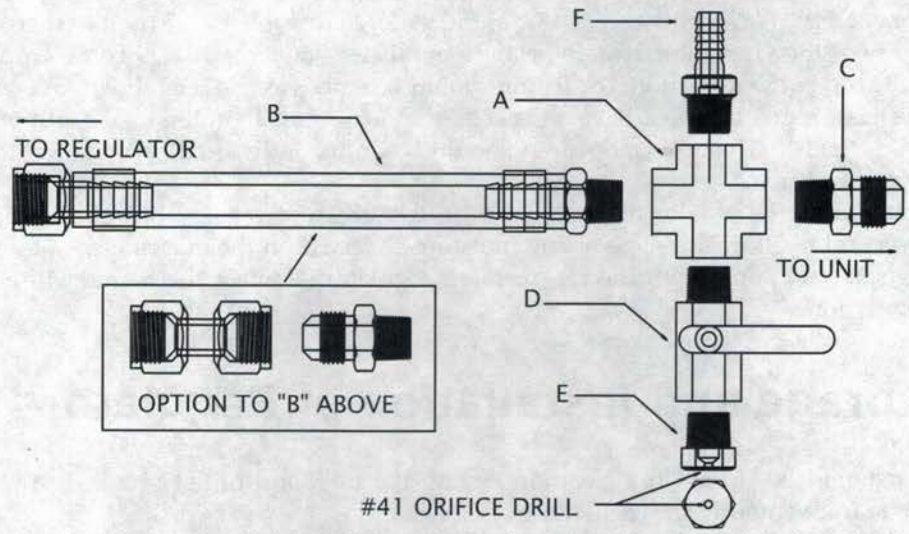
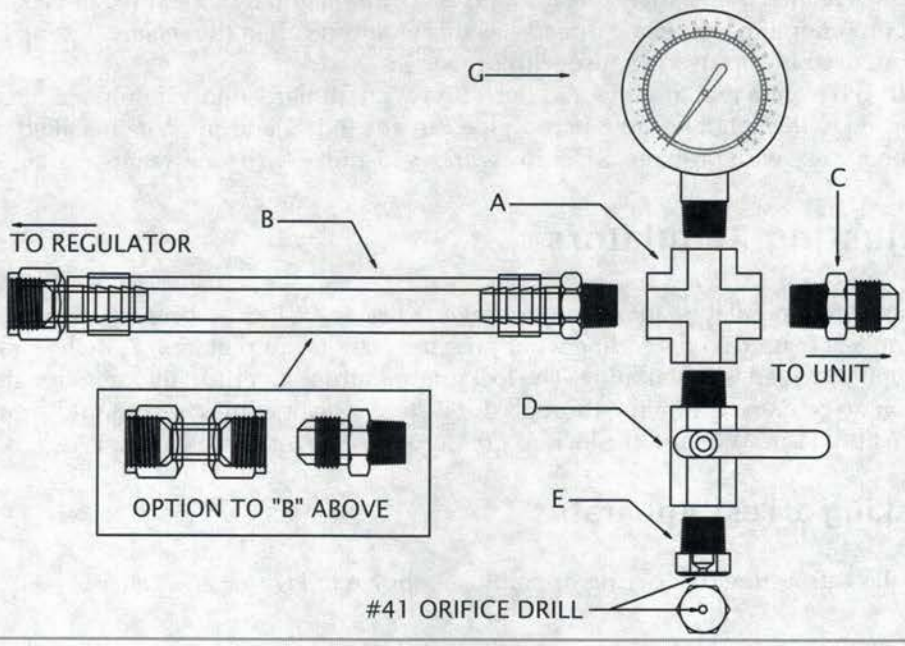


Figure 5-55 Test Apparatus with Manometer



5-3.6.1.2 Conducting an Operating Pressure Test

To conduct these tests effectively and efficiently, follow these guidelines:

1. Prepare 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. With the propane system off, disconnect the low-pressure hose or piping from the regulator outlet using backup wrenches.
5. Connect test apparatus to the regulator.
6. Connect the propane low-pressure hose to the test apparatus.
7. Connect manometer to the test apparatus. The system is now ready to test.

NOTE: Make sure all connections are leak free.

8. With the manometer connected, turn on the gas at the container.
9. Slowly open the gas cock on the test apparatus. The #41 drill hole provides a flow rate of approximately 75,000 Btu/hr. This is equal to the 30 ft^3/hr flow and represents about 50 percent or more of the Btu/hr flow rate of the appliances. A propane regulator must have a rated capacity equal to or greater than the total Btu/hr input of all appliances.
10. Measure the operating pressure in inches of water column on the manometer. The operating pressure is now shown on the manometer. It should be 11 in. WC, nominal (±0.5).
11. Remove the dust cover and adjust regulator if measured inches of water column is not correct. Use a screwdriver and turn the adjusting screw until the system's operating pressure is at 11 in. WC. When adjusting the regulator, remember that screwing in the adjusting screw (clockwise) increases the pressure; screwing out the adjusting screw (counterclockwise) decreases the pressure.
12. Document the operating pressure test results. As a minimum, the test documentation should include:

    Make, model, and identification number of RV

    The date and times of the test

    Type of manometer used

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

    Initial system pressure (inches WC)

    Adjustment procedures taken if applicable

    Corrected pressure reading

    Technician's name and signature

5-3.6.1.3 Lockup Test

Immediately after conducting the operating pressure test outlined in *"Conducting an Operating Pressure Test" on page 5-55*, 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 lockup pressure, which 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. Lockup 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 lockup requirements. The only adjustment that can be made to the regu-

lator is operating pressure. If the lockup 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 lockup pressure over 14 in. WC after approximately three 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, lockup pressure must be rechecked. After a new regulator is installed, both operating and lockup pressures must be checked and adjusted as necessary. Always observe the lockup 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 5-55.*

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

5-3.6.2 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 properly disposed of. 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 lockup pressure are within tolerances (i.e., 11 in. WC operating and 14 in. WC lockup), 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 5-55.*

5-3.6.3 Other Regulator Troubleshooting Tips

While conducting the operating pressure test, if a fluctuating pressure is observed (i.e., the needle on a mechanical manometer, or the water in a water manometer, is constantly moving up and down), this suggests several potential problems that may involve the following:

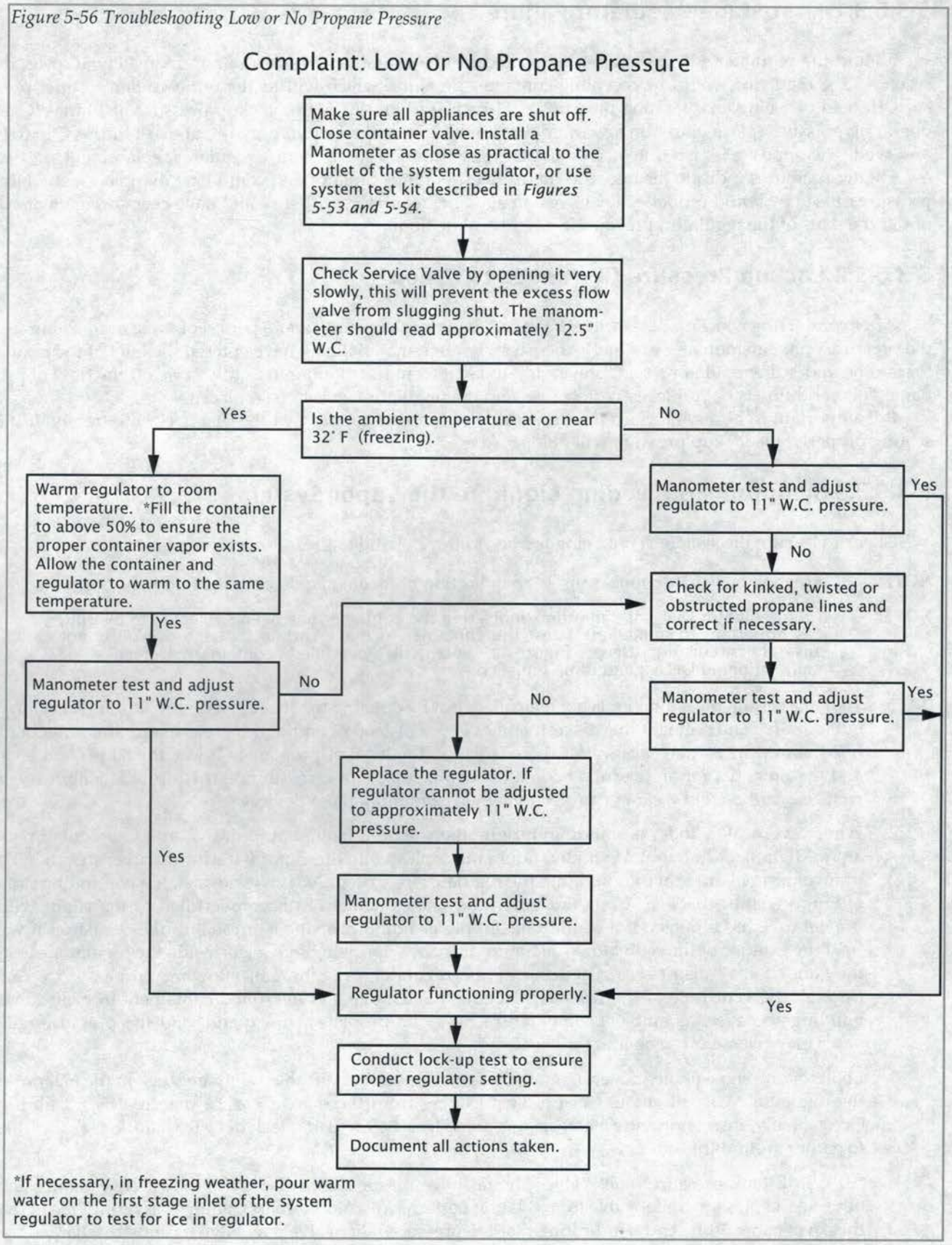
- Upward manometer fluctuations may indicate that the regulator is receiving liquid propane. Look to see if the container is overfilled, an internal withdrawal tube is not working properly, or a vertical cylinder is incorrectly used in the horizontal position.
- Downward manometer fluctuations indicates that there may be oily residue or water collecting in the low portions of the lines downstream of the regulator. The oily residue has a consistency similar to that of a light motor oil.

If any of these conditions is observed, check for the reason of the condition and correct the fault. If it cannot be corrected, replace the regulator. Tag the faulty regulator, describing clearly in writing the condition found so that, when it is returned to the regulator manufacturer, their technicians can verify the findings.

Temperature change in a piping system can cause a lockup 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 must be maintained throughout the test period.

Figure 5-56 illustrates how to troubleshoot low or no propane pressure.

Figure 5-56 Troubleshooting Low or No Propane Pressure



5-3.6.3.1 First-Stage Regulator Failure

Should the regulator's first stage no longer reduce the container pressure to approximately 10 psig, the second-stage regulator would be receiving container pressure, which will increase the system's outlet pressure. Instead of seeing an operating pressure of 11 or 11-1/2 in. WC with a lockup pressure of 14 in. WC, an operating pressure (particularly on a warm day) above 12 in. and a lockup pressure above 14 in. WC may be observed. The opposite is also true on cold days. Either situation could require regulator replacement.

Higher pressures indicate the necessity to troubleshoot the regulator and could lead to replacement. High pressure caused by liquid propane may have damaged the regulator, or there could have been foreign material under the seats of the regulator, preventing a tight seal or similar.

5-3.6.3.2 Lockup Pressure Continues to Creep

After conducting a lockup pressure test, the regulator locks up and, over a period of three or four minutes, the pressure on the manometer gradually increases. Foreign material may have entered the inlet of the regulator and be under the regulator's seat, preventing the seat from functioning to tightly close off the flow of propane. This condition is not typically correctable, and the regulator needs to be replaced.

It is important to observe lockup for a few minutes to make certain that the seat is closing tightly. If it is seating properly, the lockup pressure will hold steady.

5-3.6.3.3 Symptoms of Feeding Liquid to the Vapor System

Check to be sure the system is not being fed liquid by referring to the following six points.

