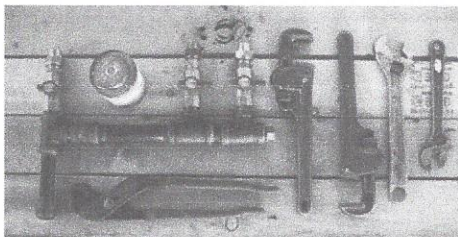




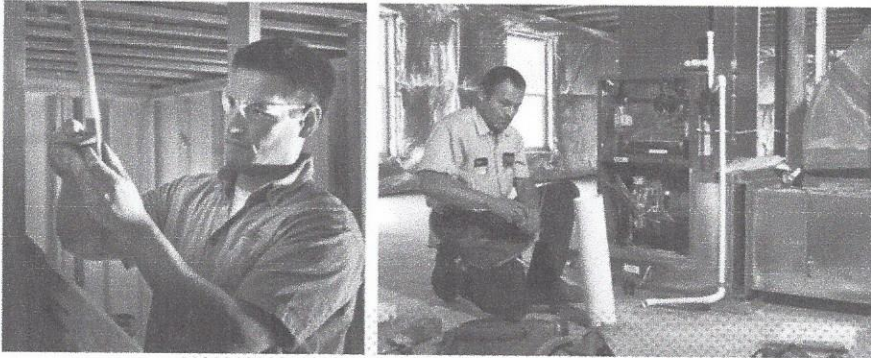
OVERVIEW OF PROPANE DISTRIBUTION SYSTEMS

FOR HVAC AND PLUMBING PROFESSIONALS



Who Should Take This Course?

- Plumbers.
- HVAC technicians.



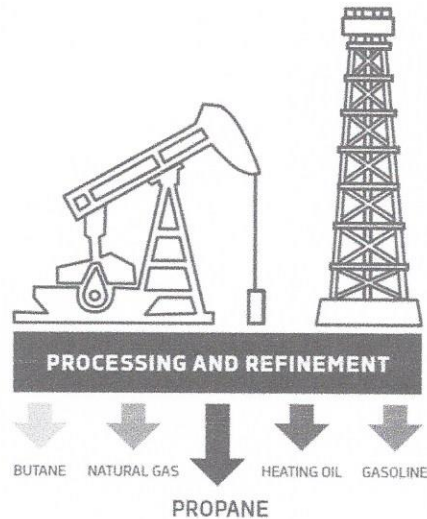
WHO SHOULD TAKE THIS COURSE?

Since safety and reliability are everyone's business, employees throughout the HVAC and plumbing industries will find this training useful, and perhaps even lifesaving.

However, this course has been specifically designed to train:

- Plumbers.
- HVAC technicians.

Sources of Liquefied Petroleum Gas



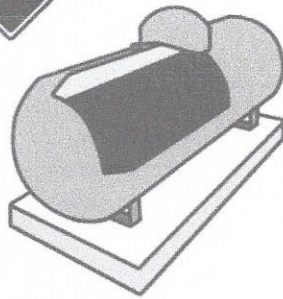
SOURCES OF LIQUEFIED PETROLEUM GAS

Main sources of Liquefied Petroleum Gas (LP-gas) are:

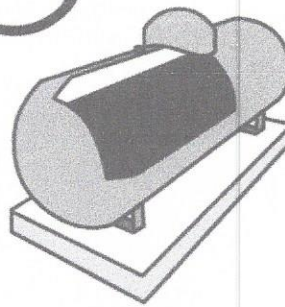
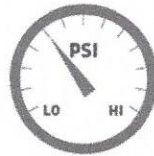
- The refining of crude oil.
- The processing of natural gas from wet gas wells.

These two sources are very different. But once refined, there's little difference between LP-gases processed from these sources.

Important Characteristics of LP-Gas



Will burn when mixed with air



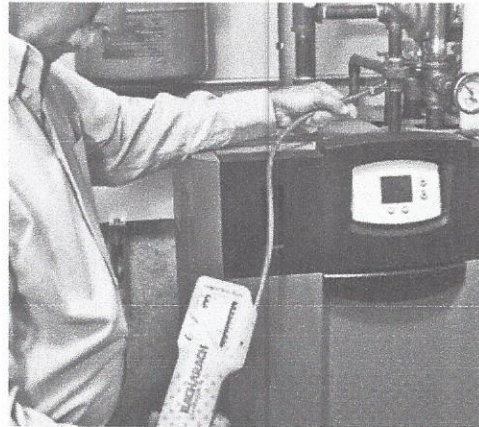
Vaporizes into gases when container pressure drops

IMPORTANT CHARACTERISTICS OF LP-GAS

- Tasteless, colorless, and odorless.
- Will burn when mixed with the proper amount of air.
- Can be solid, liquid, or vapor.
- Stored and transported as a liquid under pressure and readily vaporizes into gas when the pressure in the container drops.
- Expands when heated.
- Readily vaporizes and expands when released to the atmosphere.
- Not toxic, but presents an asphyxiation hazard if inhaled in a vapor state.

Specific Gravity

- Specific gravity helps you compare the weights of propane liquid and vapor which is critical when locating the source of a leak.

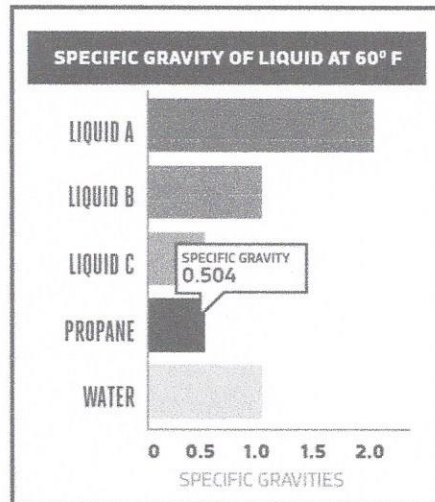


SPECIFIC GRAVITY

One of the most common ways to calculate and compare the weights of liquids and vapors is to use a value called specific gravity.

Understanding the weight of propane and how it compares with the weights of other liquids will help you know where to look for gases if they leak.

Specific Gravity of Liquids



SPECIFIC GRAVITY OF LIQUIDS

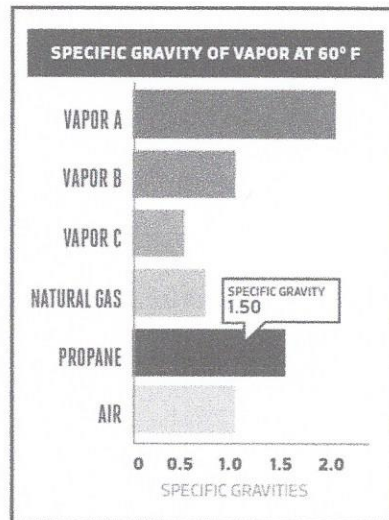
You calculate the specific gravity of a liquid by comparing it to water.

Examples:

- If the specific gravity of a liquid at 60° F is 2.0, then a given volume of that liquid at 60° F is twice as heavy as the same volume of water at 60° F.
- If the specific gravity of a liquid at 60° F is 1.0, then a given volume of that liquid at 60° F weighs the same as a volume of water at 60° F.
- If the specific gravity of a liquid at 60° F is 0.5, then a given volume of that liquid at 60° F weighs half as much as a volume of water at 60° F.

Commercial propane liquid has an average specific gravity of 0.504 at 60° F. This means that propane liquid weighs a little more than half the weight of water at 60° F.

Specific Gravity of Vapors



SPECIFIC GRAVITY OF VAPORS

You calculate the specific gravity of vapor by comparing it to air.

Examples:

- If the specific gravity of a vapor at 60° F is 2.0, then a given volume of that vapor at 60° F weighs twice as much as the same volume of air at 60° F.
- If the specific gravity of a vapor at 60° F is 1.0, then a given volume of that vapor at 60° F weighs the same as a volume of air at 60° F.
- If the specific gravity of a vapor at 60° F is .5, then a given volume of that vapor at 60° F weighs half as much as the same volume of air at 60° F.

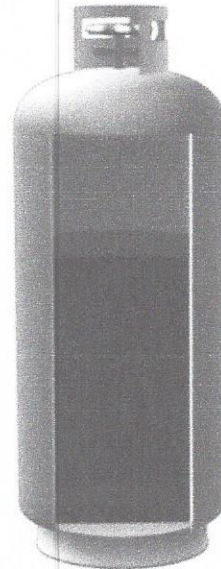
Commercial propane vapor has an average specific gravity of 1.50 at 60° F. This means that propane vapor weighs 1½ times the weight of air at 60° F.

Natural gas has a specific gravity of approximately 0.60. This means that natural gas is lighter than air (air being 1.0).

Pressure and Temperature Effects on Propane

Propane's volume, pressure, and physical state (liquid or vapor) depend on:

- How it is stored.
- The temperature of the surrounding environment.

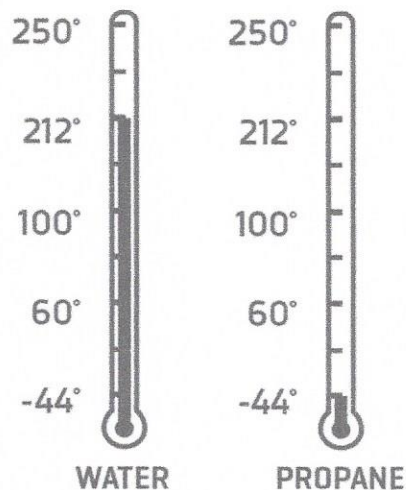


PRESSURE AND TEMPERATURE EFFECTS ON PROPANE

These three areas relate to the effects of pressure and temperature on propane:

- The effect of heat on liquids.
- Liquids and boiling points.
- Storing liquids above their atmospheric boiling points in a closed container.

Boiling Point of Propane

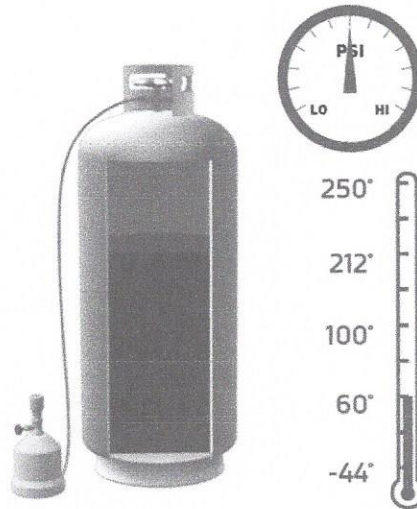


BOILING POINT OF PROPANE

Like water, propane has a boiling point at which it changes from liquid to vapor. However, the boiling point of propane is so low, -44° F, that it will boil at normal temperatures most anywhere on earth. Therefore, you usually don't need to apply an extra heat source to propane to make it boil. The heat in the air around us is more than enough.

Remember, if propane were kept at a temperature below its normal boiling point, -44° F, it would remain a liquid and could be stored in an open container.

Temperature and Pressure Balance



TEMPERATURE AND PRESSURE BALANCE

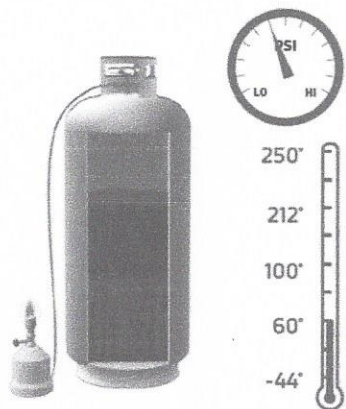
Propane is affected by heat and pressure in much the same way as water.

The figure on the slide shows propane liquid in a cylinder at a temperature of 60° F. At atmospheric pressure, the boiling point of propane is -44° F. At any temperature below that, a pool of propane will remain in liquid form, because its vapor pressure is less than atmospheric. At temperatures above -44° F, the vapor pressure of propane is greater than atmospheric pressure, therefore the liquid will vaporize.

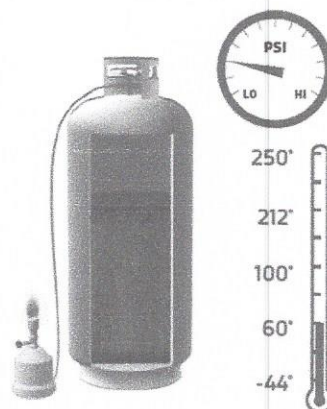
In this case, when the propane liquid was pumped into the cylinder it began to boil and pressurize the vapor space of the cylinder. Once the pressure reached 102 psig, the pressure in the container and the vapor pressure of propane at 60° F were equal, and the boiling stopped.

Outside temperature also affects the vapor pressure inside the container.

Propane Boiling Action: Valve Opened



As long as the demand for vapor remains, the propane will continue to boil, supplying fuel to the burner.



If the valve on an appliance is opened more, then the demand for propane vapor is increased and the boiling rate will also increase.

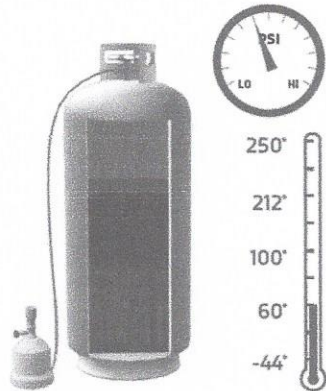
PROPANE BOILING ACTION: VALVE OPENED

If the valve on a cylinder (or appliance) is opened, propane vapor will flow to the burner, and the demand for gas vapor will immediately cause a slight drop in pressure inside the cylinder. This upsets the balance and will cause the propane to begin boiling off vapor to replace the vapor going to the burner.

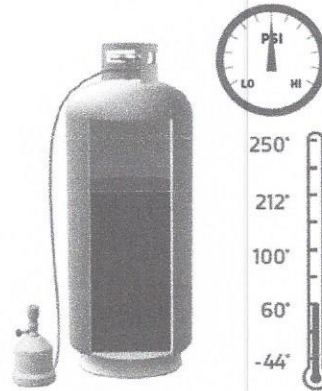
As long as the demand for vapor remains, the propane will continue to boil, supplying fuel to the burner.

If the valve on an appliance is opened more, then the demand for propane vapor is increased and the boiling rate will also increase. This same action will occur in a customer's gas system, where the tank or cylinder containing liquid propane boils off gas vapor to provide fuel to appliances.

Propane Boiling Action: Valve Closed



The boiling will slow down as the pressure in the vapor space increases to that balance point.



The boiling will eventually stop as the balance is reached.

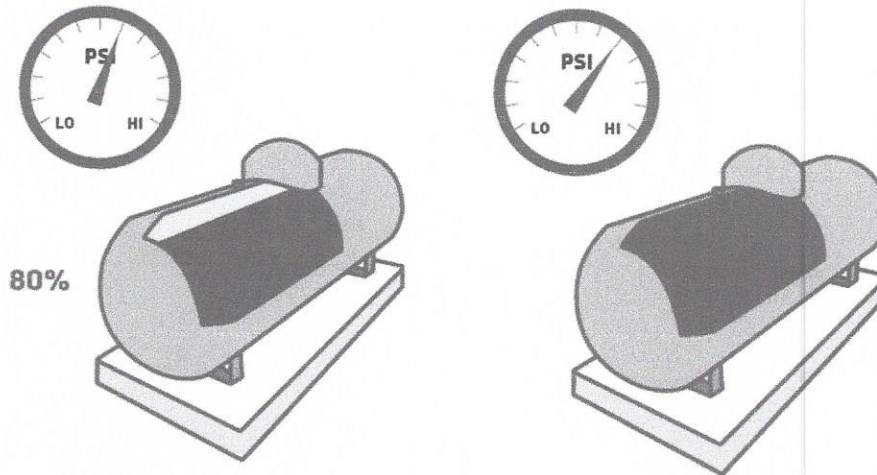
PROPANE BOILING ACTION: VALVE CLOSED

When the valve on the appliance is closed, the propane will stop flowing and return to its balance point.

The boiling will slow down as the pressure in the vapor space increases to that balance point. The boiling will eventually stop as the balance is reached.

Except for their boiling points, propane is a lot like water.

Effects of Pressure and Temperature: Product Expansion



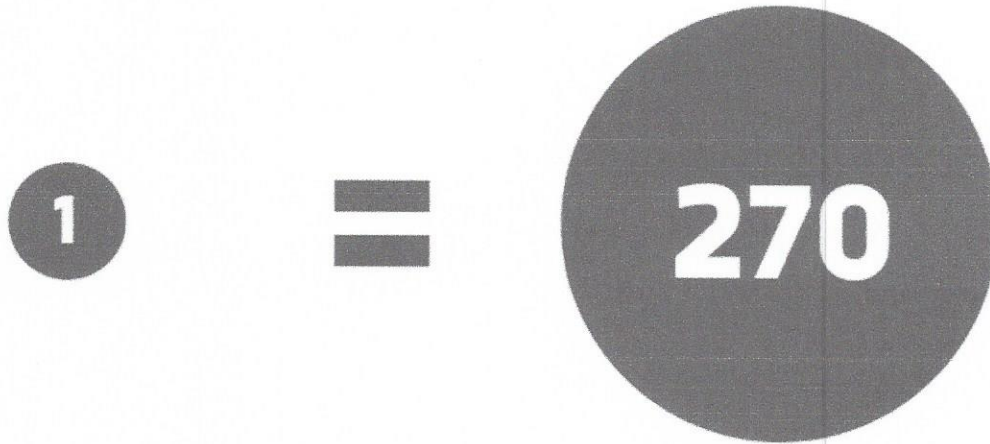
EFFECTS OF PRESSURE AND TEMPERATURE: PRODUCT EXPANSION

A propane container absorbs heat directly from the surrounding air. Hot days, cool nights, rain, and snow are just a few of the many factors that can affect the temperature of the propane liquid, which will cause changes in vapor pressure. Propane liquid can increase more than 50 pounds of pressure or more in the course of a day, without an appliance operating.

Containers are generally filled to about 80% of their capacity to account for effects of pressure and temperature.

Propane liquid expands in volume nearly 17 times greater than water even when they are exposed to the same increase in temperature. A propane container that is filled beyond the fixed maximum liquid level gauge may be at risk for an unintended propane release.

Effects of Pressure and Temperature: Additional Information



1 CUBIC FT OF PROPANE LIQUID

270 CUBIC FT OF PROPANE VAPOR

EFFECTS OF PRESSURE AND TEMPERATURE: ADDITIONAL INFORMATION

Every propane container is equipped with at least one pressure relief valve. If the pressure inside the container becomes too high, then the relief valve discharges vapor and reduces the pressure to a safe level.

A small volume of liquid boils off into a large volume of propane vapor. For example, one cubic foot of propane liquid will boil off into approximately 270 cubic feet of vapor. As a result, a leak in any propane container, large or small, can easily lead to a flammable mixture of propane and air.

Gas Leaks

If you suspect a gas leak:

- No flames or sparks!
- Leave the area immediately!
- Shut off the gas.
- Report the leak.
- Do not return to the building.
- Get your system checked.

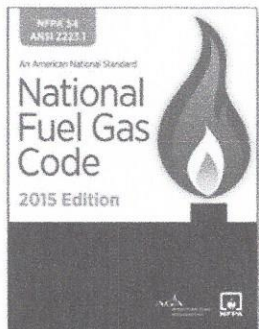


GAS LEAKS

If you smell gas or suspect a gas leak:

- **NO FLAMES OR SPARKS!** Immediately put out all smoking materials and other open flames. Do not operate lights, appliances, telephones, or cell phones. Flames or sparks from these sources can trigger an explosion or a fire.
- **LEAVE THE AREA IMMEDIATELY!** Get everyone out of the home or building or area where you suspect gas is leaking.
- **SHUT OFF THE GAS.** Turn off the main gas supply valve on the propane tank if it is safe to do so. To close the valve, turn it to the right (clockwise).
- **REPORT THE LEAK.** From a neighbor's home or other nearby building away from the gas leak, call the propane retailer right away. If you can't reach the propane retailer, call 911 or the local fire department.
- **DO NOT RETURN TO THE BUILDING OR AREA.** Until the propane retailer determines that it is safe to do so.
- **GET YOUR SYSTEM CHECKED.** Before you attempt to use any of the propane appliances, appropriate personnel must check the entire system to ensure that it is leak-free.

Gas Service Interruptions



NOTE: Always follow your company's procedures when responding to service calls.

GAS SERVICE INTERRUPTIONS AND RELATED FACTORS

Any time a gas distribution system loses gas pressure, a service interruption occurs.

Without adequate gas pressure, appliance pilot lights could go out and if the safety device doesn't function properly then a potentially unsafe condition may exist.

Therefore, it is very important that all gas service interruptions be handled properly.

If you interrupt the gas service and cause a loss of pressure to the piping system, you will need to conduct a leak check according to your company policy. If you need assistance with doing so or with restoring the gas service, contact the propane supplier for assistance.

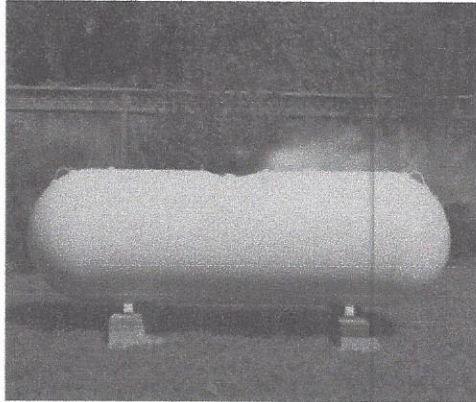
Resources to support an investigation and response to a gas service interruption include:

- NFPA 54
- State and local guidelines

Uncontrolled Release of Propane

Uncontrolled release of propane = one that cannot be readily shut off.

- Open valve.
- Open/damaged container component.
- Piping failure.
- Container breach.



UNCONTROLLED RELEASE OF PROPANE

An uncontrolled release of propane liquid or vapor could lead to an explosion, fire, or other emergency situation.

A propane-related emergency can occur anywhere propane is present; for example, at a residence, business, bulk plant, or en route to a location.

What To Do In An Emergency

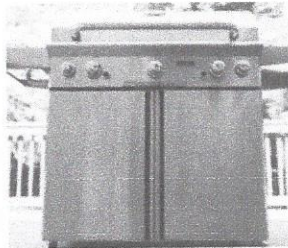
Evacuate the area immediately.



Be aware of surroundings.



Call for help.



WHAT TO DO IN AN EMERGENCY

Evacuate the area immediately.

- Remain calm
- Leave immediately
- Evacuate to a safe distance from spill or lead – at least 330 ft away in all directions
- Stay upwind

Be aware of surroundings.

When evacuating, if you can do so safely, try to:

- Identify the source of the leak.
- Check for sources of ignition and shut them off if possible.
- Note the wind direction.
- Try to collect other technical information, such as the location and type of container involved, the amount of material present, and the location of shutoff valves.

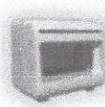
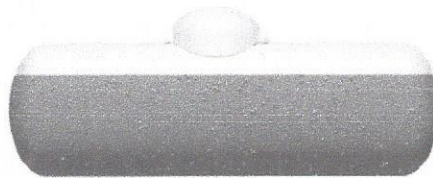
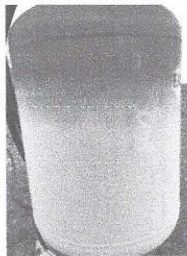
Call for help.

When you call 911, provide the following information:

- Your name.
- Your company's name.
- The address of the emergency location.
- Your contact information.
- A brief summary of the emergency.

Vaporization and Container Sizing

- Vaporization rate = amount of vapor a container can produce during a period of operation.