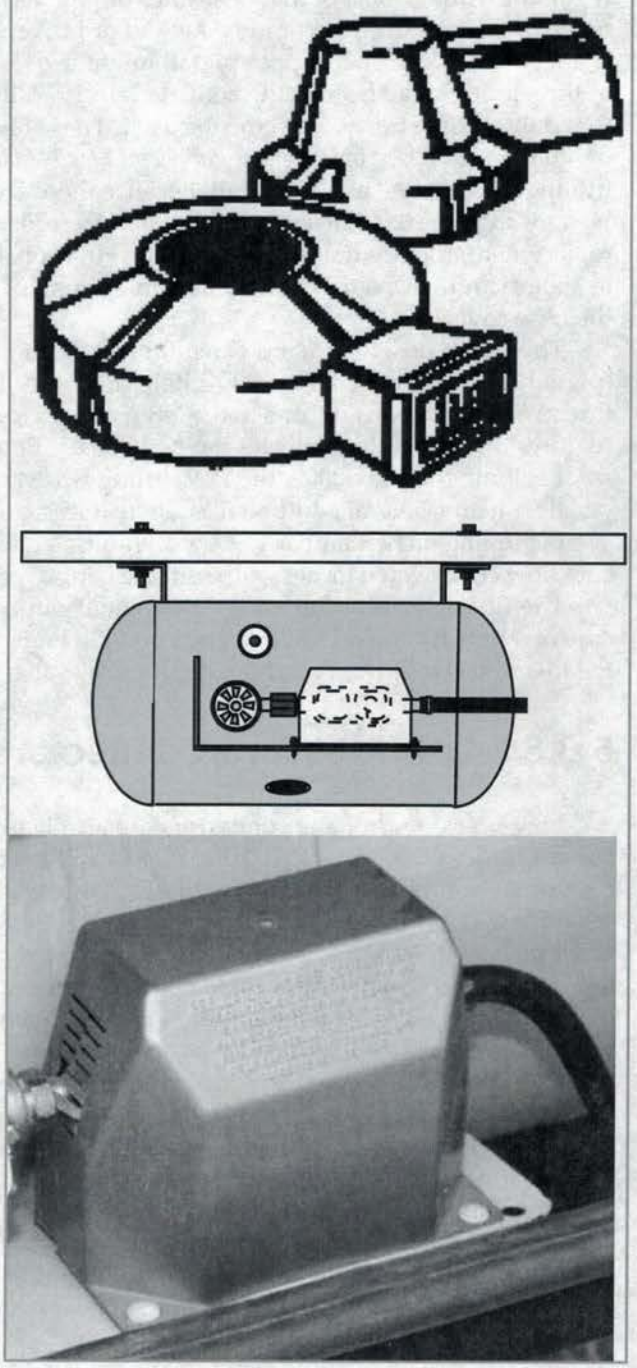
NOTE: A manometer that "bounces up" is an indication of feeding liquid propane into the system.

NOTE: If the regulator that has symptoms indicating the container has been subjected to overfill, it is important to immediately test the container to make certain that the overfill is not currently occurring. Never ignore a potentially overfilled container! Defective or malfunctioning OPDs need to be replaced.

1. To make certain the container is not overfilled, test by opening the (fixed maximum liquid level gauge) outage valve and seeing if there is a stream of vapor instead of liquid. If there is liquid, the container is filled above the 80 percent level. If there is vapor, the level of propane is below the 80 percent level, and the potential for an overfilled container can be discounted, assuming the dip tube length is correct. Use caution and wear eye protection when examining these devices.
2. When a vertical cylinder is standing upright, there should be no liquid drawn into the regulator. On an ASME tank or horizontal cylinder, liquid may splash into the vapor withdrawal tube, and an initial draw of a small amount of liquid into the regulator may occur, which is normal. If a continuing draw of liquid results, this is a strong indication that the container has been overfilled or the vapor withdrawal tube has a defect. If a continuing supply of liquid propane is present in the regulator, it will frost the exterior of the regulator. The liquid propane vaporizing into a gas inside the regulator causes this, and it may also cause rupturing of the regulator's diaphragm, allowing propane to escape through the vent hole of the first-stage regulator. Remove any overfilled containers from inside of buildings because, as ambient temperature rises, the propane will expand, and the pressure relief valve may release propane into the shop.
3. Look for any signs of oily material or an abnormal amount of dirt that might be stuck to the exterior of the regulator. A small amount of propane leaking from these areas can be detected by a leak test. Occasionally, insects provide a clue as to a small leak before using leak detector solution, as they like to gather around this odor.
4. All ASME tank pressure relief valves should have plastic dust covers. If the dust cover is missing, observe the pressure relief valve for oxidation patterns (discolored brass). Shiny brass could mean that the cover came off recently, indicating that the pressure relief valve may have recently discharged.

5. Wipe off the pressure relief valve area. If residual odorant from around the pressure relief valve area is transferred, then the odor will be detected. This indicates that there had been previous discharge at the pressure relief valve.
6. If a pressure relief valve is leaking, empty the container. (See *"Fuel Transfer Safety" on page 5-41.*) Do not tamper with pressure relief valves, and do not attempt repairs. Replacement is mandatory. Be sure the pressure relief valve used for replacement has the correct pressure setting of 312.5 psi for ASME tanks. Using a valve with a lower pressure setting can result in premature relief and possible unsafe situations.

Figure 5-57 Snap-On Regulator Cover and ASME Below-Floor Regulator Compartment



5-3.7 Regulator Covers

According to *NFPA 1192 paragraph 5.2.15.8* and *CSA Z240 paragraph 7.1.3*, regulators are required to be under protective covers when installed above the vehicles' floor line, as with trailers, or "compartmentalized" where installed below the floor line, as with motorhomes. *Figure 5-57* shows a snap-on regulator cover and ASME below-floor regulator cover.

5-3.7.1 Regulators above the Floor

If the regulator is not in a compartment, check the regulator to be sure that it has the plastic regulator cover installed. The plastic cover protects the regulator and vent, preventing it from being contaminated by wheel spray, freezing rain, mud, or any other materials that might plug the vent opening.

5-3.7.2 Regulators below the Floor

If the regulator is located below the floor line, it must be in a compartment. This is again to help protect the regulator vent from road elements and to provide sufficient space for it to function. The compartment is an enclosure with six sides (see *Figure 5-57*). None of the sides may be the propane regulator itself. The sides may be fabricated from wood, metal, plastic, or equivalent and be part of the RV sidewalls or floor, the container or its valve guard, or any combination of the above. According to the *NFPA 1192*, the size of the regulator compartment in a below-floor installation must allow for sufficient room for tool operation for connection to and replacement of the regulator(s). In addition, this compartment must have at least a 1 in^2 vent opening located within 1 in. of the compartment floor. The most common regulator "compartment" is a five-sided plastic box attached to the tank valve guard (sixth side).

5-3.8 Connectors and Hoses

5-3.8.1 High-Pressure Connectors or Pigtails

High-pressure propane connectors or pigtails are the gas lines between the propane cylinder(s) and the regulator. Today, most of these gas lines or pigtails are flexible hose assemblies. Prior to 1977, RV pigtails were made of copper. Copper could be kinked or broken in RV use, in vehicle accidents, or from repeated cylinder change-out. A kink in a copper pigtail might provide enough flow restriction to prevent the excess flow valve in the service valve from being activated. In 1977, the *Standard for Recreational Vehicles* was changed to require that only flexible hose connectors be used. These high-pressure propane connectors are listed as a total assembly to the *UL 569, Standard for Pigtails and Flexible Hose Connectors for LP-Gas.* An *assembly* means the hose and fittings are supplied as a total unit. Because these are listed assemblies, the hose and both ends must be assembled by an authorized hose assembly manufacturer. If a fitting on the assembly is damaged or otherwise needs replacement, replace the entire assembly. High-pressure propane connectors are listed for use at pressures up to 350 psi and have a maximum allowable length of 5 ft (60 in. or 152.4 cm). The 350-psi rating is embossed on the hose cover.

The bullet nose, left-hand thread, brass fitting on the container end of the high-pressure hose assembly (pigtail) is called a POL (Prest-O-Lite). "PUT ON LEFT" is a common memory aid. The POL has left-hand threads, which means it turns to the left (counterclockwise) to tighten. There are different styles of POLs. Code requires that recreation vehicles have the excess flow POL.

Beginning in May 2002, the POL fitting was changed (nationally) to a Type I. This connection has a large plastic nut and several additional safety features, and it is easier to connect and disconnect.

Beginning on September 1, 2005, all multiple-cylinder propane systems are required to be equipped with a backflow check valve located either in the connector or at the regulator inlet.

The fitting at the other end of the pigtail can be male pipe thread, 1/4 in. inverted flare fitting or, in the case of a transfer hose, POL or Type I on both ends. Pipe threads must use an approved pipe sealant, whereas the inverted-flare POL Type I must not use a sealant.

5-3.8.2 Low-Pressure Connectors

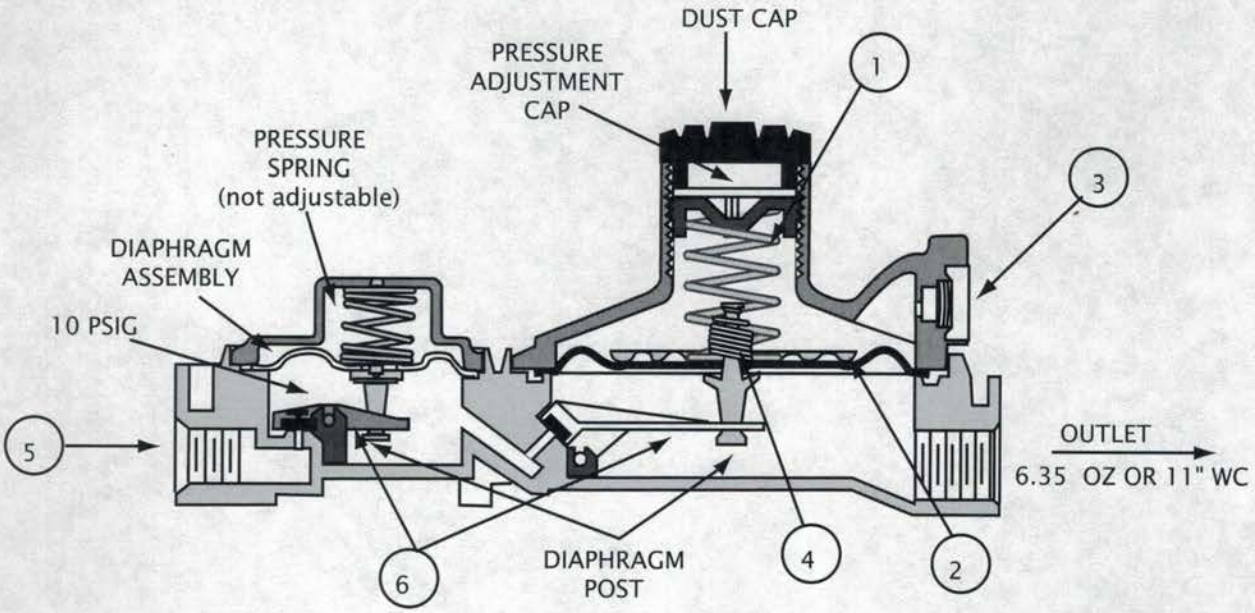
Low-pressure propane connectors are also listed assemblies manufactured to comply with *UL 569* with a maximum length of 60 in. (152.4 cm). These connectors are used downstream of the regulator and are most commonly found between the regulator outlet and the manifold of the RV's propane system. In situations where low-pressure flex hose assemblies are required (e.g., in a kitchen slide room), flex hose constructed in accordance with the provisions of *UL 21* or *UL 569* propane hose may be used. These low-pressure connectors are also used to connect moveable appliances found in folding camping trailers where the kitchen units fold down for travel and where the ranges can be moved outside for use. These hose assemblies are listed with a working pressure of 1 psi. The 1 psi is embossed on the hose covering.

In applications where the regulator is permanently installed, as is the case with some travel trailers where the regulator is mounted on the front exterior wall, a flexible hose connector is not required. A properly sized copper line can be used, since the regulator is not moved when removing or filling the cylinder(s).

Twisting or kinking a hose assembly can cause a restriction in the propane supply and possibly leakage. A twist in a high-pressure hose will usually be less restrictive than a twist or kink in a low-pressure hose, because even though the high-pressure hose has a smaller diameter, the higher propane pressure will typically supply more flow. Install the end of the assembly without a swivel first. The end that attaches to the service valve has a swivel, but be aware that a twist could appear even with a swivel.

5-3 Review

1. Which symptom(s) of a regulator would require its replacement?
   A. Leaking at a very small vent hole near the spring tower
   B. Leaking around the crimped area
   C. Neither A nor B
   D. Both A and B
2. A customer complains that all of the appliances work but not at normal efficiency. Based on the symptoms, it is determined that the problem is probably low pressure. The first thing to do is:
   A. Remove the regulator.
   B. Check for kinks in the propane line.
   C. Check operation of the service valve.
   D. Check need for recertifying propane container.
3. List two symptoms of overfill.
   A.
   B.
4. Propane regulator component identification:



Insert the proper name of the component numbered on the diagram.