VAPORIZATION AND CONTAINER SIZING

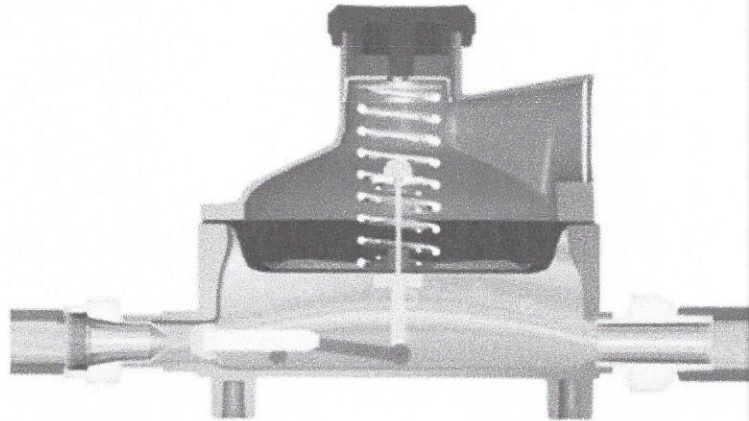
Vaporization rate = The amount of vapor that a container can produce during a period of operation.

Small cylinders have a lower vaporization rate than a larger container. When a container is sized for vapor service, the goal is to ensure the vaporization rate of the container is greater than the demand for propane.

If you find a propane container that is covered in frost or ice, you will most likely find the gas pressure dropping inside. The frost and ice forming on the walls of the container is a sign that the container may not be properly sized for the load.

Purpose of a Regulator

- Regulators control the flow of propane in the vapor distribution system.



PURPOSE OF A REGULATOR

Regulators control the flow of propane in the vapor distribution system and deliver propane vapor through the piping system to the appliances at the required operating (or delivery) pressures.

Regulators:

- Compensate for changes in container pressure and demand.
- Deliver a steady flow of propane to appliances.

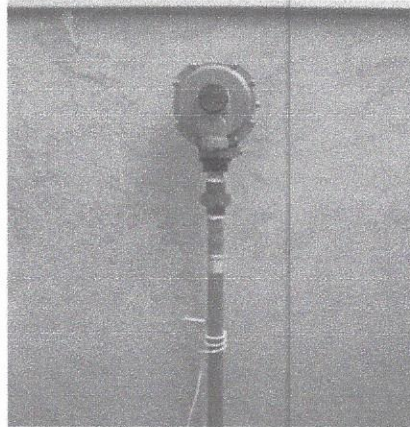
A regulator needs to satisfy a downstream gas demand while maintaining the downstream system pressures within acceptable limits. When gas demand is low, the regulator restricts the flow and the flow rate decreases.

Regulator Sizing and Selection

First-stage regulator



Second-stage regulator



REGULATOR SIZING AND SELECTION

If a regulator is undersized for the total system demand, the gas pressure will be too low when the appliances operate at full capacity.

You may find you have low gas pressure at the appliance inlet after you have added a new appliance to an existing gas piping system. If you check the gas pressure at the outlet of the final stage regulator (second stage for example) with the appliances operating and the pressure is less than 11" of water column (w.c.), then the regulator may need a simple adjustment. If that isn't the issue, then the problem is most likely upstream, the regulator is not working properly, or it is undersized.

If you find a problem with the regulator or anything upstream of it, you should contact the propane supplier for assistance. If the pressure at the second stage regulator is 11" w.c. while the appliance is operating, then the regulator and everything upstream is working properly and you should verify the size of the gas piping leading to the appliances.

Sizing Gas Piping

TABLE 6.2(b) Schedule 40 Metallic Pipe

													Gas: Natural	
													Inlet Pressure: Less than 2 psi	
													Pressure Drop: 0.5 in. w.c.	
													Specific Gravity: 0.60	
Pipe Size (in.)														
Nominal:	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	81	170	320	657	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	65	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,700	95,700	152,000
70	60	126	237	486	728	1,400	2,230	3,950	8,050	14,600	23,600	48,500	88,100	139,000
80	56	117	220	452	677	1,300	2,080	3,670	7,490	13,600	22,000	45,100	81,900	130,000

SIZING GAS PIPING

It's important to verify that the size of the piping will be able to supply the correct amount of pressure to the appliances connected to the system. If the correct pressure is not supplied at the appliance inlet with the appliance operating, you may encounter service problems such as improper combustion or appliance malfunction. Improper combustion may result in a potentially hazardous condition such as the formation of soot and the likelihood of producing carbon monoxide.

The differences between gas piping used with natural gas appliances and piping used with propane appliances are the actual size and gas pressure supplied to them. For low pressure gas piping systems, propane piping systems are generally smaller in diameter than natural gas piping systems. This is because the gas pressure for propane is generally higher than natural gas piping systems.

The table on the slide shows the piping size requirements for natural gas. The specific gravity for propane is different than for natural gas. This difference, coupled with the actual pressure differences, will generally result in a smaller diameter pipe for propane systems.

Sizing Gas Piping (cont'd)

TABLE 6.3(d) Schedule 40 Metallic Pipe

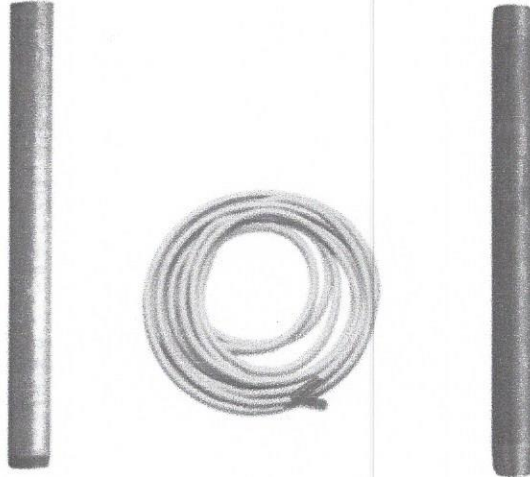
				Gas: Undiluted Propane					
				Inlet Pressure: 11.0 in. w.c.					
				Pressure Drop: 0.5 in. w.c.					
				Specific Gravity: 1.50					
INTENDED USE: Pipe Sizing Between Single- or Second-Stage (Low-Pressure) Regulator and Appliance.									
	Pipe Size (in.)								
Nominal Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	291	608	1,150	2,350	3,520	6,790	10,800	19,100	39,000
20	200	418	787	1,620	2,420	4,660	7,430	13,100	26,800
30	160	336	632	1,300	1,940	3,750	5,970	10,600	21,500
40	137	287	541	1,110	1,660	3,210	5,110	9,030	18,400
50	122	255	480	985	1,480	2,840	4,530	8,000	16,300
60	110	231	434	892	1,340	2,570	4,100	7,250	14,800
80	101	212	400	821	1,230	2,370	3,770	6,670	13,600
100	94	197	372	763	1,140	2,200	3,510	6,210	12,700

SIZING GAS PIPING (cont'd)

This table shows the piping size requirements for propane.

Identifying Problems with Pipe Sizing

- One way to identify when a gas piping system is not sized properly is to conduct a system flow pressure and lock up test.



IDENTIFYING PROBLEMS WITH PIPE SIZING

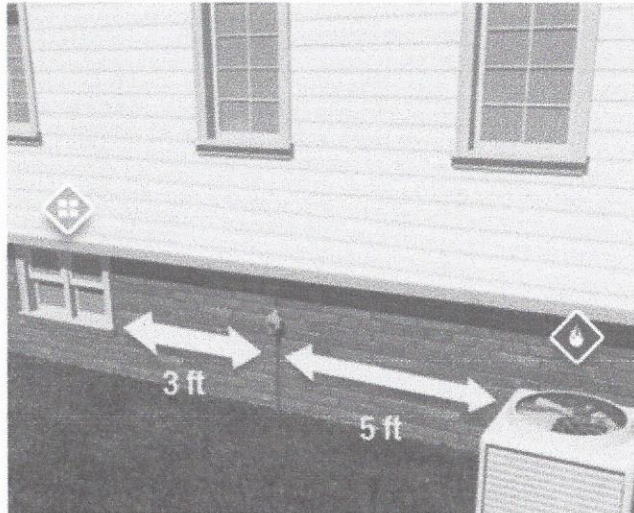
If the gas pressure is low at the appliance during operation, you should verify if the final stage regulator is supplying the correct pressure.

If the pressure at the regulator is correct, but too low at the appliance, this would indicate a pipe sizing issue.

If the pressure is too low at the outlet of the final stage regulator even after adjusting it, then the problem is with one of the following:

- The first stage regulator located at the storage tank.
- The underground gas piping.
- A defect in the second-stage regulator.
- Container sizing.

Location of Gas Piping Stub Out



LOCATION OF GAS PIPING STUB OUT

You may need to make decisions about where appliance sidewall vent terminations, A/C units, and piping stubs will penetrate the building wall. Choosing the right location for these things can have an effect on the propane container and regulator location.

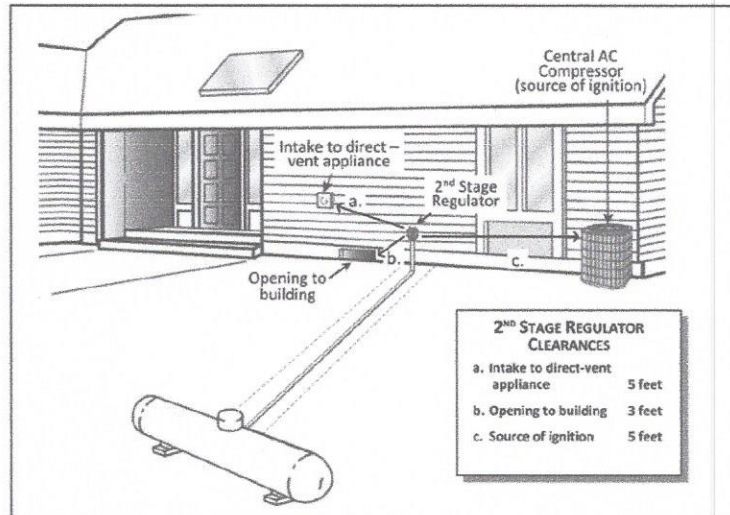
For example, if the gas piping stub out is installed right next to an appliance sidewall direct vent termination and air intake, the gas supplier would need to install a second-stage regulator at the gas pipe stub. However, because NFPA 54 code requires the regulator vent to be located a minimum of five feet in any direction from a direct vent air

intake, the parties involved would have only two options:

1. Extend the gas piping down the outside of the building wall five feet from the air intake of the appliance and install the regulator at that location (provided the underground gas line and ditch had not already been installed).
2. Install the regulator on the pipe stub right next to the air intake and then extend the regulator vent down the wall to get it a minimum of five feet away from the air intake. Look at the image below to see what this looks like on the outside of the

building wall.

Location of Gas Piping Stub Out (cont'd)



LOCATION OF GAS PIPING STUB OUT (CONT'D)

As shown on the slide, a better solution for the customer would be to stub the gas pipe out through the wall a minimum of five feet away from the air intake and exhaust termination and have the underground line and ditch come to the pipe stub.

That way the regulator can be installed at the pipe stub and be in compliance with the NFPA code requirements.

Additionally, the customer will be much happier with a professional looking gas system installation.

Location of Gas Piping Stub Out (cont'd)



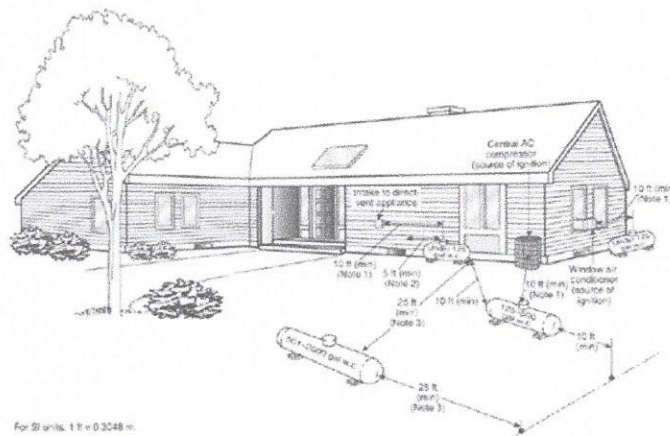
LOCATION OF GAS PIPING STUB OUT (CONT'D)

If a small propane container is needed and will be positioned up near the building wall, stub the pipe out right near it (provided proper code requirements can be met).

That way, the gas piping will continue into the propane container and a single integral two-stage regulator is generally used inside the container.

As you plan the location of the underground gas line and required ditch, be mindful of the code requirements. Ideally, a ditch is dug and a gas line is installed in direct line with the piping stub out. This stub out location should not impact the location of the appliance vent or installation of the air conditioning condenser.

Location of Containers and Sources of Ignition



LOCATION OF CONTAINERS

When planning the installation of HVAC equipment, you should consider specific distance requirements of propane containers from appliance vents, air intakes, mechanical air intakes, sources of ignition, and building openings.

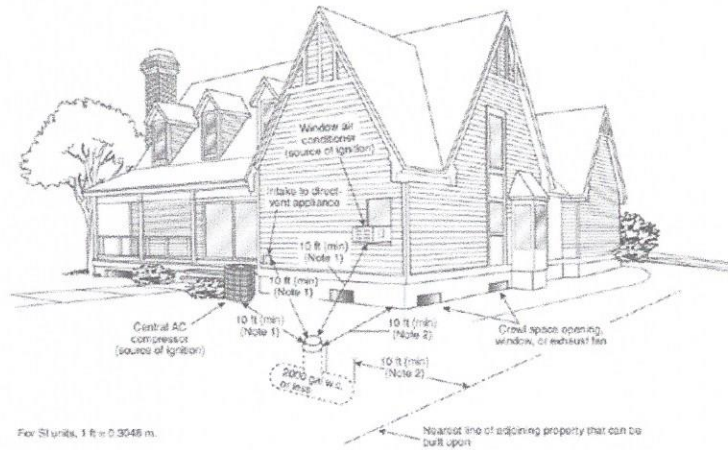
SOURCES OF IGNITION

NFPA 58 code requires a propane container be located 10 feet in any direction from a source of ignition such as an air conditioning condenser.

An air intake of a direct vent appliance or a mechanical air intake must also be located at least 10 feet from a propane container. These propane containers are generally filled on site and during the process of filling them a small amount of propane vapor is bled into the air.

These minimum distance code requirements are to help prevent the ignition of propane vapor while filling or should an overpressure event take place.

Location of Containers and Sources of Ignition (cont'd)

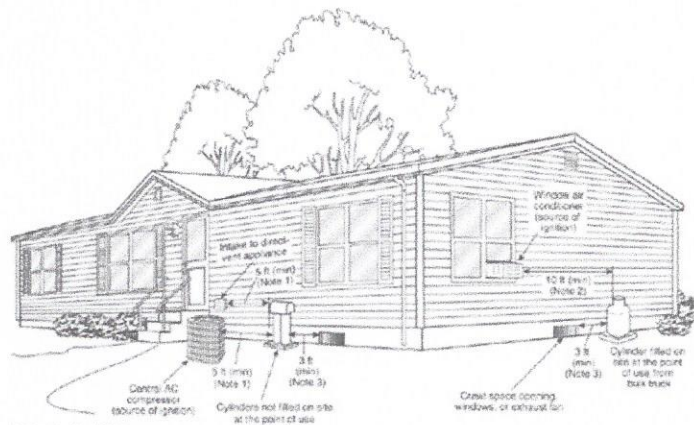


For SI units, 1 ft = 0.3048 m.

Notes:

- (1) The relief valve, filling connection, and fixed maximum liquid level gauge vent connection at the container must be at least 10 ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 6.3.4.4.
- (2) No part of an underground container can be less than 10 ft from an important building or line of adjoining property that can be built upon. Refer to 6.3.2.3.

Building Openings



For SI units, 1 ft = 0.3048 m.

Notes:

- (1) 5-ft minimum from relief valve in any direction away from any interior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to Table 6.3.4.3.
- (2) If the cylinder is filled on site at the point of use from a bulk tank, the filling connection and vent valve must be at least 10 ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 6.3.4.4.
- (3) Refer to 6.3.4.3.

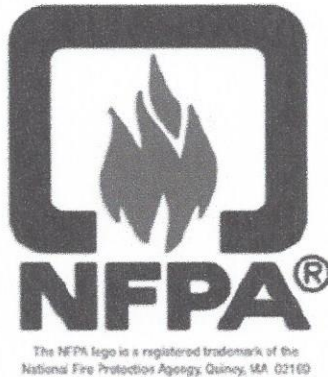
BUILDING OPENINGS

NFPA 58 code requires a propane container installed near a building opening be located a minimum of three feet away from the opening for a DOT cylinder that is filled on site and five feet minimum for an ASME of 125 gallons or less.

Any propane container greater than 125 gallon capacity must be located a minimum of 10 feet from an important building which would then meet the building opening distance requirement.

Location of Regulators and Sources of Ignition

- NFPA 58 contains code requirements for location of regulators and distances from sources of ignition.



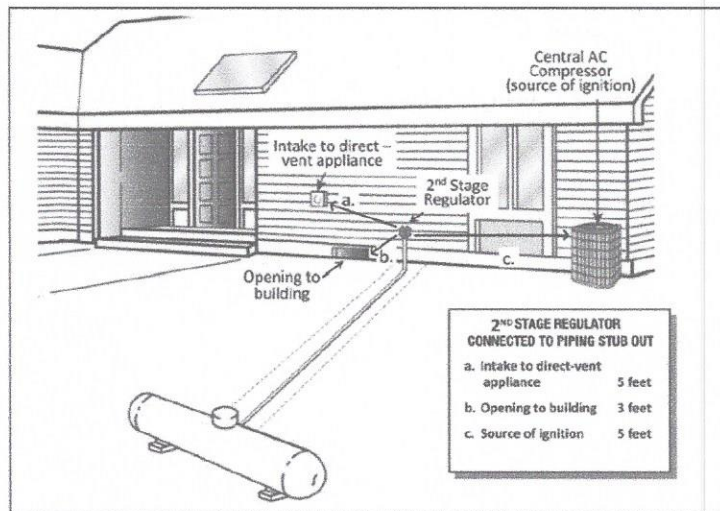
LOCATION OF REGULATORS

NFPA 58 contains specific code requirements that indicate the proper distances from a gas regulator to a source of ignition, direct vent air intake or mechanical air intake, as well as building openings.

SOURCES OF IGNITION

NFPA 58 requires a regulator vent be located a minimum of five feet in any direction from a source of ignition, air intake of a direct vent appliance termination, or a mechanical air intake.

Building Openings

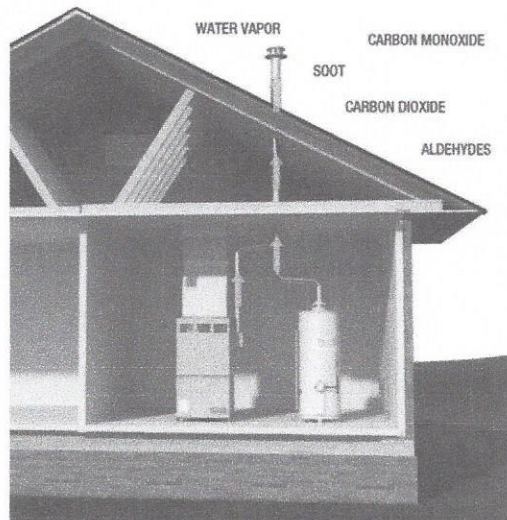


BUILDING OPENINGS

The regulator pressure relief/vent discharge must be located no less than three feet horizontally away from building openings that are below the level of discharge.

Note: If these distances cannot be met, then the regulator vent discharge must have a remote vent installed to pipe it away from either a source of ignition, direct vent air intake, mechanical air intake, or a building opening.

Importance of Proper Venting



IMPORTANCE OF PROPER VENTING

Ensure that all appliances are vented properly to allow the products of combustion to exit the building or structure.

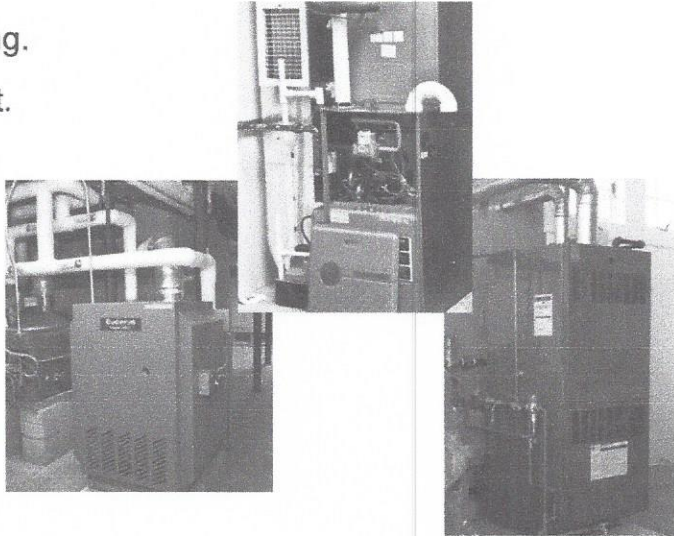
The purpose of the venting system is to move the products of combustion out of the structure. Products of combustion are water vapor and carbon dioxide; incomplete combustion can produce carbon monoxide, aldehydes, soot, and excessive water vapor.

A properly designed and installed appliance venting system:

- Directs combustion gases out of the structure.
- Protects a building structure from fire hazards due to overheating walls or other surfaces.
- Prevents damage to walls and furnishings due to the escape and condensation of combustion gases.
- Provides for good air flow and adequate oxygen supply for the appliance and the building occupants.

Vented Appliances Categories

- **Category I:** Natural draft venting.
- **Category II:** Mostly do not exist.
- **Category III:** Sidewall vented, non-condensing.
- **Category IV:** High-efficiency, condensing.



VENTED APPLIANCES CATEGORIES

Venting systems operate either as a negative draft system or as a positive pressure vent system. The vent category specifies whether the vent system operates under a negative pressure or a positive pressure, and whether it is possible for the products of combustion to condense into a liquid.

The different categories of vented appliances include:

- **Category I:** Classified based on the principle that heated gases rise, sometimes referred to as “natural draft venting.” If an appliance is equipped with a draft hood it is considered a natural draft unit with the venting system under a negative pressure and in a non-condensing state. In this type of system the products of combustion are hot enough to stay well above their dew point. A Category I vent system is typically vented with Type “B” vent materials or an interior lined masonry chimney.
- **Category II:** For the most part, do not exist because they would need to be designed for a negative draft and would be
- of the condensing type.
- **Category III:** Are typically sidewall vented, non-condensing appliances that are usually vented with stainless steel alloy pipes or other special gas venting materials. These systems are generally under a positive pressure and all joints and seams are

sealed to prevent flue gasses from leaking out. This positive pressure in the vent system is generated by a forced draft fan. Category III vent systems maintain flue gas temperatures above dew point and should not condense in the flue.

- **Category IV:** High-efficiency appliances are typically condensing-type furnaces and water boilers that have venting systems with a positive pressure, and may be terminated either horizontally or vertically. A Category IV vent system's flue products cool below their dew point, therefore, these high-efficiency systems will have significant condensation. The appliances are designed to deal with this excess condensate by providing a means to collect the condensate and channel it away from the furnace and vent system to a drain.

Temperature and Condensation

Dew point is the temperature at which gaseous products of combustion condense into liquid.

TEMPERATURE AND CONDENSATION

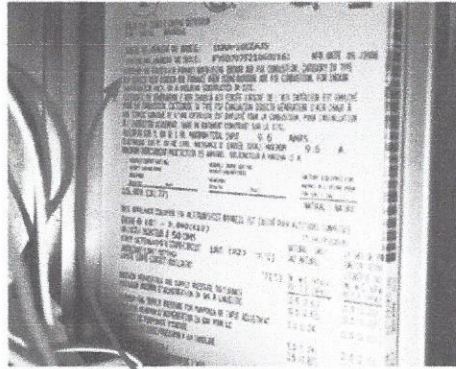
As the efficiency of an appliance goes up, the temperature of the flue gases goes down, and is then more likely to condense in the flue.