1.
2.
3.
4.
5.
6.

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Chapter

5-4 Propane Piping Systems

- Identify related terminology.
- Perform cutting and flaring of copper tubing.
- Identify piping system components, their relationship and functions.
- Leak test (using electronic leak tester, leak detection solution, etc.).
- Sizing, support, and sealing of black iron pipe.
- Demonstrate the ability to inspect/replace propane piping system.
- Identify and size copper tubing types.
- Conduct time pressure drop test.
- Install and seal brass fittings.

5-4.1 Materials, Sealants, and Testing

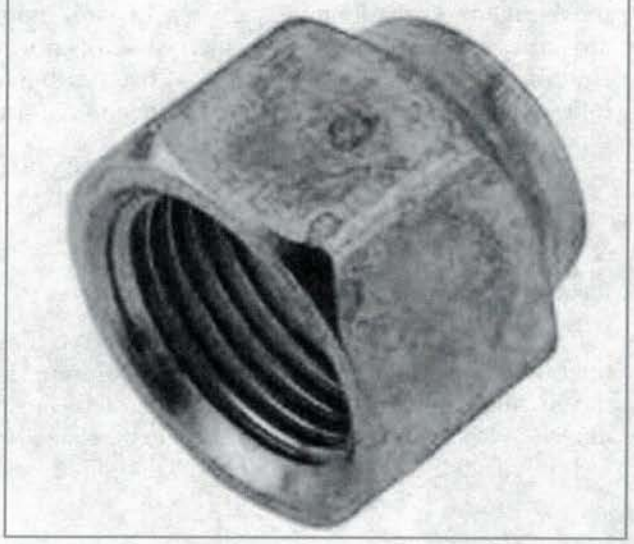
The piping of the propane system of an RV is designed to safely transfer the propane vapor from the container to the appliances. The piping system can be made of many different materials. Any material used has to be new and free of defects. Damage to fittings and piping requires removal of the damaged section or replacement with new parts. Any material used has to have a melting point of not less than 1450°F (790°C) (except for listed flexible hose assemblies) and can include the following materials:

- Piping: steel, wrought iron (black iron pipe), threaded copper, or brass. Galvanized pipe is also allowed, but rarely used.
- Fittings: steel, wrought iron (black iron pipe), or brass (stress-relieved or forged). Compression fittings are not permitted.
- Tubing: copper (annealed type K or L). Where used for natural gas, the tubing must be internally tinned, seamless brass, or steel.
- Hose: listed flexible, nonmetallic tubing, or hose for use with propane.

For practical purposes, most RVs have propane piping systems consisting of a main manifold made of iron pipe, with risers of copper tubing branching off the main manifold to each appliance. Some RVs have propane piping systems consisting of only copper tubing. A typical RV propane piping system reflecting a manifold and risers is shown in *Figure 5-60*.

Steel and wrought iron, referred to commonly as black iron pipe, are specifically permitted by the NFPA 1192 RV Standard. This pipe material is generally used on the outside, underneath the RV's floor. Joints or fittings within the underbelly are not permitted, as leaks may not be detectable. If stubs of black iron pipe are routed up and into the interior of the RV, this is acceptable under the guidelines of 1192. However, CSA Z240 does not permit propane fittings or connections within the RV's interior, except for connections at the appliance. Black iron pipe is available in two different schedules. Schedules apply to the wall thickness of pipes. Schedule 80 pipe has thicker walls than a schedule 40 pipe. "Thicker" implies that the material is stronger, so schedule 80 pipe is used upstream of the system regulator where container pressure is involved, and schedule 40 pipe is used downstream, where only regulated system pressure is found.

Figure 5-58 Milled and Forged Bonnet Nut for a Flare Fitting



Brass flare nuts must be either stress relieved or of the forged type, as shown in *Figure 5-58*. A non-stress-relieved machined flare nut is not acceptable. Although

a forged flare nut is easy to identify visually, machined, stress-relieved and non-stress-relieved flare nuts appear very similar and documentation may be necessary to prove compliance.

Conformance of type K or L copper tubing with *ASTM B88* will be marked as follows:

Figure 5-59 K and L incised on tubing

- The name or trademark of the manufacturer and the mark indicative of the type shall be permanently marked (incised) on each tube at intervals not greater than 1-1/2 ft, as shown in *Figure 5-59.*
- Seamless copper tube for air conditioning and refrigeration field service marked in accordance with *ASTM B280* will be as follows:
  - The soft, straight lengths or coils shall be identified by a sticker, tag, or label attached to the package, wrapping, or the tube itself, carrying the following statement:
  - This tube has been manufactured in conformance with the requirements of *ASTM B280*, for seamless copper tube for air conditioning and refrigeration field service, or manufactured *ASTM B280.*

When using steel tubing flare connections, the tubing needs to be double flared, as single steel tubing flares may crack.

Flexible nonmetallic tubing or hose needs to be part of a listed assembly where an independent third party evaluates the fittings, the hose, and how the fittings are attached to the hose. Two listing agencies that list assemblies are Underwriter's Laboratories (UL) and Canadian Standards Association (CSA).

Flexible hose assemblies, or just flexible hoses, are made of special plastic materials. They are not made of rubber.

Flexible hoses that are intended to be used between the container shutoff valve and the system regulator are listed as high-pressure connectors. These high-pressure hosed are listed to a working pressure of 350 psi. Since regulated propane is 14 in. WC, low-pressure hoses are listed at 1 psi. Low-pressure hoses are used where the regulator has to move to fill the container. This is most common with cylinders used on trailers. If the regulator does not move, such as when it is mounted to the front wall of a trailer or equal, copper tubing or any other acceptable material could be used. Since cylinders are always removable, the connectors between the shutoff valve and the regulator must use flexible hose connectors. Otherwise, copper tubing would become fatigued over time due to the removable and replacement of cylinders.

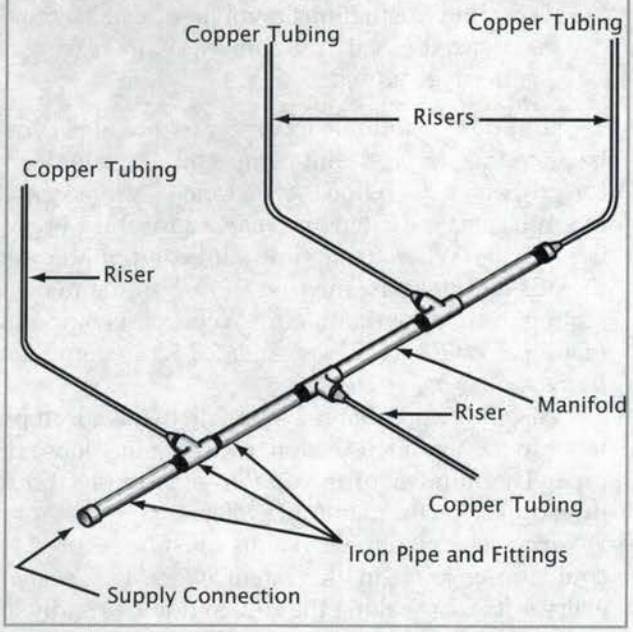
5-4.1.1 Iron Pipe Manifolds

5-4.1.1.1 Propane Piping Sizing

Propane piping systems need to be sized so the pressure drop to any appliance, when all appliances are in operation, is not more than 0.5 in. water column. Compliance will be ensured if the piping connector between the manifold and regulator is also included. Furthermore, any additional in-line devices such as propane detectors or related solenoid valves must be sized appropriately. Conformance may be determined by actual test or with the *NFPA 1192 tables 5.3.4.2(a) through 5.3.4.2(d)* or other approved method.

5-4.1.1.2 Testing

Figure 5-60 Manifold and Risers



Because the test involves propane, the lines and propane must be of the same temperature so as not to affect the test results. Manometers are to be installed in the branch lines at the appliance inlet connections. Another manometer is placed at the regulator outlet. With at least one appliance valve on, turn the propane supply on to allow the manometer to stabilize, then turn the appliance valve off and check for leaks with a bubble solution (do not use products that contain ammonia or chlorine). At this point, be sure that all manometers are equal in their readings. Each reading will be higher than a reading with the valve open, because the regulator is in a lockup condition. When the appliance valve shuts off the flow of propane, pressure is built up in the regulator to the point where it also shuts off and no longer allows propane to flow. This shut off or lockup pressure will be as much as 120 percent of the manometer pressure readings produced by the regulator when it is flowing propane. If the manometers are not reading equal at this point, a kinked or twisted line might be the problem. Sometimes air within the propane lines needs to be bled off. When all manometers are reading equal, light every appliance and operate them at their maximum possible propane flow. Compare each manometer at an appliance with the manometer at the regulator and if the difference is 0.5 in. WC or less for each appliance, the system design is acceptable.

When the test method is employed, the manufacturer may choose to test his "worst-case" conditions. Depending on the number of different propane line configurations, more than one test may need to be conducted. Usually, "worst-case" conditions are the longest manifold runs between branch line connections and the longest branch lines containing the largest appliances (Btu/hr rating) farthest from the propane supply. When determining worst-case conditions, all fittings and offsets must be included as these, in addition to length, have an impact on system performance. Only the "worst-case" propane line configurations need to be tested—not every design the manufacturer utilizes.

5-4.1.1.3 Sizing by the Tables

The gas sizing *Tables 5.3.4.2(a) through 5.3.4.2(d) from 1192* have been extrapolated from much larger tables, used for sizing gas lines of houses and commercial buildings (NFPA 54) and have been expanded herein to address the smaller piping systems of recreation vehicles. The following is one of several ways to size a propane piping system:

> The maximum developed length must first be determined. The maximum developed length is the longest run of piping from the regulator to the most remote appliance ("remote" here is determined by actual length). An appliance may be located farther to the rear of the vehicle than another appliance, and the closer appliance may be the most remote due to the length of the branch line needed to connect the appliance to the system. This may be true when comparing the branch line of a range and a water heater. The maximum developed length is then used to determine the proper length column of the appropriate *table in 5.3.4.2*. If the maximum developed length is longer than a column length of the table, the next highest column length is used. Once the column length is determined, no other length column is used in the determining of propane piping size for any portion of the system. Begin at the end of the system farthest from the supply connection. Determine the total Btu/hr demand for each section of piping and locate the Btu/hr equal to or greater than the demand for the section of piping being sized. When the Btu/hr figure is selected under the length column (determined from the maximum developed length), move horizontally to the left in the table where the size for the section of pipe

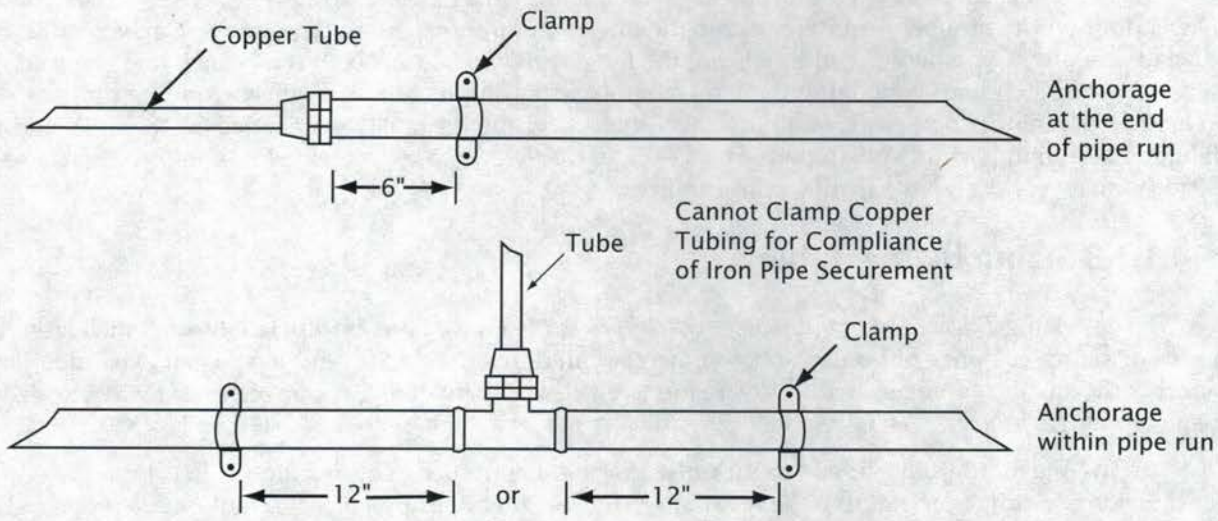
involved is given. To change from one piping material to another, or from one propane supply type to another, simply change tables but do not change column lengths. Use the iron pipe table (*5.3.4.2(c)*) for sizing calculations involving flexible connectors used within the system. The remainder of the system is sized exactly the same way, increasing the Btu/hr demand as appliance branch lines and manifold lines are added.