Since flue gases consist mainly of water vapor, condensing can occur when the flue products are allowed to cool below their dew point. Damage can occur to a vent system when acidic condensate accumulates on a vent layout and materials.

Although higher efficiency is desired in appliances, some appliances are designed to handle the resulting condensation and other appliances are not.

Proper Venting Materials

- Be sure to select the correct vent materials for a specific appliance category.



CAT IV Reference

PROPER VENTING MATERIALS

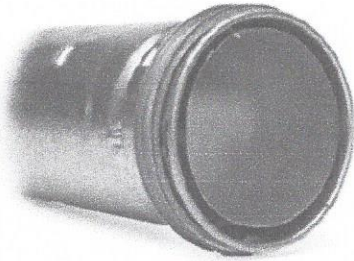
Make sure you select the right vent components for a specific appliance category. If the wrong vent material is used on an appliance it wasn't designed for, you could potentially have an unsafe appliance installation.

For example, if PVC venting material was utilized on a Category I appliance, the PVC may overheat and breakdown over time causing flue gas to leak into a building structure or cause a fire.

Providing Proper Clearances

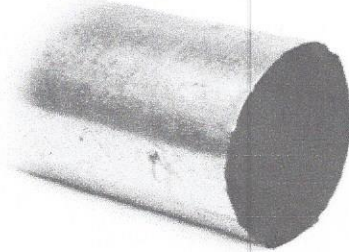
B- and L-vents

1" Clearance



Single-wall vents

6" Clearance



PROVIDING PROPER CLEARANCES

Maintaining proper clearances between an appliance venting system and combustible materials will help avoid potential hazards.

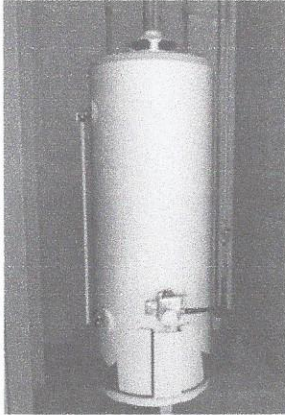
If an appliance vent is installed too close to combustible materials such as wood, the wood may overheat and could potentially catch on fire over time.

Vents should be positioned away from floors, ceilings, and combustible material. Most natural draft residential and light commercial gas appliances require a clearance of 1" for B- and L-vents and a 6" clearance for single-wall vents.

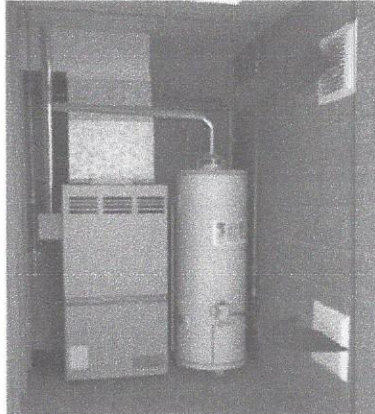
The reason for the greater clearance requirement for a single-wall metal vent pipe is because it gives off a higher temperature than a double-wall vent pipe such as type B- or L-vents .

Combustion and Ventilation Air

Air for combustion



Ventilation air



COMBUSTION AND VENTILATION AIR

For gas appliances to burn properly, they must have adequate combustion air. For natural draft appliances

to vent properly, adequate dilution air is necessary. Direct vent appliances may get combustion air directly from the

outside, however, that doesn't mean that direct vent appliances don't need ventilation air.

AIR FOR COMBUSTION

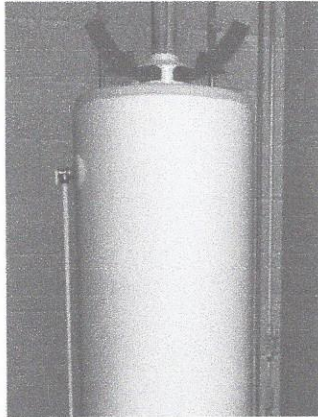
"Air for combustion" is the air needed at the gas burner to support proper combustion. If gas appliances do not receive enough air to burn properly, combustion is incomplete. This can create a potentially hazardous condition, such as carbon monoxide build up.

VENTILATION AIR

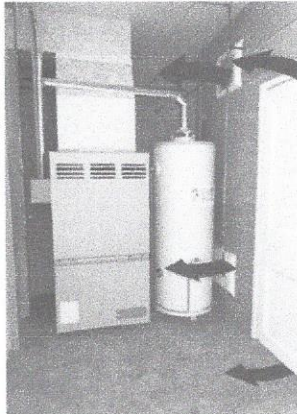
"Ventilation air" is the air needed at the gas appliance to help prevent its housing and components from overheating. Appliances located in small confined areas may get too hot if there is not enough ventilation air to keep them cool.

Combustion and Ventilation Air (cont'd)

Dilution air



Makeup air



DILUTION AIR

“Dilution air” is the air needed at the appliance draft hood to mix with flue gases on all natural draft appliances equipped with a draft hood. Without the proper amount of dilution air supplied at the draft hood, the appliance’s ability to vent the flue products to the outside may be affected.

MAKEUP AIR

“Makeup air” is the air that replaces air used in a space. Once air is burned and the flue products are vented outside, more air must come into the space to “make up” or replace the air leaving the room. The space must have access to makeup air to support combustion, assist with venting, and help keep the appliances from overheating.

- One of the most important appliance location considerations is its safe distance from combustible materials.



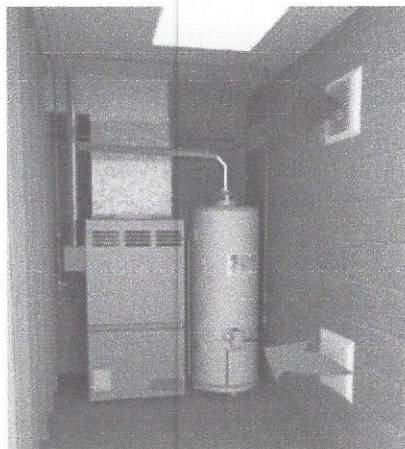
Some common appliance clearance code requirements include:

- To determine minimum clearances to combustible materials for listed, unvented appliances, refer to the appliance name plate and the manufacturer's installation instructions.
- Appliances should have enough clearance from combustible materials.
- Room heaters must be placed away from curtains and furniture and be located away from walkways, doors, and direct contact with walls and floors.
- Appliances designed and marked "For Use in Noncombustible Fireplace Only" can only be installed as such and nowhere else.
- Name plates are required when installing a listed appliance.

Appliance Location Code Requirements

NFPA 54 includes installation requirements specific to:

- Central heating boilers and furnaces.
- Room heaters.
- Gas fireplaces.
- Pool heaters.
- Wall furnaces.
- Outdoor cooking appliances.
- Open flame decorative appliances.
- Many others.



APPLIANCE LOCATION CODE REQUIREMENTS

Before installing any gas appliance, make sure you are familiar with the requirements on the slide as well as the appliance manufacturer's installation instructions.

Install an appliance in a residential garage so that all burners and burner ignition devices are at least 18" above the floor, unless an appliance is listed as being Flammable Vapor Ignition Resistant (FVIR). The reason for this is if gasoline vapors spill inside a residential garage, the vapors will typically stay low to the floor.

If you want to install a water heater in a bedroom or a bathroom, the water heater must be installed inside a closet that has a weather-stripped door with no openings and is equipped with a self-closing device, or the water heater must be of the direct vent type.

Do not locate an appliance where flammable liquids are used, handled, or stored, unless the appliance reduces the possibility of igniting flammable vapors, like a FVIR water heater.

Check the Name Plate

- Check the name plate on each dedicated appliance to be sure it says the appliance is to be used with “propane” or “LP-gas.”



CHECK THE NAME PLATE

It is vital to your customers' safety that you check to ensure all appliances are designed and converted to operate using propane. You must check this prior to hooking up any gas

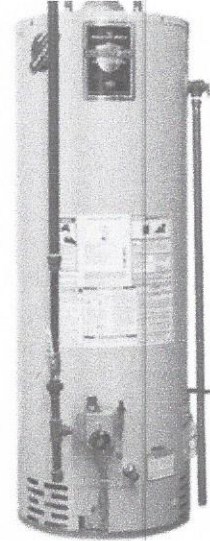
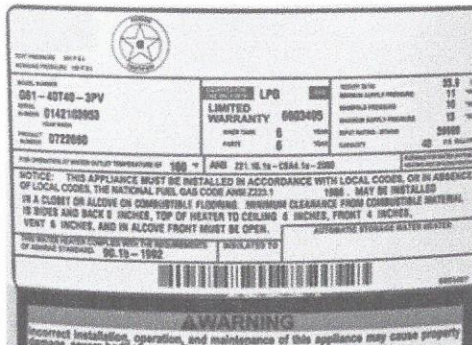
appliance and placing it into service.

With convertible appliances, ensure the appliance is marked to indicate it has been converted to LP-gas. A converted appliance should have a fuel conversion tag attached to it

indicating it has been converted.

Dedicated Appliances

- Appliance designed by its manufacturer to operate with only one fuel gas.



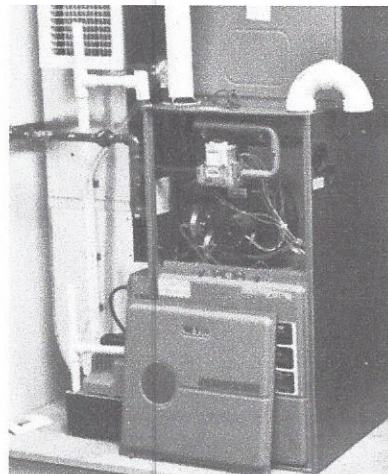
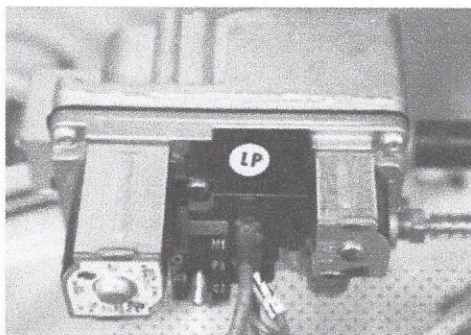
DEDICATED APPLIANCES

A “dedicated” appliance is an appliance that is designed by its manufacturer to operate with only one fuel gas, such as propane or natural gas. An example of a dedicated appliance is a standard, tank-type water heater or a gas log.

You should never attempt to convert a dedicated natural gas appliance to propane gas or attempt to convert a dedicated propane gas appliance to natural gas.

Convertible Appliances

- Appliances designed to be used with either propane or natural gas.



CONVERTIBLE APPLIANCES

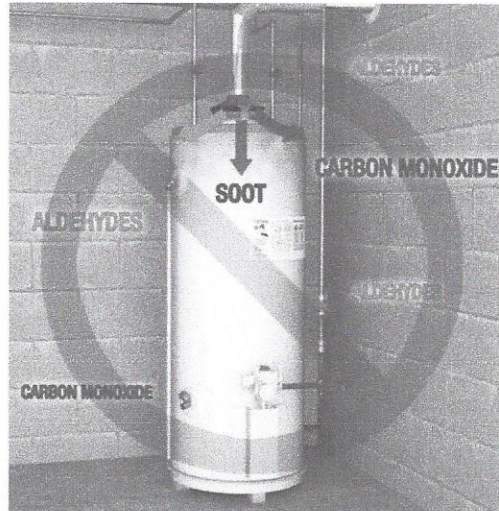
Convertible appliances are designed to be used with either propane or natural gas. Typical convertible gas appliances include ranges, dryers, furnaces, and boilers.

To ensure that an appliance has been converted for use with propane, look at the appliance name plate and look for a conversion sticker with the letters "P," "LP," or the word "propane" on the appliance gas control or regulator.

Most convertible gas appliances require the gas orifice be replaced with an orifice that is compatible with the new gas.

Do not attempt to convert an appliance until you have been trained to do so.

High Altitude Combustion and Operation



HIGH ALTITUDE COMBUSTION

Combustion is the same regardless of altitude. But at higher elevations the atmospheric pressure is less, the air is less dense, and a cubic foot of air does not have as much oxygen as the same volume measured at sea level. This means that a greater volume of harmful products of combustion will be given off if a burner is not properly adjusted for high altitude operation.

If an appliance does not have the capacity to handle the normal volume of combustion products at a low altitude, it will not properly handle an increased volume at a high altitude resulting in improper combustion.

HIGH ALTITUDE OPERATION

The appliance name plate on a listed appliance will contain details of its input Btu ratings and whether or not the unit is equipped for installation in a high altitude.

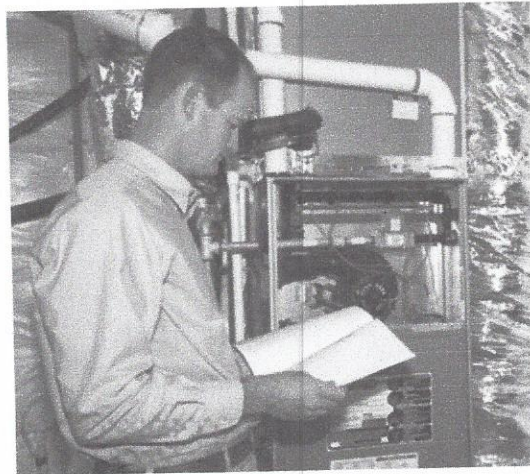
Appliances that are not designed for low and high altitude operation can produce operating problems and potentially hazardous conditions can occur if installed in the wrong location.

If an appliance designed to operate at a high altitude is installed at sea level, it will be underfired, causing the appliance to perform improperly. Inversely, if a sea level-designed appliance is installed at a high altitude, the appliance will be overfired, which could lead to excessive temperature in the appliance or vent. NFPA 54 prohibits overfiring a burner or appliance.

Converting an appliance to high altitude operation requires replacing the burner orifice with an orifice with a smaller opening sized for the derated (or lowered) Btu/hr input, and adjusting the primary air settings as directed by the manufacturer in the operating instructions.

Tagging Converted Appliances

- Some AHJ require a qualified technician to place a prescribed conversion tag on an appliance when it is converted to LP-gas.



TAGGING CONVERTED APPLIANCES

Some AHJ require a qualified technician to place a prescribed conversion tag on an appliance when it is converted to LP-gas.

Be sure that you comply with the manufacturer's specifications and any applicable local code requirements for marking or tagging converted appliances.

Metallic Pipe and Tubing

TABLE A.5.6 *Pipe, Tube, Fittings, and Joints for Natural Gas and Liquefied Petroleum Gas Applications*

<i>Pipe</i>		<i>Fitting Types</i>	<i>Joint Types</i>	<i>Other Requirements</i>
<i>Material</i>	<i>Standard</i>			
Metallic Pipe Black Steel <i>Minimum</i> <i>Schedule 40</i>	ASTM A106*	Steel Malleable Iron Steel Cast Iron ASME B16.1* Brass Bronze Special	Threaded Flanged	5.6.5, 5.6.6, 5.6.7, 5.6.8, 5.6.8.4, 7.13

METALLIC PIPE AND TUBING

Some common interior piping materials include steel and wrought-iron pipe, copper, and corrugated stainless steel tubing (CSST).

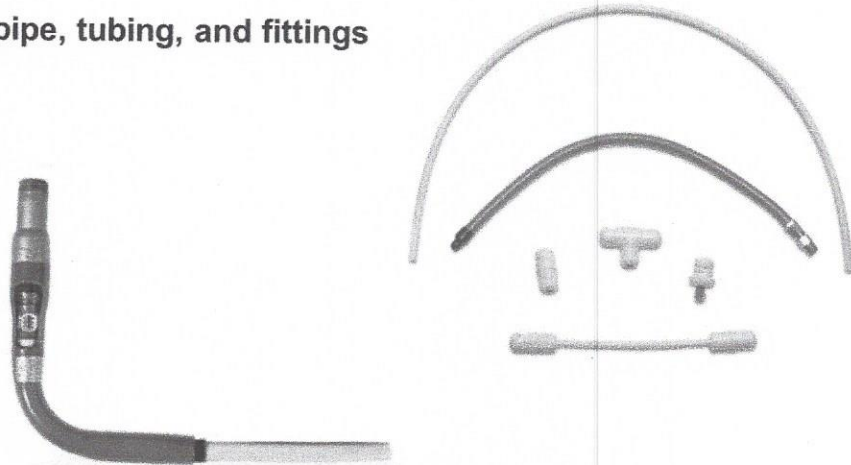
Steel and wrought-iron pipe must be at least of standard weight (schedule 40) and comply with American National Standards Institute (ANSI) or American Society for Testing and Materials (ASTM) standards.

Only use copper and brass pipe and tubing that has been approved for use with propane. Cast iron pipe cannot be used. CSST can be used only if it meets ANSI standards.

Plastic Pipe and Anodeless Riser

Polyethylene (PE) pipe, tubing, and fittings

Anodeless riser



PLASTIC PIPE AND ANODELESS RISER

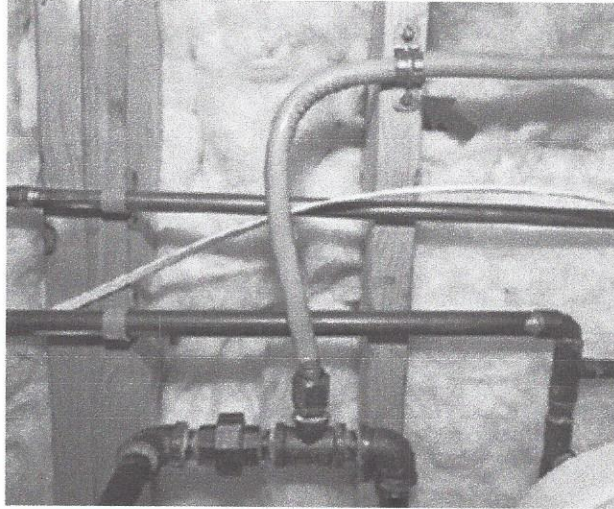
Polyethylene (PE) pipe, tubing, and fittings can only be used outdoors and underground, and never inside the building. PVC and CPVC cannot be used for gas lines.

An anodeless riser is an assembly that connects underground plastic pipe or tubing to aboveground metal pipe or tubing. Example: One-piece, factory-assembled unit with a baked-on protective coating. Because of its construction, it does not require anodes.

When anodeless risers are used, they must comply with the following:

- Factory-assembled anodeless risers must be leak tested by the manufacturer.
- Service head adapters and field-assembled anodeless risers must have installation instructions provided by the manufacturer and must be design-certified by the manufacturer to meet ASTM and CFR standards.

Piping Supports

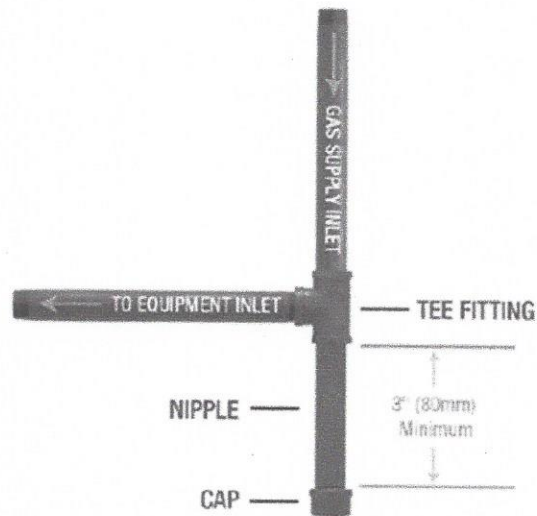


PIPING SUPPORTS

Piping supports must be anchored to prevent undue strains on connected appliances and equipment, and cannot be supported by other piping.

It must be of adequate strength and located at proper intervals to be able to support the installed piping.

Sediment Traps



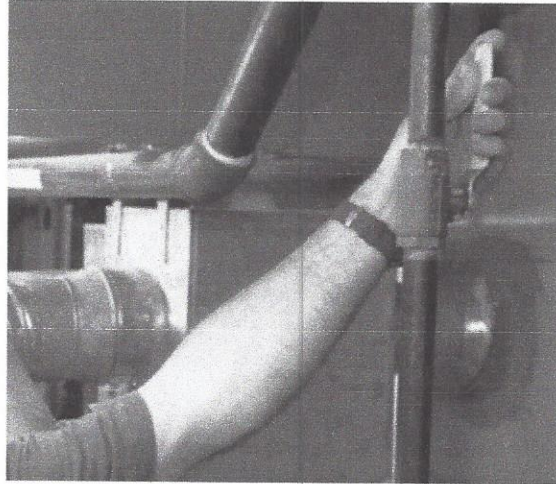
SEDIMENT TRAPS

NFPA 54 requires that a sediment trap be added when installing an automatically operated appliance that does not already contain one, otherwise a customer may not discover a damaged appliance until much later.

Manually operated appliances do not require a sediment trap, because if sediments have found their way into the controls and the appliance stops working, the customer would know immediately if the appliance needed repair.

Manual Shutoff Valve

- **Purpose:** Isolate one appliance for repair or replacement without having to turn off all other gas appliances.



MANUAL SHUTOFF VALVE

The purpose of a manual shutoff valve is to isolate one appliance for repair or replacement without having to turn off all other gas appliances. In most cases, this valve must be installed in the piping system within six feet of a single appliance and must be readily accessible.

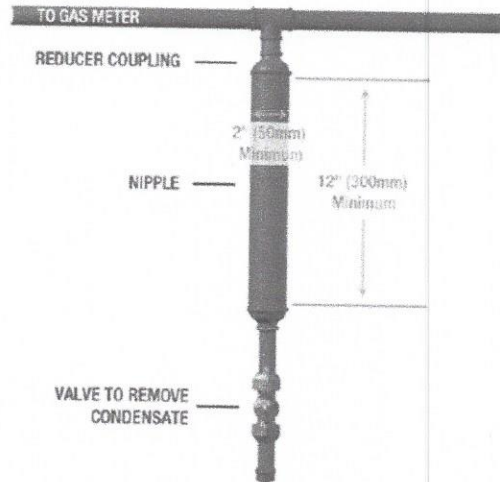
Don't confuse the manual shutoff valve with the required emergency shutoff valve located outside of the structure. On an LP-gas system, the emergency shutoff valve can be the service valve at the tank.

In most cases, the following exceptions are noted for installing manual shutoff valves if they are readily accessible and permanently identified:

- Shutoff valves serving an appliance in a vented fireplace do not have to be installed within six feet of the appliance.
- When the shutoff valve is installed in a manifold, it may be up to 50 feet away from the appliance it serves.

Drip Legs

- **Drip leg:** Device that is used to collect condensate in a wet gas system and is not a component of the appliance.



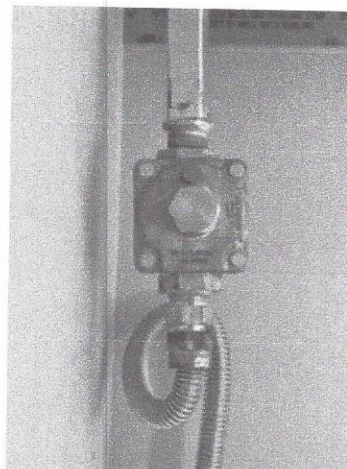
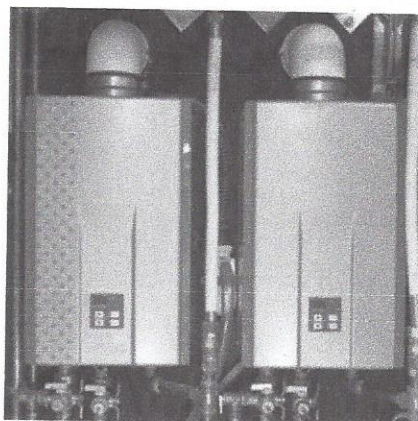
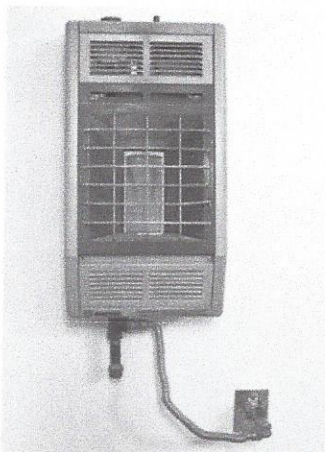
DRIP LEGS

Sediment traps are not the same as drip legs.