Iron pipe manifolds incorporate threaded pipe connections. Pipe threads are tapered and are intended to be joined using pipe joint compound. Pipe joint compound used for this purpose must be listed and marked for propane use. Teflon®-type tape is also acceptable for use with propane when coupling pipe and fittings but must also me listed and marked for this purpose. Note that Teflon tape must be wrapped *in the direction* of the threads. When using pipe joint compound or tape, be sure to apply the pipe joint compound only to male threads and not past the first thread on the male fitting. This will allow the pipe joint compound to assist in sealing the joint without letting pipe joint compound or tape inside the piping system. Pipe threads need to be made per *NFPA 1192 paragraph 5.3.5.1* in compliance with *ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch.*

Also be aware that it is possible to have iron pipe that is overthreaded (too many threads). This affects the taper in the threaded section, resulting in a loose fit with the female fitting and a substantial weakening of the pipe. The number of threads on a properly threaded pipe is between 10 and 11. Keep this in mind when threading pipe for manifold systems.

Iron pipe manifold systems must be secured to prevent vibration, rattling, and any other movement that could loosen joints in the system. *NFPA 1192 paragraph 5.3.18.1* requires the iron pipe manifold to be supported every 4 ft (1.2 m) along the run, and to be rigidly anchored to the vehicle within 6 in. (15.24 cm) of the supply connection. In addition, under *NFPA 1192 paragraph 5.3.18.3*, all pipe is to be anchored within 6 in. (15.24 cm) of tubing connections at the end of pipe runs and within 12 in. (30.5 cm) of tubing connections within pipe runs, as shown in *Figure 5-61*.

Figure 5-61 Iron Pipe Manifold Anchorages



5-4.1.2 Copper Tubing

Copper tubing is always sized by an outside dimension (OD) through its diameter. The size may be incised (marked) on the tubing, or it can be physically measured. Copper tubing used in RVs is typically sized 3/8 or 1/2 in. and sometimes 5/8 in. OD.

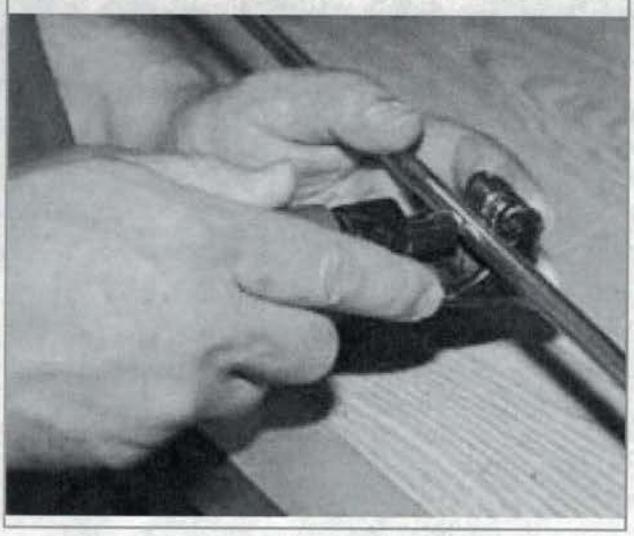
Copper tubing joints in RVs use flared fittings, as required by SAE J533, where the tubing is flared out with a 45° flaring tool. Be sure flaring tools used are not for 37° fittings when working on RVs. Tools for flaring can be hand held, as shown in *Figure 5-62*, or sometimes can be bench mounted. The flare fitting is designed to

accept a flared tube and make a metal-to-metal connection without pipe joint compound. Remember, pipe joint compound on a flared fitting is prohibited!

Flare connections can be made up by any service technician using the following procedure and a hand-held flaring tool.

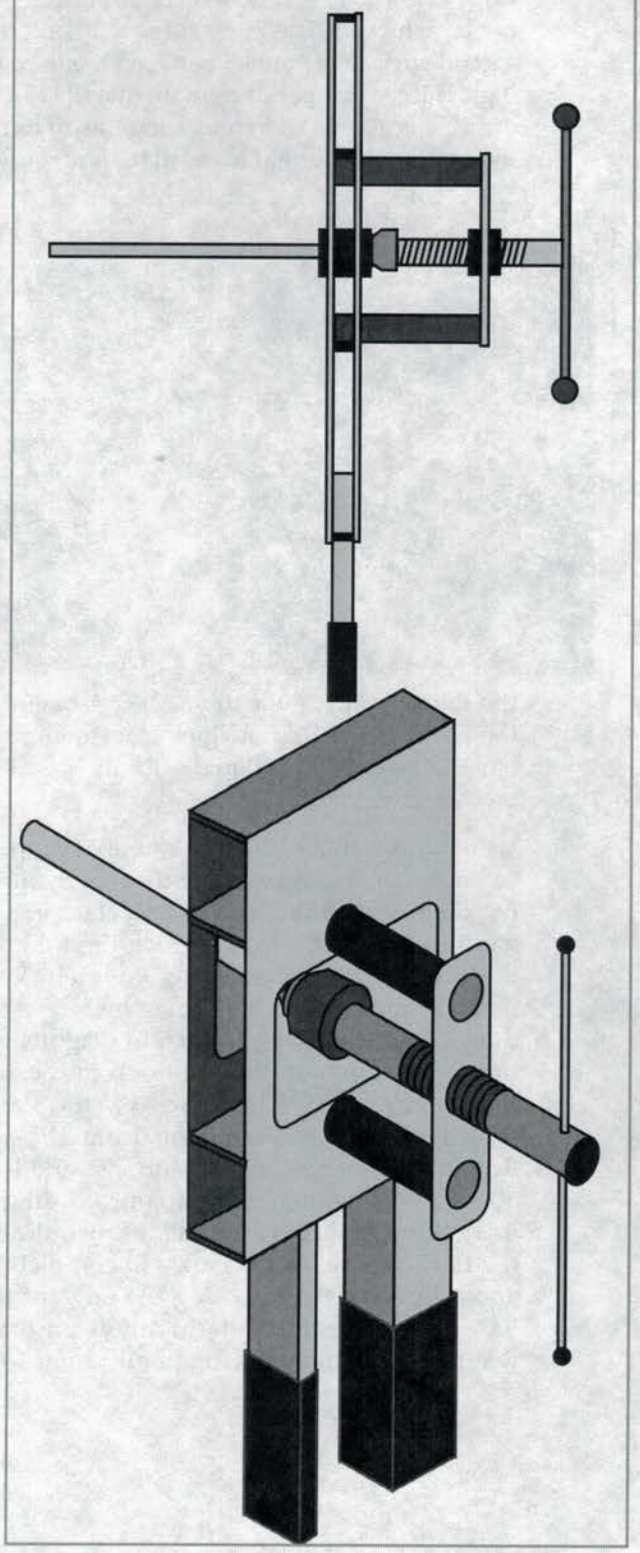
1. The tubing must first be cut square. This is best accomplished using a special tubing cutting tool. Cutting tubing with a saw blade will substantially reduce the chances of obtaining a good seating surface during the flaring process and will result in excessive burrs. Cut the tubing with a tubing cutter of the appropriate size. Some tubing cutters are large, for more leverage, and some are small for tight locations. Both will cut tubing sizes used in RVs. Place the tubing inside the cutter and rollers of the cutter and turn the knob until it contacts the tubing. Start rotating the cutter around the tubing and turn the knob to apply more pressure with each revolution. Do not apply too much pressure, as it will distort the tubing. Just tighten the cutter about 1/8 to 1/4 turn of the knob with each revolution around the tubing. The amount of pressure applied should be enough to feel resistance on the knob, but do not force it. The cut will be smooth and the tubing will retain its round form. After cutting through, the tubing will have a rounded outer edge and a raw lip or ridge on the inside diameter.

Figure 5-63 Cutting Tubing Square



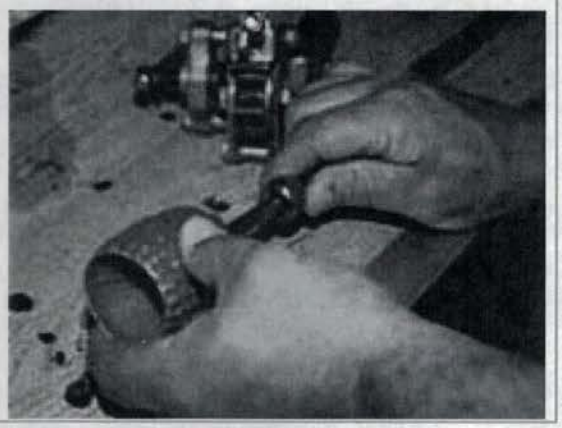
2. Check the outside of the tubing to be sure it is smooth and free of loose particles. If it is not, file or sand the tubing smooth.

Figure 5-62 Hand Flaring Tool



3. Reaming on the inside of the tube prevents burrs and other imperfections during the flaring process. The larger-style tubing cutters will usually have a reaming blade mounted on the handle of the tool. To ream the tubing, insert the reaming blade inside the tubing and rotate it around until the lip or ridge is gone. This is extremely important because, if the lip or ridge is not removed, a good flare cannot be achieved. The lip or ridge will "roll over" inside the flare during the flaring process, preventing a good surface of contact between the flare nut and fittings. If the tubing cutter does not have a reaming device, a scraper or a small, fine file can be used. File or scrape the inside of the tubing until the lip or ridge is gone. When removing the lip or ridge, it is a good practice to hold the tube opening toward the ground so the shavings fall to the ground instead of staying inside the tubing.

Figure 5-64 Clean and Deburr (Ream)

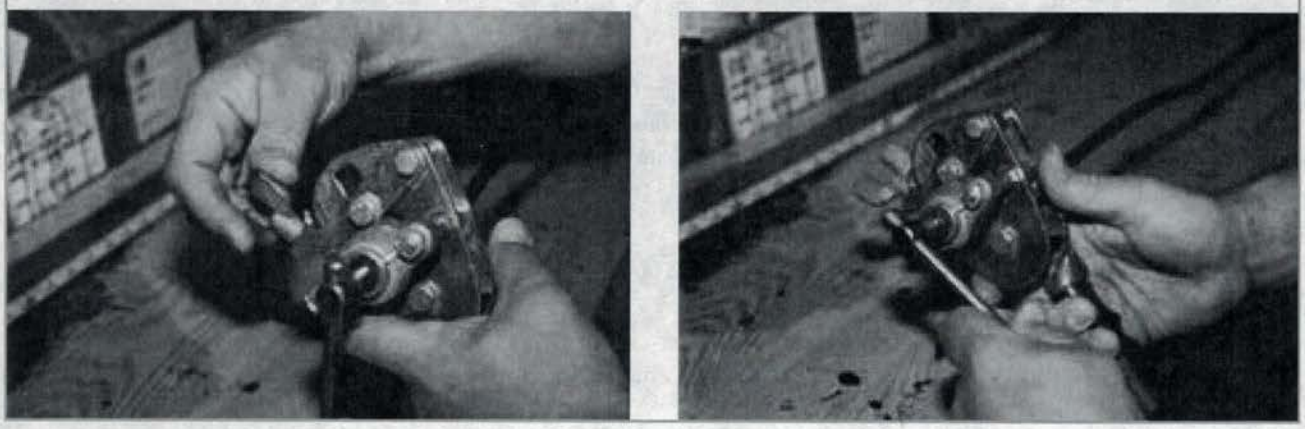


4. Put the flare nut on the tubing before beginning the flare. If this is not done, the tubing may have to be cut and reflared after the nut is put on correctly.

Figure 5-65 Install Flare Nut

5. Using the handheld flaring tool, clamp the tubing in the vise portion of the tool by inserting the tubing into the jaws and clamping the handles together. This will lock the tubing in the tool. Tighten the flaring cone clockwise into the open end of the tubing by screwing it down in a clockwise direction. Tighten the flare cone down on the tubing until it can no longer be turned. Then back off the flaring cone and release the tubing from the vise. Reclamp the tubing in the hand vise and leave about 1/8 to 3/16 in. of tubing protruding from the top of the vise. (This 1/8 to 3/16 in. is approximate for 3/8 in. O.D. tubing and would be slightly more for 1/2 in. O.D. tubing). Tighten down the flaring cone again. This will complete the flare. This two-step method will assist in making a good flare without cracking the edge of the tubing or creating burrs and excessive length in the flare. There are many flaring tools on the market, each with specific operational characteristics. Refer to the manufacturing publications for correct operation.