A drip leg is a device that is used to collect condensate in a wet gas system and is not a component of the appliance.

A propane system is not considered a wet gas system and therefore does not require a drip leg unless required by the AHJ.

Appliance Connectors



APPLIANCE CONNECTORS

Flexible connectors between a structure's rigid piping and its appliances enable you to move an appliance without breaking its connection to the rigid piping. Connectors must be corrosion free and leak free.

Connectors come in an array of materials and styles, including:

- Rigid metallic pipes and fittings.
- Semi-rigid metallic tubing and fittings.
- Standard connectors for gas appliances approved for propane service.
- Connectors for outdoor gas appliances and manufactured homes.
- Corrugated Stainless Steel Tubing (CSST).
- Listed gas hoses for outdoor use only.

APPLIANCE CONNECTOR REQUIREMENTS

Other than rigid pipes, connectors:

- Cannot be installed in an opening of an appliance housing cabinet or casing, unless the connector is protected from damage.
- Must not exceed six feet in length.

- Must not be concealed or run from one room to another or pass through wall partitions, ceilings, or floors.
- Must be protected from damage, such as stretching, kinking, and puncturing.

Other Design Requirements

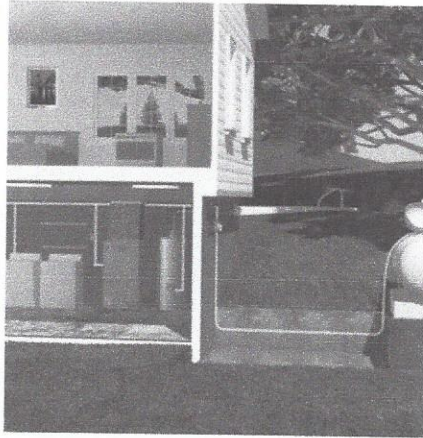


OTHER DESIGN REQUIREMENTS

- The installation of gas piping cannot cause excessive structural stresses within building components, and must have AHJ approval before any beams or joints are cut or notched.
- Residential piping cannot be used as a ground for an electrical system, and must not be located in the same conduit with electrical wiring.
- The maximum design operating pressure for piping systems located inside buildings cannot exceed five per square inch (psi) except for a limited number of circumstances which are not typically found in residential and small commercial fixed-piping installations.
- Every piping outlet, including valve outlets, must be capped or plugged if an appliance is not connected to the outlet immediately. If an appliance is to be removed for any length of time, the outlet must again be capped or plugged.
- Where a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap must be installed as close to the inlet of the equipment as practicable at the time of equipment installation.

Pressure Test Per NFPA 58

- A pressure test checks for propane leaks at the **exterior** portion of the piping.



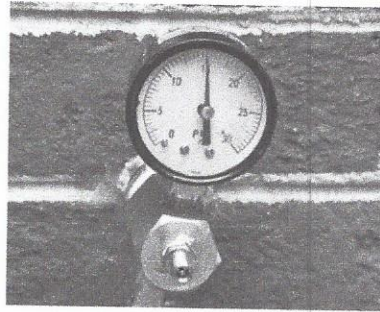
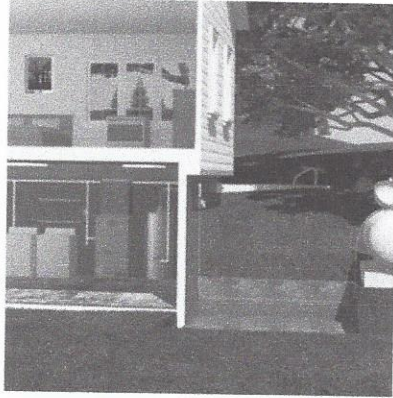
PRESSURE TEST PER NFPA 58

According to NFPA 58, a pressure test checks for propane leaks at the exterior portion of the piping only.

This pressure test is most commonly performed by applying pressure on the exterior piping to see if a leak occurs. This test must be performed between the tank and the final-stage regulator inlet on all newly installed exterior piping, including manifold tank installations. It shall be done after assembly of the exterior piping, and should be done before the trench is covered.

Pressure Test Per NFPA 54

- Pressure test applies an elevated pressure to the *interior* portion of the vapor distribution system.



PRESSURE TEST PER NFPA 54

According to NFPA 54, a pressure test applies an elevated pressure to the interior portion of the vapor distribution system. This covers the lines downstream of the outlet of an integral two-stage regulator, second-stage regulator, or meter.

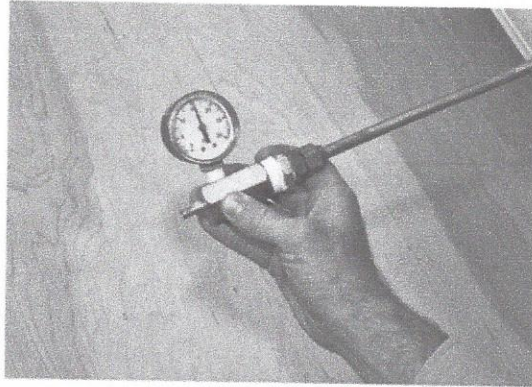
This test is performed only on newly-installed interior piping systems or segments, and on systems repaired or modified.

This test is done prior to placing the system into operation and is performed using an inert gas or air, not propane vapor.

Disconnecting or isolating each appliance is important because many appliances are not designed to withstand the amount of pressure that will be used during the pressure test.

Test Pressure

- No less than one and a half times the maximum working pressure, but not less than three pounds per square inch gauge (psig).



TEST PRESSURE

NFPA 54 requires a test pressure of no less than one and a half times the maximum working pressure for the piping section, but not less than three pounds per square inch gauge (psig).

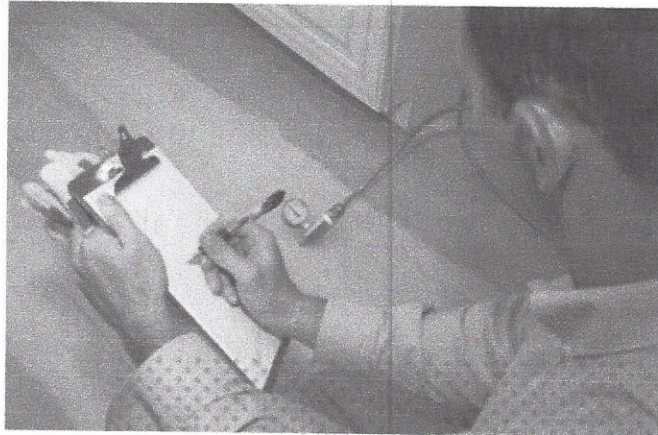
Example 1: The second-stage pipe supplying propane to an appliance has an operating pressure of approximately 11" w.c. In this situation, the test pressure must be at least three psig, and regulators, appliances, and their controls cannot be connected to the piping system during the test. Valves should not be subjected to the elevated test pressure unless the valve has been determined that the valve is designed to safely withstand the pressure.

Example 2: A piping section downstream of a 2-psi service regulator supplying a line regulator would also be tested at a minimum of three psig, which is equal to one and a half times the working pressure of the line (the outlet pressure of the 2-psi regulator).

Pressure Test Device

Gauges measure pressure in:

- Pounds per square inch (psig).
- Inches water column (w.c.) (mechanical or manometer).



PRESSURE TEST DEVICE

The source of pressure shall be isolated from the piping being tested before the pressure tests are performed.

The propane industry uses gauges that measure pressure in one of two ways:

- Pounds per square inch (psig).
- Inches water column (w.c.) (mechanical or manometer).

For pressure testing, inches w.c. gauges do not offer sufficient pressure measuring ranges and are not used in piping pressure tests.

Example: A 0-15 psig gauge should be used for a three psig pressure test, while a 0-60 (75 maximum) psig would be required for a 15 psig test.

PRESSURE TEST DURATION

NFPA 54 requires 10-minute test duration for single- family dwellings and small capacity distribution systems with less than 10 cubic ft (1,666 linear feet of 1" steel pipe) of pipe.

Additional Requirements

- Testing must be performed with air or an inert gas.
- Piping installations must be visually inspected.
- Inspection must consist of visual examination, during or after manufacturing, fabrication, assembly, or pressure tests as appropriate.
- Pressure test newly-installed branch lines.
- Test a piping system as a complete unit or in sections.
- Isolate appliances, equipment, or equipment components by disconnecting them and capping the outlet(s) if they are designed for operating pressures of less than the test pressure.

ADDITIONAL REQUIREMENTS

Additional NFPA 54 pressure test requirements include the following:

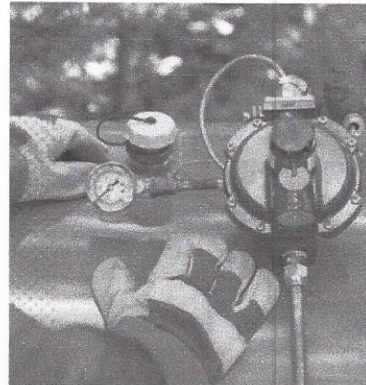
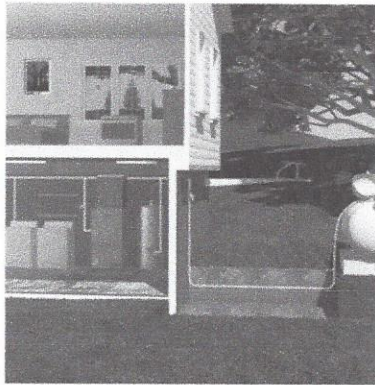
- Testing must be performed with air or an inert gas, such as nitrogen or carbon dioxide but never with oxygen or fuel gas.
- Piping installations must be visually inspected to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code prior to acceptance and initial operation.
- Inspection must consist of visual examination, during or after manufacturing, fabrication, assembly, or pressure tests as appropriate. Where repairs or additions are made following the pressure test, the affected piping must be tested. Minor repairs and additions are not required to be pressure tested provided that the work is inspected and connections are tested with a non-corrosive leak-detector fluid or other approved leak-detection method.
- Pressure test newly-installed branch lines; only the newly installed branches are required to be pressure tested. Connections between the new piping and the existing piping must be tested with a non-corrosive, leak-detector fluid or other approved leak detection method.
- Test a piping system as a complete unit or in sections. Under no circumstances can a valve in a line be used as a bulkhead between gas in one section of the piping system and a test medium in an adjacent section, unless two valves are installed in

a series with a valve “tell-tale gauge” located between these valves. A valve cannot be subjected to the test pressure unless it can be determined that the valve, including the valve closing mechanism, is designed to safely withstand the pressure.

- Isolate appliances, equipment, or equipment components by disconnecting them and capping the outlet(s) if they are designed for operating pressures of less than the test pressure.

Introduction

- Tests for propane leaks by applying pressure to the system downstream from the point of delivery.



INTRODUCTION

A required NFPA leak check tests for propane leaks by applying pressure to the system downstream from the point of delivery. It basically checks up to the outlet of the equipment or appliance shutoff valve. However, many propane marketers check the entire vapor distribution system, including the appliance connectors, and the appliance gas controls.