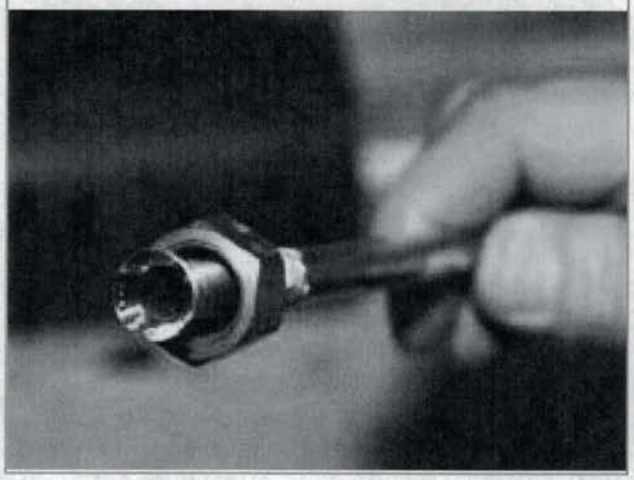
Figure 5-66 Flaring Tool



6. The flare has to be perfectly formed in order to produce a tight connection. Attempting to make the flare all at once can "bell" the flare. Once proficiency is achieved in using the flaring tool, flaring tubing in one operation can become routine. Until then, use the two-step method described previously.

7. Once the flare is complete, inspect it carefully for any deformity or defect that could cause or lead to a leak. *Figure 5-68* shows examples of correct and incorrect flares. The flare should be conical in appearance without burrs or cracks. Look closely to see if hairline cracks are present, usually extending from the outside edge of the flare toward the inside of the pipe. If any of these defects are present, cut the flare off the end of the pipe and begin again. Also, if the tubing was protruding from the end of the vise portion of the tool too far, an overlap or doubling back can occur. Be sure the finished flare has no visible faults, as it is this surface that will be fitted between the male flare receiver and the bonnet nut that forms and keeps the seal.

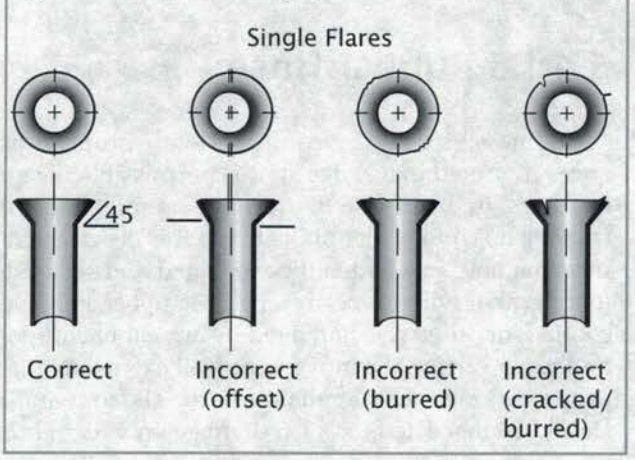
Figure 5-67 Perfect Flare



Never use sealants such as pipe dope or thread tape (Teflon® tape) on flare fittings. The copper forms a tight seal against the "nose" of a flare fitting upon tightening. The use of sealants can prevent a proper seal.

The standard allows propane hoses to pass through floors, walls, partitions, and ceilings if (a) grommets or equivalent are used to prevent chaffing, (b) the entire length of the hose is readily available for inspection, and (c) no part of a hose is concealed in the hollow space of a wall, floor, partition, or ceiling where it could be unknowingly damaged. As long as the hose passes directly through a grommet in the floor or wall and can be pulled in either direction for inspection, it will be considered acceptable regardless of sealant being displaced from the hole and requiring resealing.

Figure 5-68 Proper and Improper Flares



Flexible hose connectors are always listed as assemblies using *UL 21* or *UL 569*. The difference is that *UL 569* hose assemblies are limited to a maximum length of 60 in. CSA has a similar standard, and their listing criteria are *CAN/CGA 8.1* or *CSA CAN1-8.3*. Most flexible hose connects are dual listed for use in the RV industry.

Flexible nonmetallic tubing or hose is not permitted to enter the body (i.e., burner box) of a listed range or cooktop as the final connection. Typically, a short length of copper tube is used between the range or cooktop's manifold and the flexible hose. This keeps the flexible hose out of the range's burner box. Griddles and large pans covering several burners that are in operation may build heat within the burner box to temperatures high enough to melt the flexible hose. Therefore, it hose is not allowed with the burner box.

5-4.1.3 Routing of Copper Tubing

Copper tubing must be installed and routed so as to prevent any potential for physical damage when encountering vibration over the service life of the vehicle. This means it should never be routed against a surface that could cause damage, such as metal edges. Be sure to use grommets or other protection where tubing passes through structure, cut holes, and so on. Tubing must also be supported at least every 4 ft (1.2 m) to prevent excessive vibration.

5-4.1.4 Propane Piping Sizing

The term *piping* is used to describe both rigid (iron pipe) and semirigid (copper tubing) materials of the propane supply system, while the term *pipe* describes only rigid materials (iron pipe) of the system.

This requirement mandates the use of materials of propane piping systems to be new and free from defects. Dented, kinked, damaged, or defective piping (pipe and tubing) would not be acceptable.

Deformed tubing will restrict the flow of propane and is considered defective when it is flattened beyond the allowable tolerance as checked using a go/no-go gauge as shown in *Figure 5-69*.

Copper tubing that is in compliance will not bottom out in the notch of the go/no-go gauge. In *Figure 5-70*, it can clearly be seen that the gauge does not fit over the deformation in the copper tubing. Therefore, the copper tubing would need to be replaced.

Figure 5-69 Go/No-Go Gauge Dimensions

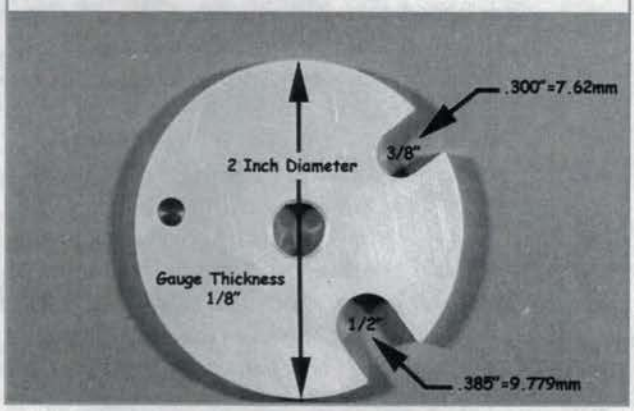


Figure 5-70 Go/No-Go Gauge Use

5-4.1.5 Rubber Hose

Some RVs may be equipped with propane appliances mounted in a slideout. It is permissible for manufacturers to used listed, flexible, nonmetallic tubing (rubber hose) in such applications. It is crucial that any propane hose in a slideout be installed and secured in a manner that will not permit the hose to become kinked, chaffed, or otherwise damaged by any other component on the RV during the movement (full extension and retraction) of the slide room. Failure to do so may prohibit propane flow to any appliance in the slideout and potentially cause propane leaks. All rubber propane hoses should be inspected for such damage on a regular basis and during any pre-delivery inspection (PDI).

5-4.1.6 Flare Nuts

Brass flare nuts are used for connecting copper tubing. Flare nuts are required by *NFPA 1192 paragraph 5.3.2.5* to be either forged or stress relieved. Forged flare nuts have much more rounded edges and a bumpy exterior, and they are thicker than milled fittings.

Flare nuts that are milled from bar stock need to be annealed (stress relieved by being heated then cooled) to reduce the stress that is created by milling. Without annealing the nuts, the potential for cracking or splitting is substantially increased under normal use. Only the fitting manufacturer can identify stress-relieved nuts. Visual identification is difficult.

When flare nuts are loosened or tightened, use two wrenches to keep the tubing from twisting and possibly kinking. Using two wrenches in this manner is referred to as using "backup wrenches." Employ this practice when working with any piping fittings. Backup wrenches enable the service technician to correctly tighten a fitting joint without damaging the system. Be careful that fitting joints are not overtightened.

5-4.1.7 Leak Testing the Piping System

NOTE: When the propane system is opened by loosening a fitting, removing an appliance, or 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 by 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 and 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.

A lock-out tag-out process is used whenever the propane system is opened (such as when removing any appliance, device, or fitting for replacement, testing, or repair) and the removed item is not immediately reinstalled. The "lock-out" safely prevents an unintentional release of propane if the system is opened by ensuring that the opening is plugged or capped appropriately (flare plug, pipe plug/cap, and so forth). This lock-out process also prohibits airborne contaminants from entering the distribution system.

An identifying tag, the "tag-out," is to be attached securely to the "lock-out" to inform others that a propane component has been removed from the system. The tag should list the:

- Name of the technician responsible for returning the system to normal
- Date the system was opened
- Component(s) removed from the system
- Estimated date of the final system repair

A second warning tag can be attached to the service valve(s) of the propane container. This alerts others the propane system is being worked on and that care should be taken if further work is undertaken by another technician.

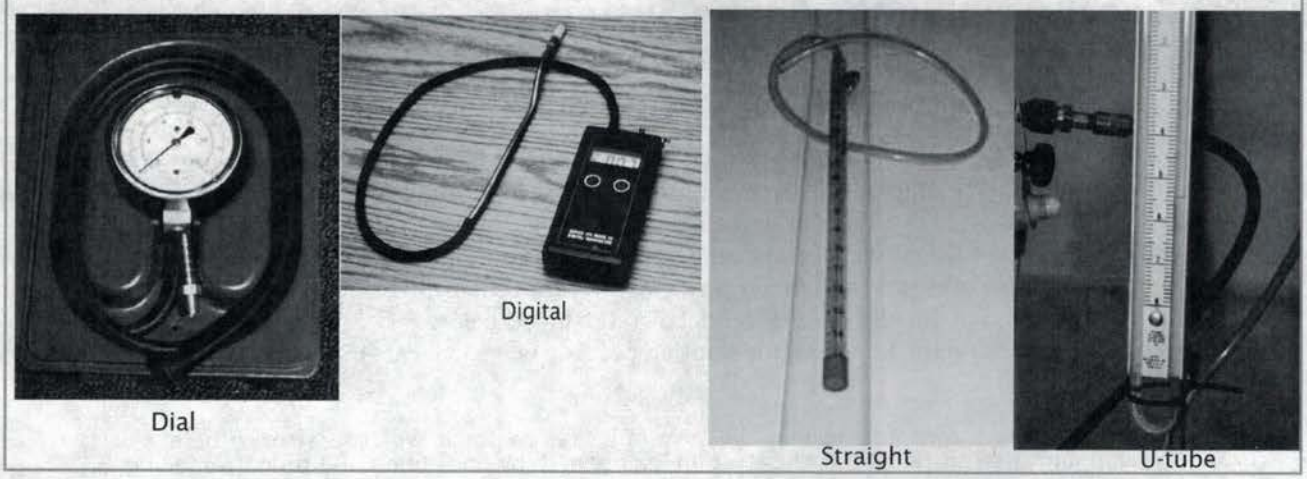
Tag-out tags should be attached to the repair order after the repair is completed and a timed pressure leak test is conducted.

5-4.1.7.1 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 5-71*. 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 is left out in cold weather overnight and 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 5-71 Manometer Examples

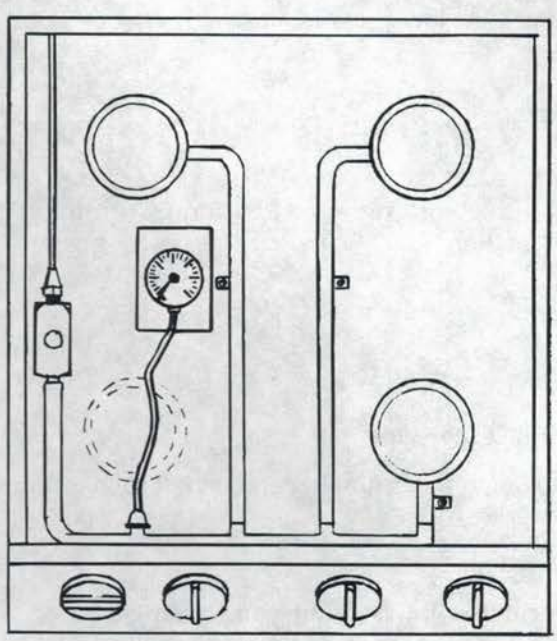


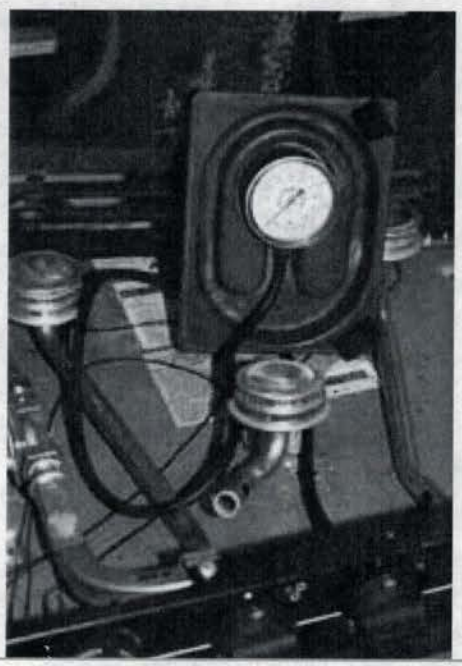
Timed Pressure Drop Test at the Range Burner

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 5-72*.
6. Turn the 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 "PFFFT" 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 to 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) water column. 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 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, as 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
    - Documentation of both the exact manometer measurement and duration when conducting the timed pressure drop test

Figure 5-72 Manometer at Range Burner with Rangetop Off





Timed Pressure Drop Test with a Test Apparatus

NOTE: Instructions for "*Making a Test Apparatus" on page 5-53.*

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 outlet 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. Turn propane system on slowly at the service valve. Bleed pressure to a nominal 8 in. WC (i.e., 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 "PFFFT" 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 leak(s) 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 test results. 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

5-4.1.8 Locating Piping Systems Leaks

5-4.1.8.1 Detector Solution Test

After it has been determined a leak is present by using the timed pressure drop test outlined in *"Timed Pressure Drop Test" on page 5-72*, 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 is readily available. If a leak is present, the leak detector solution will bubble around the leaking fitting.

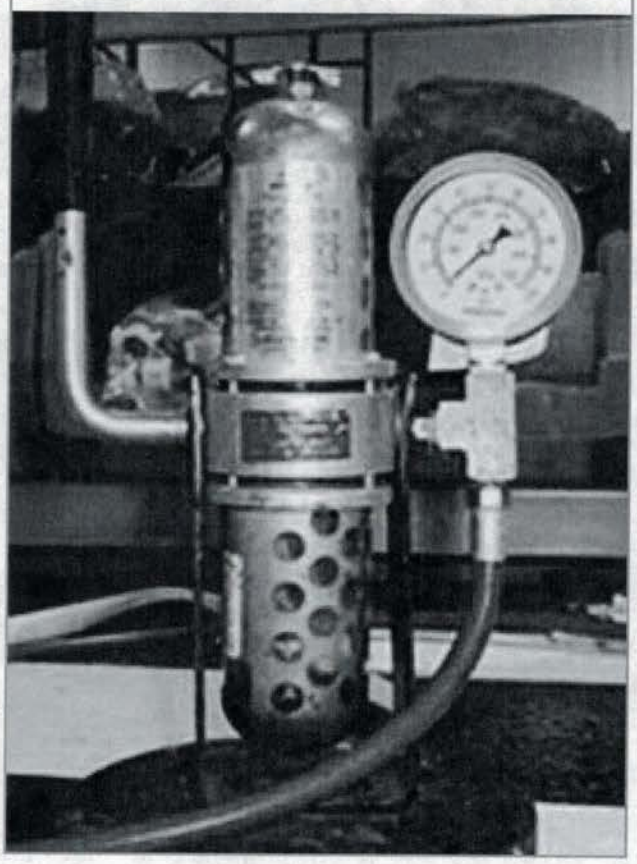
NOTE: Using two wrenches to prevent twisting the tubing or stripping the fittings, tighten the leaking joint to make the bubbles stop.

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

5-4.1.8.2 Bubble Leak Test

Bubble leak testers, shown in *Figure 5-73*, 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 only need to be engaged for 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.

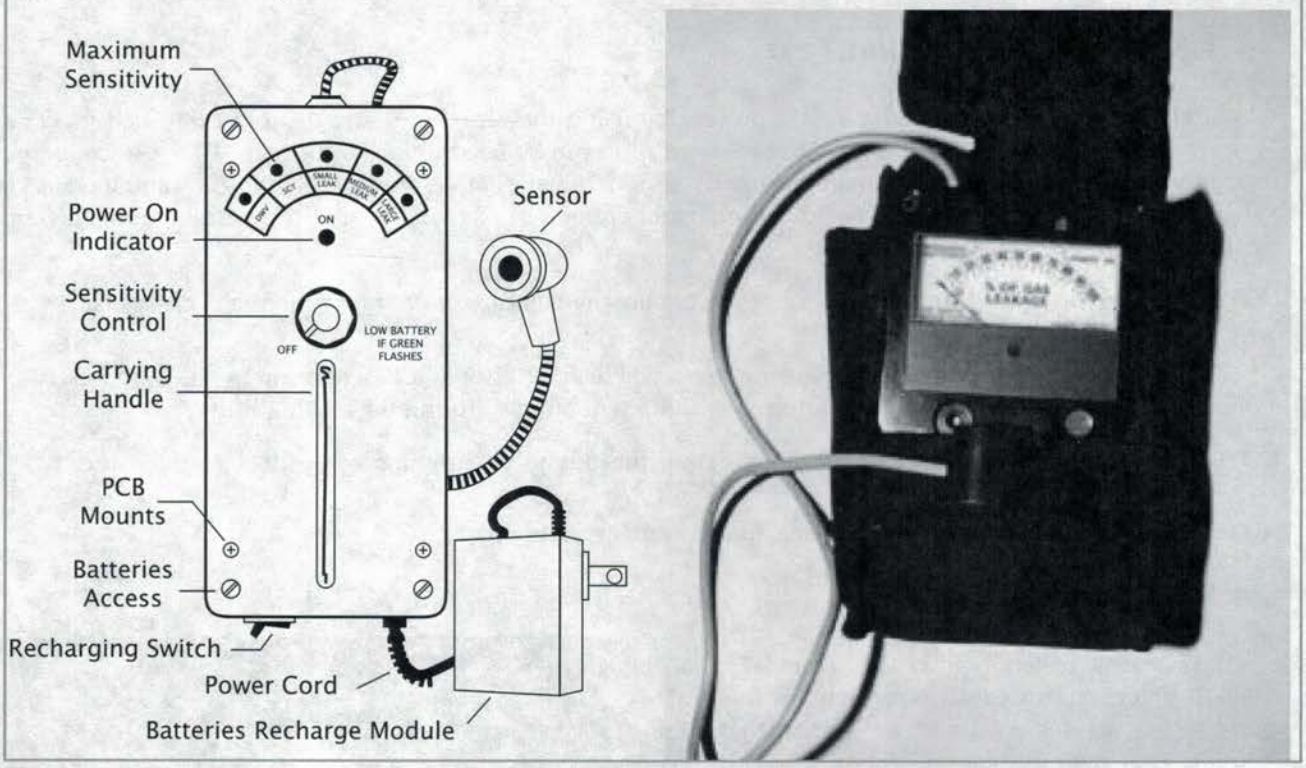
Figure 5-73 Bubble Leak Tester



5-4.1.8.3 Electronic Leak Test

Leaks can also be located using an electronic leak detector. Follow the electronic leak detector (shown in *Figure 5-74*) 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 5-74 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 and so forth have not contributed to false indication, conduct the leak test.

5-4.1.9 Correcting Leaks in Propane Systems

Any leaks in the propane system must be repaired. The method used will depend on the material where the leak is present. Leaks in threaded connections of the iron manifold will often require the threaded connection to be disassembled, the old sealant cleaned off, and new sealant applied to the male threads and reconnected. Pinhole leaks at elbows or "Ts" of the iron manifold are sometimes not at the threaded connection and can only be repaired by replacing the fitting. Leaks at flared fittings can often be corrected by simply tightening the flare nut. If this fails to correct the leak, remove the flare nut and reflare the copper tubing. Leaks resulting from cracked flare nuts can be repaired only by replacing the flare nut. Leaks in flexible hose connectors cannot be repaired, and they must be replaced.

NOTE: Remember to retest the system after any leak is repaired to ensure that the fix has been successful.

5-4.1.9.1 Documentation of Tests

Whenever a test of the propane system is conducted, it is important to document the results. This records the work, and it can also protect against potential lawsuits. The following form provides a single document for each RV that is tested. All tests are outlined for common use.

5-4.1.9.2 Sample Propane System Testing Checklist

The following is a sample of a checklist that could be used to record pertinent data from propane system testing.

Year, make, and model of RV unit: _____
License number and state: _____
Unit serial/identification number: _____

Test conducted: **Operating Pressure Test**
Test date: _____
Start and end times of the test: _____
Location manometer attached (example: before regulator on range): _____
Type of manometer used: _____
Date manometer last calibrated (if other than a U-tube): _____
Air and piping temperature during test: _____
Initial inch WC propane pressure reading: _____
Adjustment procedures taken (if necessary):
_____
Corrected inch WC propane pressure reading: _____
Technician's printed name: _____
Technician's signature: _____

Test conducted: **Regulator Adjustment**
Test date: _____
Start and end times of the test: _____
Location manometer attached (example: before regulator on range):
_____
Type of manometer used: _____
Date manometer last calibrated (if other than a U-tube): _____
Air and piping temperature during test: _____
Initial inch WC propane pressure reading: _____
Adjustment procedures taken (if necessary): _____
_____
Corrected inch WC propane pressure reading: _____
Technician's printed name: _____
Technician's signature: _____

Test conducted: **Regulator Lockup Test**
Test date: _____
Start and end times of the test: _____
Location manometer attached (example: before regulator on range):
_____
Type of manometer used: _____
Date manometer last calibrated (if other than a U-tube): _____
Air and piping temperature during test: _____
Initial inch WC propane pressure reading: _____
Propane pressure at the beginning of the 3 minute observation period: _____
Propane pressure at the end of the 3 minute observation period: _____

Note: Lockup pressure must occur at 14 in. WC or less. If pressure exceeds 14 in. WC, the regulator must be replaced.

Action taken (if any): _____
Technician's printed name: _____
Technician's signature: _____

Test conducted: **Timed Pressure Drop Test**
Test date: _____
Start and end times of the test: _____
Location manometer attached (example: before regulator on range):
_____
Type of manometer used: _____
Date manometer last calibrated (if other than a U-tube): _____
Air and piping temperature during test: _____
Initial inch WC propane pressure reading: _____
Beginning and ending time of the 3 minute observation period: _____
Propane pressure at the end of the 3 minute observation period: _____
Corrective actions taken (if necessary): _____
_____

Note: Continue conducting the test and corrective procedures until a successful test is completed.

Corrected inch WC propane pressure reading: _____

Note: Record the exact pressure within the nominal pressure range (e.g., 7-3/4 in. WC, 8-1/4 in. WC, etc.)

Beginning and ending time of the 3 minute observation period: _____
Technician's printed name: _____
Technician's signature: _____

Test conducted: **Leak Test**
Test date: _____
Type of detector used:
_____ Liquid leak detector solution
_____ Electronic leak detector
Air and piping temperature during test: _____
Detailed description of all leaks found and action taken: _____
_____
Timed Pressure Drop Test results (if conducted): _____
See Timed Pressure Drop Test form.
Technician's printed name: _____
Technician's signature: _____

5-4 Review

1. Which of the following materials is not approved for use as propane piping?
   A. Steel
   B. Copper
   C. Brass
   D. Plastic
   E. Wrought or black iron
2. List two approved materials for joining pipe connections.
   A.
   B.
3. Flare fittings are designed to be used without any sealant material.
   True False
4. Check for leaks on propane systems only once each year.
   True False
5. List the two methods of locating leaks in RVs.
   A.
   B.
6. *NFPA 1192* requires that a timed pressure drop test be conducted for a minimum of _____ minutes.
7. During the timed pressure drop test, the pressure must be maintained at a nominal _____ or less WC for the minimum time frame.
8. The number of threads in a threaded pipe does not affect performance.
   True False
9. Copper tubing should be supported every _____ to prevent physical damage from vibration.
10. The two types of flare nuts approved for use in RVs are:
    A.
    B.

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Chapter

5-5 RV Propane System Codes and Standards

· Identify codes and standards.

5-5.1 Industry Codes and Standards

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

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

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

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

5-5.2 Code Summary

Table 5-8 is a summary of the current RV standard that pertains to the normal duties of the RV service technician. This summary is provided as a quick reference, NOT AS A SUBSTITUTE FOR THE ACTUAL STANDARDS. Once the reference in these tables has been found, go to the referenced standard for the exact wording and use the handbook for the detailed explanation.

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

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

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Inspect, adjust, replace propane regulator	7.1.1	5.2.15.4	Vent openings for regulators must be positioned within 45° of vertical downward.

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Inspect, adjust, replace propane regulator	7.1.3	5.2.15.8	Above-floor regulator(s) must be equipped with a durable cover to protect the regulator vent opening from the elements.
	8.2.2.4	5.3.6.1	Single- or double-flare tubing joints of 45° must conform to SAE J533.
		5.3.6.3	Restricts the use of sealants on flare joints.
		5.3.7.2	Thread sealants may be used but only on the male threads.
	8.1.2	5.3.6.1	Compression type fittings must be listed as vibration resistant to be acceptable for use.
Inspect, repair, replace propane piping system	9.12	5.3.2.2	Any defective gas tubing or piping must be replaced, not repaired.
	8.2	5.3.2.5	Gas pipe shall be steel or wrought iron pipe complying with ANSI B36.10M. Also, copper tubing shall be type K or L and conform to ASTM B88.
	9.5	5.3.8.2	Where tubing passes through walls, floors, partitions, etc., it shall be protected by snugly fitting weather-resistant grommets.
	9.3	5.3.9.1	Pipe or tubing joints are restricted from being located in any wall, floor, partition, or concealed construction.
	9.6	5.3.9.2	Propane tubing located in storage areas must be protected.
	5.14.1 Electrical	551.56(E)	Gas supply systems are to be electrically bonded to the chassis by approved (listed) means.
Testing the propane system with appliances connected	11.1.2 Propane	5.3.20 5.3.20.1	Requirements for this test are as follows: • All appliances shall be installed and connected to gas system prior to performing this test. • The system requires a minimum test setting of 8 to 14 in. WC be maintained. • Systems that monitor the test pressure by connecting the gauge to a range spud need to have the test pressure reduced to 8 in. WC.

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Testing the propane system with appliances connected	11.1.2 Propane	5.3.20.2 5.3.20.6(1)(a) 5.3.20.6(1)(d) 5.3.20.6(3)	• Temperature of the air and piping shall be approximately the same at the beginning of the test and remain the same throughout the test period. • The entire piping system shall be pressurized at 10 to 14 in. WC (or 6 to 8 oz). • The appliance shutoff valves shall be closed. • The source of pressure shall be disconnected or turned off. • This requirement does not allow any drop in pressure during the three-minute test period. • If a regulator is used downstream of the test pressure source, the system must be bled off to release any high pressure that may be trapped between the pressure source and regulator. This may be accomplished by opening a range burner until the manometer drops. • Test the appliance connections with soapy water or bubble solution. Products that contain ammonia or chlorine shall not be used. • An alternate test allows a dial gauge or U-tube manometer to be used to perform the test. The gauge or manometer used must be capable of measuring in inches of water column or 1/2 oz increments.
Selecting propane fuel lines	9.12	5.3.2.1	Materials used in gas piping system must be free from defects (dents, kinks, or other damage).
	9.12	5.3.2.1	Gas tubing shall not be flattened beyond allowable tolerance.
	8.1.1.1 8.2.1.1	5.3.2.5	Gas pipe shall be steel, iron, copper, or brass.
	8.1.1.1	5.3.2.5	Iron pipe and fittings used on high-pressure side of regulator shall be schedule 80.
	8.2.2.4	5.3.2.5	Fittings for gas piping shall be iron, steel, or brass.
	8.2.2.2	5.3.2.5	Brass flare nuts shall be of the stress-relieved or forged type. Provide evidence that milled flare nuts are stress relieved.

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Selecting propane fuel lines	8.2.1.2	5.3.2.5	Copper tubing shall be marked type K or L on the tubing or be identified as ASTM B280 tubing on the package or tubing.
		5.3.2.5	Steel tubing flare connections shall be double flared.
	7.2.2 10.2.1	5.3.2.5(11)	Flexible nonmetallic tubing or hose shall be assembled using listed hose and fittings or be part of a listed assembly.
		5.3.3	Gas piping systems shall be designed for propane gas.
Propane fitting installation/assembly	8.2.2.4(a)	5.3.6.1	Tubing joints shall be made with single or double flares.
		5.3.6.1	Flares shall be free from defects.
		5.3.6.3	Sealants shall not be used on flared tubing joints.
	8.1.5	5.3.7.1	Provide evidence of listing for use with propane for sealants used on pipe threads.
		5.3.7.2	Pipe joint sealant shall be applied to male threads only.
Propane fuel line installation and routing	9.3	5.3.8.1	Tubing or hose shall not be run inside walls/floors/partitions/roof.
	9.5	5.3.8.2	Tubing or hose shall be protected where it passes through walls/floors/partition/roof.
	9.5	5.3.8.2	Grommets to protect tubing or hose shall be secured in place.
		5.3.8.3	Tubing or hose shall be protected against physical damage, sharp edges, and moving parts.
		5.3.8.3	Tubing or hose must not be routed in direct contact with any metal edge.
		5.3.8.3	Tubing or hose must be routed above approach/departure angle of RV.
	9.6	5.3.9.1	Pipe or tubing joints shall not be located in concealed construction space.
	9.6	5.3.9.1	Gas piping joints shall not be installed inside the underbelly.
	9.6	5.3.9.1	Gas piping joints shall be accessible.

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Propane fuel line installation and routing	9.6	5.3.9.2	Pipe joints located in storage area shall be located within 2 in. of the compartments ceiling or shall be substantially protected.
	9.6	5.3.9.2	Tubing joints located in storage area shall be protected and located within 2 in. of the compartments ceiling.
	9.6	5.3.9.2	Appliance connection joints shall not be located in storage area unless within 2 in. of the compartment ceiling.
	9.6	5.3.9.4	Tubing in storage area shall be protected by routing and additional protection.
	7.2	5.3.10.1	Supply connection shall be located at the container location.
	10.1.1	5.3.13.1	Flexible hose connector shall pass through floor, wall, ceiling, or partition as directly as possible, and entire hose must be capable of inspection.
Propane fuel lines	7.2.1	5.3.12.2	Propane supply connectors shall be listed to *UL 569*.
	7.2.2	5.3.12.3	Listed high-pressure flexible connector shall be used if propane cylinders are removable or if regulator is mounted on a cylinder support bracket.
	7.2.1	5.3.12.4	Flexible hose connector used in low-pressure propane connections shall be listed.
	7.2.2	5.3.12.4	Listed flexible hose connector must be used from regulator to propane piping system if the regulator is mounted on a cylinder support bracket.
	10.1.1	5.3.13.1	Flexible gas hose shall not be concealed.
Propane inspect and repair		5.3.17	Gas piping shall not be used for a grounding electrode.
	9.11	5.3.18.1	Gas piping or hose shall be adequately supported at intervals of not more than 4 ft.
	9.11	5.3.18.2	Pipe, tubing, or hose supply connections shall be rigidly anchored within 6 in. of supply connections with metal clamp or equivalent.
	9.11	5.3.18.2	Pipe, tubing, or hose supply connection shall be rigidly anchored (no movement by hand).

Table 5-8 Propane—Applicable to RV Service Technicians

Service Technician's Task	2008 CSA Z240	2011 1192	Summary of Requirements
Propane inspect and repair	9.11	5.3.18.3	All piping shall be anchored within 6 in.of tubing or hose connections at end of run.
		5.3.18.3	All piping shall be anchored within 12 in. of tubing or hose connections within run.
	9.15	5.3.18.3	Iron pipe requiring anchoring within 6 or 12 in. shall allow no more than 1/8 in. of movement.
Select and install/replace gasoline and diesel fuel lines	5.11.2.1 General req.	5.10.8.3	Valves, filters, strainers, and similar components shall be accessible for maintenance.
	5.10.1 General req.	5.10.8.4	All fuel distribution equipment shall be protected from road damage.
	5.10.3 General req.	5.10.8.5	Tubing must be prime aluminized steel or identified for use with fuel.
	5.10.4 General req.	5.10.8.6	Provide evidence hose used conforms to J30R7 or better.
	5.10.5 General req.	5.10.8.7	Provide evidence hose-to-tube joints shall remain leak-free when subject to 20 lb axial pull test for 1 minute.
	510.6 General req.	5.10.8.8	Fuel line shall be supported to protect from chaffing.
	5.10.6 General req.	5.10.8.10	Maintain 4-1/2 in. between fuel distribution system and unshielded exhaust system.
	5.10.7 General req.	5.10.8.11	Fuel system shall not be in contact with electrical wiring.
	5.10.8 General req.	5.10.8.12	Fuel system shall be designed so leakage from tanks or joints will not contact electric or exhaust system.
Inspect, adjust, replace propane regulator	7.1.1	5.2.15.4	Vent openings for regulators must be positioned within 45° of vertical downward.
	7.1.3	5.2.15.8	Above-floor regulator(s) must be equipped with a durable cover to protect the regulator vent opening from the elements.

5-5.3 References

The following documents or portions thereof are referenced. Please note the edition used within this textbook is indicated for each standard.

American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch), 1983 edition (reaffirmed 2001)

ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe, 2004 edition (reaffirmed 2010)

ANSI/RVIA 12V, Standard for Low Voltage Systems in Conversion and Recreational Vehicles, 2011 edition

American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017

ASME, Boiler and Pressure Vessel Code, Section VIII, Division I, 2010 edition

Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario L4W 5N6

CSA Z240 RV Series, 2008 edition

Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly VA 20151-2923

CGA C-6, Standards for Visual Inspection of Steel Compressed Gas Cylinders, 2007 edition

NFPA Publications, National Fire Protection Association, BatteryJune Park, Quincy, MA 02269

NFPA 1192, Standard on Recreational Vehicles, 2011 edition

NFPA 58, Liquefied Petroleum Gas Code, 2011 edition

RegO Products, 100 RegO Drive, P.O. Box 247, Elon, NC 27244

LP-Gas Serviceman's Manual, Revised 7/03

NOTE: There is no review for this chapter.

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5 Answer Key

Chapter 5-1

1. True *(page 5-5)*
2. True. The odorant ethyl mercaptan is added to natural propane. *(page 5-6)*
3. False. Propane does, water boils at 212°F 100°C. *(page 5-6)*
4. True *(page 5-6)*
5. False. Propane weighs 4.2 lb 1.9 kg per gallon at 60°F 15.6°C. *(page 5-5)*
6. False. Propane expands as temperature is warmed, 1-1/2 percent for every 10°F. -12.2°C. *(page 5-6)*
7. True *(page 5-8)*
8. 15.5 US gallons 12.7 imperial gallons full
   12.38 12.4 gallons at 80 percent full level
   Propane weighs 4.20 lb per gallon at 60°F or 5.1 lb per imperial gallon at 15.5°C. Divide 65 lb capacity of ASME tank by 4.20 propane weight per gallon = 15.476 rounded to 15.5 × 0.8 = 12.38. *(page 5-5)*
9. 12,150 Btu/hr. A DOT/TC cylinder at 50 percent full and at -5°F, the Btu/hr vaporization capacity is 12,150 Btu/hr. *(page 5-7)*

Chapter 5-2

1. POL plug or dust cap *(page 5-15)*
2. C *(page 5-15)*
3. B *(page 5-16)*
4. C *(page 5-16)*
5. Vapor withdrawal tube *(page 5-18)*
6. 80 percent full level *(page 5-19)*
7. B *(page 5-19)*
8. False. Pressure relief valves are adjusted by service personnel. *(page 5-27)*
9. C *(page 5-27)*
10. A *(page 5-27)*
11. Excess flow valve *(page 5-28)*
12. 12 10, 5 10 *(page 5-30)*
13. False. Used containers that have had their service valve left open also need to be purged. *(page 5-35)*
14. 25 7.6 *(page 5-37)*
15. D *(page 5-38)*
16. oily spot *(page 5-39)*
17. By weight *(page 5-39)*
    By container volume *(page 5-40)*

Chapter 5-3

1. D *(page 5-56)*
2. C *(page 5-57)*
3. Any two of the following: *(page 5-58)*
   - When the outage valve is opened, there is a stream of liquid.
   - If there is a continuous draw of liquid into the regulator.
   - Any signs of oily material or an abnormal amount of dirt that might be stuck to the exterior of the regulator.
   - There may be a residual odorant from around the relief valve area.
   - Missing dustcover and shinny brass.
4. 1. Pressure adjustment spring *(page 5-48)*
   2. Diaphragm assembly *(page 5-48)*
   3. Drip lip vent *(page 5-48)*
   4. Relief mechanism *(page 5-48)*
   5. Inlet tank pressure *(page 5-48)*
   6. Lever arm assemblies *(page 5-48)*

Chapter 5-4

1. D *(page 5-63)*
2. A. Pipe joint compound marked for propane use *(page 5-66)*
   B. Teflon® tape approved for propane use *(page 5-66)*
3. True *(page 5-66)*
4. False. The system should be tested at least once before each camping season and anytime the system is opened by loosening a fitting, removing an appliance, replacing a line, or leak is suspected. *(page 5-71)*
5. A. Leak detector solution *(page 5-71)*
   B. Electronic tester *(page 5-71)*
6. 3 *(page 5-74)*
7. 8 in. *(page 5-74)*
8. False. Overthreading can cause loose fitting and weakening of pipe. *(page 5-66)*
9. 4 ft 1.2 m *(page 5-70)*
10. A. Forged *(page 5-71)*
    B. Stress-relieved *(page 5-71)*

Chapter 5-5

There is no review for this chapter.

5 Glossary of Propane Terms

AGA American Gas Association. A trade association whose functions include standards, testing, and approval of gas-fired appliances.

Anneal To subject (glass or metal) to heat and slow cooling to toughen and reduce brittleness.

ANSI American National Standards Institute. An organization that establishes criteria for the development of voluntary consensus standards concerning products and equipment.

NFPA 1192 The Standard on Recreational Vehicles. This document contains the fuel systems, fire and life safety, and plumbing requirements for recreation vehicles.

ASME American Society of Mechanical Engineers.

ASME Code The Boiler and Pressure Vessel Code (Section VIII. "Rules of the Construction of Unfired Pressure Vessels") of the American Society of Mechanical Engineers. Only Division I of Section VIII of the ASME Code is applicable in this standard except UG-125 through UG-136 shall not apply (*NFPA 58*).

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

Authority Having Jurisdiction The organization, office, or individual responsible for approving equipment, an installation, or a procedure (*NFPA 58*).

Backflow Check A mechanical valve used in conjunction with the fill valve that permits the flow of vapor or liquid in only one direction.

Back-Seating The sealing action at the "open" when the valve is opened all the way and the valve stem presses against the upper seat to close off the gas pressure so it cannot get out of the system from around the valve stem.

Boyle's Law (Boyle-Mariotte Law) The law that states that, at a constant temperature, the volume of a gas is inversely proportional to the pressure applied to it.

Btu British thermal unit—A unit of energy. One Btu/hr will raise the temperature of one pound of fresh water 1° F.

Butane A hydrocarbon fuel gas heavier than methane or propane and a constituent of liquefied petroleum (LP) gas.

Celsius The scale of temperature measurement in the metric system of units. It is based on the freezing point of water at 0°C and boiling point at 100°C, standard pressure conditions.

CGA Compressed Gas Association. A trade association whose function is the development and promotion of safety standards and safe practices in the industrial and medical gas industry.

Container Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of propane (*NFPA 58*).

Container Appurtenances Items connected to container openings needed to make a container a gas tight entity. These include, but are not limited to, pressure relief devices (shutoff, backflow check, excess flow check valves) liquid level gauges, and plugs (*NFPA 58*).

Container Assembly An assembly consisting essentially of the container and fittings for all container openings. These include shutoff valves, excess flow valves, liquid gauging devices, pressure relief devices, and protective housings (*NFPA 58*).

Cylinder A portable container constructed to DOT/TC cylinder specifications or, in some cases, constructed in accordance with the ASME code of a similar size and for similar service. The maximum size permitted for use in an RV under DOT/TC specifications is 1,000 lb (454 kg) water capacity.

Dip Tube The vent stem of a DOT/TC shutoff valve assembly that extends into the cylinder to the 80 percent full level. Excess liquid is vented through the bleed port. The length of the stem is marked on the guard of the cylinder.

DOT U.S. Department of Transportation.

Emergency Shutoff Valve A shutoff valve incorporating thermal and manual means of closing and providing for remote means of closing (*NFPA 58*).

Ethyl Mercaptan A sulfur compound (odorant) added to propane gas as a warning agent (*NFPA 58*).

Excess Flow Valve (Also called excess flow check valve)—A device designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate as determined by pressure drop (*NFPA 58*).

Fahrenheit The common scale of temperature measurement in the English system of units. It is based on the freezing point of water being 32°F and the boiling point of water being 212°F at standard pressure conditions.

False Container Pressure The result of an improperly purged container, where air in the container is pushed to the top of the container and compressed, yielding an excessive pressure reading.

Fixed Liquid Level Gauge A type of liquid level gauge using a relatively small positive shutoff valve and designed to indicate when the liquid level in a container being filled reaches the point at which this gauge or its connecting tube makes contact with the liquid in the container (*NFPA 58*).

Fixed Maximum Liquid Level Gauge A fixed liquid level gauge, which indicates the liquid level at which the container is filled to its maximum permitted filling limit (*NFPA 58*).

Flexible Connector A short, not exceeding 36 in. (1 m) overall length, component of a piping system fabricated of flexible material (such as hose) and equipped with suitable connections on both ends. Propane-resistant rubber and fabric (or metal), a combination of rubber and fabric, or all metal may be used. Flexible connectors are used where there is the need for, or the possibility of, greater relative movement between the points connected than is acceptable for rigid pipe (*NFPA 58*).

Float Gauge A gauge constructed with a float inside the container and resting on the liquid surface, which transmits its position through suitable leverage to a pointer and dial outside the container, indicating the liquid level. Normally, the motion is transmitted magnetically through a nonmagnetic plate so that no propane is released into the atmosphere (*NFPA 58*).

Gallon US standard, 1 US gal.
1 US gal = 0.833 imperial gal = 231 in^3 = 3.785 L (*NFPA 58*).

Gas Liquefied petroleum gas in either the liquid or vapor state. The more specific terms "liquid propane" or "vapor propane" are normally used for clarity (*NFPA 58*).

High-Pressure Connector A connector designed to carry full container pressure.

High-Pressure Hose Also called a *pigtail,* one end contains a fitting for connection to the service valve, and the other end varies, depending upon application. This hose must be rated at 350 psi minimum.

Hydrocarbon Compounds consisting of hydrogen and carbon found in propane, carbon monoxide, alcohol, cleaning solutions, hair sprays, and other organic compounds.

Labeled Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled

equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner (*NFPA 58*) (e.g., CGA, AGA).

Liquefied Petroleum Gas (Propane or LPG) Any material having a vapor pressure not exceeding that allowed for commercial propane composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes (*NFPA 58*).

Listed Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with evaluation of product and services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states either that the equipment, material, or service meets identified standards or has been tested and found suitable for use for a specified purpose (*NFPA 58*) (e.g., UL).

Lockup When the regulator seat is closed and there is no flow of propane. Lockup must not exceed 14 in. WC for RV vapor systems.

Low-Pressure Hose A connector hose that carries maximum of 1 psi and is to be used in connection with any gas source that usually carries low-pressure gas to appliances.

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

Methane A hydrocarbon gas that is flammable, odorless, and colorless with a chemical formula of CH_4 and is the principal component of natural gases.

Natural Gas Mixture of approximately 94 percent methane, plus 6 percent other gases. Formed naturally below the earth's surface, it is tasteless, odorless, and colorless.

NFPA National Fire Protection Association.

NFPA 58 The Liquefied Petroleum Gas Code.

Odorant Fade Problem caused when the odorant that is added to propane (ethyl mercaptan) is not detectable as a warning agent. The proper purging of air from a new container or one that has been mistakenly left open will help prevent oxygen or rust in the container that may combine with the odorant and reduce the detectability. "Sniff test" the fuel when filling.

OPD Overfilling prevention device. (Previously known as stop-fill device.) Device that prevents filling of propane containers beyond the maximum 80 percent full level.

Pascal's Law (Principle of Transmission of Fluid-Pressure) The law that pressure exerted anywhere in a confined fluid is transmitted equally in all directions throughout the fluid.

Piping, Piping Systems Pipe, tubing, hose, and flexible rubber or metallic hose connectors made up with valves and fittings into complete systems for conveying propane in either the liquid or vapor state at various pressures from one point to another (*NFPA 58*).

POL (Prest-O-Lite) A fitting or cylinder service valve with a left-hand (turns counterclockwise to tighten) thread design produced by the Prest-O-Lite company and used for connections at the cylinder valve. (Also known as CGA Type 510 connection or *spud and nut.*)

POL Plug A plug inserted into a DOT/TC cylinder's POL service valve during transport or when the cylinder is not connected for service.

Pressure Drop Test A pressure test conducted on a propane systems to determine if the system has a leak.

Pressure Relief Device A device designed to open to prevent a rise of internal fluid pressure in excess of a specified value due to emergency or abnormal conditions (*NFPA 58*).

Propane A liquefied petroleum gas (C_3H_8); a gaseous hydrocarbon of the methane series found in petroleum.

Propane System An assembly consisting of one or more containers with a means for conveying propane from the container(s) to dispensing or consuming devices (either continuously or intermittently) and that incorporates components intended to achieve control of quantity, flow, pressure, or state (either liquid or vapor) (*NFPA 58*).

PSI, PSIG, and PSIA Pounds per square inch, pounds per square inch gauge, and pounds per square inch gauge absolute, respectively (*NFPA 58*).

Purging A process of displacing the dehydrated air or any contaminants from a container using propane vapor prior to its first filling or as needed when contaminants or atmospheric pressure have been introduced into the container.

Regulators Regulators are devices that reduce pressure.

Regulator, Automatic Changeover An integral two-stage regulator that combines a high-pressure regulator and a second-stage regulator into a single unit. It incorporates two inlet connections and a service-reserve pressure indicator and is designed for use with dual or multiple cylinder installations. The system automatically changes the propane vapor withdrawal from the designated service cylinder(s) when depleted to the designated reserve cylinder(s) without interruption of service. The service reserve indicator gives a visual indication of the cylinder(s) that are supplying the system (*NFPA 58*).

Regulator, First-Stage A pressure regulator for propane vapor service designed to reduce pressure from the container to 10.0 psi (69 kPag) or less (*NFPA 58*).

Regulator, High-Pressure A pressure regulator for propane vapor service designed to reduce pressure from the container to a lower pressure in excess of 1.0 psi (6.9 kPag) (*NFPA 58*).

Regulator, Integral Two-Stage A pressure regulator that combines a high-pressure regulator and a second-stage regulator into a single unit (*NFPA 58*).

Regulator, Second-Stage A pressure regulator for propane vapor service designed to reduce first-stage regulator outlet pressure to 14 in. WC (4.0 kPag) or less usually set at 11 in. nominal (*NFPA 58*).

Regulator, Single-Stage A pressure regulator for propane vapor service designed to reduce pressure from the container to 1 psig (6.9 kPag) or less (*NFPA 58*).

Remote Senders An electrical device located in the float gauge assembly that transmits an electrical signal to an internal readout on the monitor panel located inside the RV that indicates the level of propane in the container(s).

Sight Gauge A visual magnetic gauge responding to an internal float to indicate the approximate quantity of fuel in a propane container.

Slugging A term used to describe the automatic closing of an excess flow check valve. The closing or "slugging" occurs when the liquid or vapor flow rate exceeds the excess flow valve's designed capacity.

Stop-Fill Device An overfilling prevention device that will prevent filling a container above the 80 percent maximum filling level.

Tank Refer to ASME tank.

TC Transport Canada.

Tinned Coated or plated with tin.

Type I Valve This is a CGA 791 valve that has 1-5/16 in. ACME threads on the exterior of the valve. The interior of the valve outlet retains the old POL left-hand thread so that the cylinder can be filled with existing equipment. Connection to the valve is accomplished by attaching the mating vehicle side right-hand threaded 1-5/16 in. ACME nut with a force applied by hands only; no tools are used for this connection.

Type II Valve This is a CGA 810 valve that has an outlet of the quick-connect type, requiring no tools or threads to complete the connection.

Two-Stage Regulator System A propane vapor delivery system that combines a first-stage regulator and a second-stage regulator(s), or an integral two-stage regulator (*NFPA 58*).

Vapor Withdrawal Tube An internal withdrawal tube, inside ASME tanks and all horizontal cylinders, that communicates with the vapor space at or near the highest point in the container when it is in the service position. The tube draws vapor from the container to the regulator. In the RV industry, it is sometimes referred to as the riser or drop tube. It can be straight or "J" shaped.

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

Water Capacity The amount of water in either pounds or gallons at 60°F (15.5°C) required to fill a container full of water (*NFPA 58*).

Water Column Abbreviated as WC, it is a unit measure used for expressing pressure (27.7 in. WC = 1 psi).

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