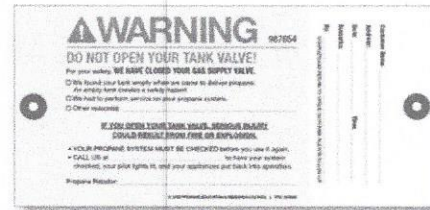
This test is normally conducted using fuel gas instead of air.

You are required to perform a leak check immediately after turning on the gas in a new vapor distribution system or when a system has been restored after an interruption of service.

Performing a Leak Check

Perform a leak check:

- Immediately after the gas is turned on into new or modified piping.
- When gas has been initially restored to a system after an interruption of service.



PERFORMING A LEAK CHECK

Typically, you should perform a leak check:

- Immediately after the gas is turned on into new or modified piping.
- When gas has been initially restored to a system after an interruption of service.

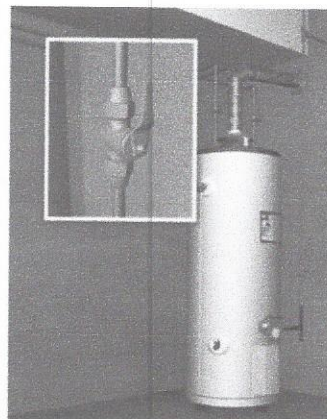
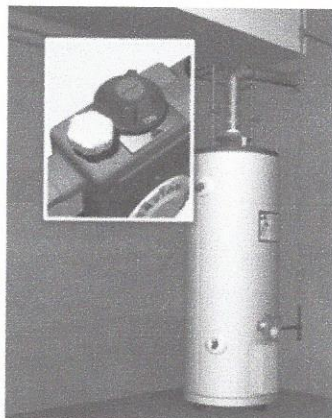
Examples:

- When a vapor meter is replaced.
- When a regulator is replaced.
- When there is an “out-of-gas” condition.
- Any time the gas piping has been depressurized.
- When a tank is changed out.

Appliances with 100% Safety Shutoff Valves

Ensure these two valves are in the **ON** position:

- The 100% safety shutoff valve.
- The manual gas shutoff valve or "gas cock."



APPLIANCES WITH 100% SAFETY SHUTOFF VALVES

An appliance with a 100% safety shutoff valve will automatically stop any gas from passing through the gas control to the appliance's combustion chamber when the control is in the "ON" position and there is no ignition source.

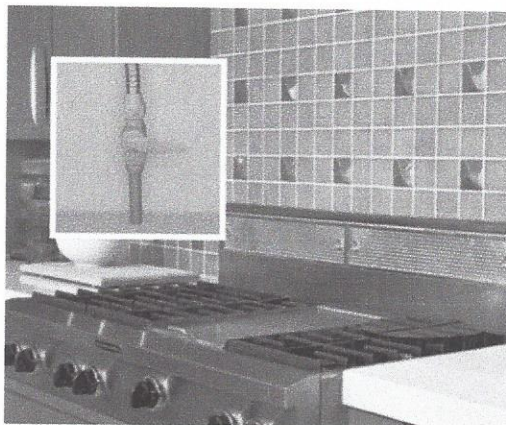
When performing a leak check on systems with this type of appliance, you must ensure two valves are in the "ON" position:

- The 100% safety shutoff valve.
- The manual gas shutoff valve or "gas cock."

This allows propane to flow through the system to the 100% safety shutoff valve to ensure that the valve is not allowing any propane to the appliance combustion chamber, thereby proving its functional stability.

Appliances Without 100% Safety Shutoff Valves

- The manual gas shutoff valve must be in the **OFF** position.



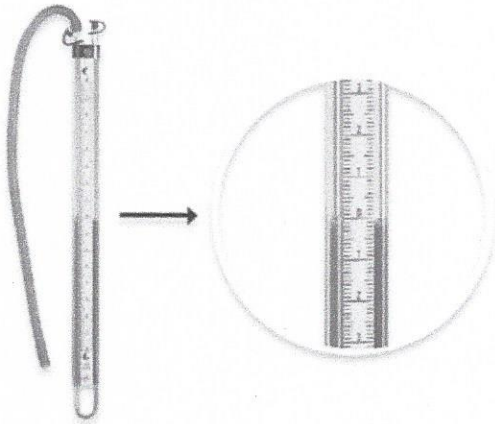
APPLIANCES WITHOUT 100% SAFETY SHUTOFF VALVES

An appliance without a 100% safety shutoff valve does not have a safety device to automatically stop gas from passing to the combustion chamber.

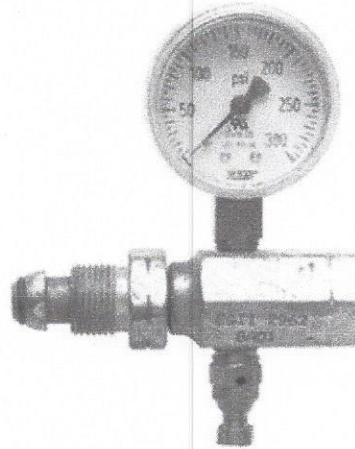
When performing a leak check on this type of appliance, the manual gas shutoff valve must be in the "OFF" position, thereby shutting off the supply of gas to the appliance.

Leak Check Instruments

Water Manometer



Test-Block Gauge



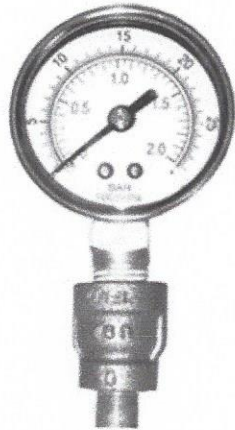
LEAK CHECK INSTRUMENTS

The two types of leak check instruments illustrated on the slide are:

- Manometer
- Test-block gauge (0-300 pounds per square inch pressure gauge (psig))

Leak Check Instruments (cont'd)

High pressure gauge



Vapor meter



LEAK CHECK INSTRUMENTS (CONT'D)

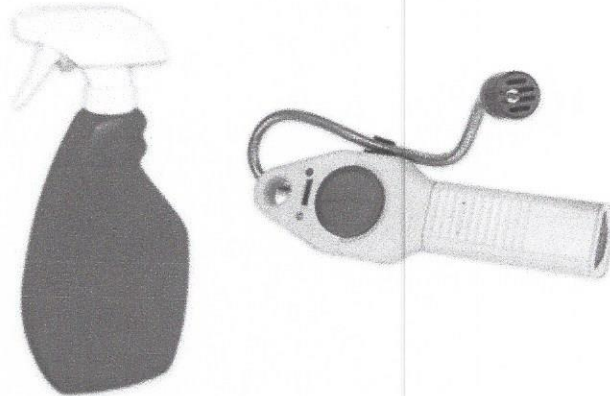
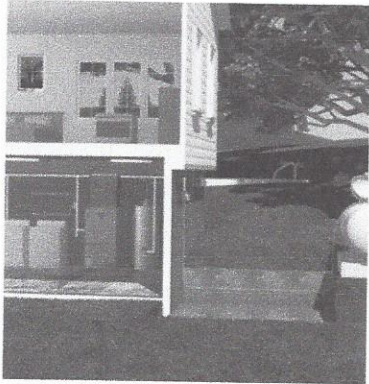
Two additional leak check instruments are:

- High-pressure gauge (0-30 psig)
- Vapor meter

There are many factors that dictate which testing instrument you should use, including your company policy and the most convenient location to tap into the vapor distribution line.

Leak Test

- Uses a leak detection solution or electronic leak detector to determine the location of a leak.



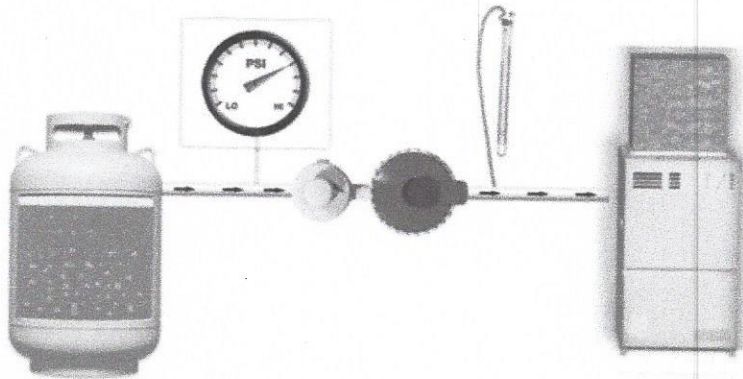
LEAK TEST

A leak test uses a leak detection solution or electronic leak detector to determine the location of a leak found by the test for leakage, pressure test, or leak check test.

Once located, the leak must be repaired and the system must be retested until it is deemed to be leak-free.

Purpose of Tests

- Determine if the container, piping, and regulator(s) are sized correctly and ensure that the regulators are set and functioning properly.



PURPOSE OF TESTS

When you turn a propane appliance on, propane vapor flows through the line to the appliance for use. The regulator makes sure the amount of gas flowing to the appliance is not too high or too low. When the appliance is shut off, vapor pressure will continue to build in the line unless the regulator automatically turns off the flow of propane.

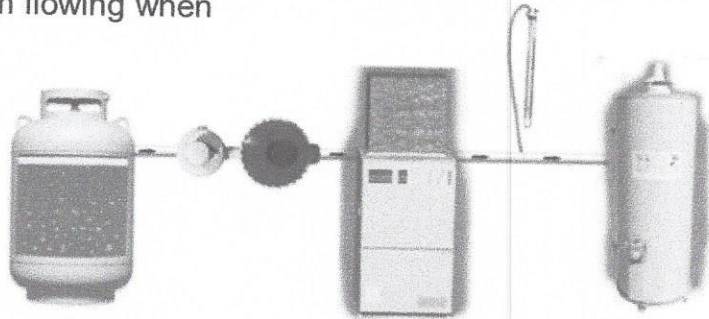
"Flow" and "lock-up tests," are typically performed on vapor distribution systems to determine if the container, piping, and regulator(s) are sized correctly and to ensure that the regulators are set and functioning properly so they do not over pressurize the piping system downstream from them. Regulator adjustments are made in response to the flow

test. Therefore, the flow test is performed before the lock-up test.

After an appliance is connected to a vapor distribution system, you should conduct a flow test to measure the gas pressure at the appliance under full load to determine if the regulator(s), and piping system can supply the amount of gas the appliance demands.

Flow and Lock-Up

- **Flow pressure:** Ensure that appliances are receiving an adequate amount of propane at the manufacturer recommended pressure.
- **Lock-up:** Amount of pressure necessary to seal off the regulator inlet orifice to stop the propane from flowing when there is no demand.



FLOW AND LOCK-UP

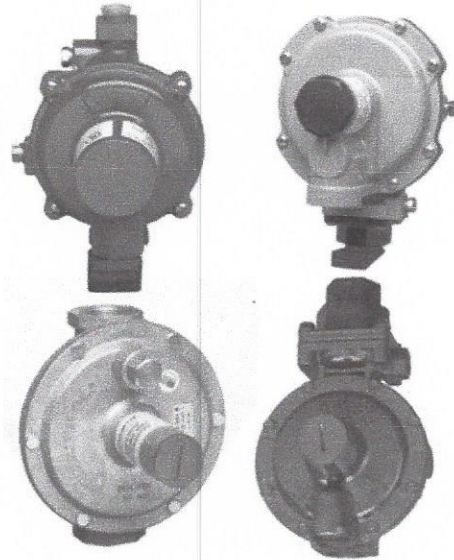
Flow pressure is tested to ensure that appliances are receiving an adequate amount of propane at the manufacturer recommended pressure. Flow pressure is affected by friction loss within piping. Performing a flow test as close as possible to an appliance helps verify that the container, piping, and regulator(s) are properly sized.

Lock-up is the amount of pressure necessary to seal off the regulator inlet orifice to stop the propane from flowing when there is no demand. A lock-up test measures the amount of delivered pressure to an appliance with no demand to ensure that the regulator will shut off the flow of propane when the appliances are not in use.

Regulators

Regulator flow pressure and lock-up tests are typically performed on:

- First-stage regulators.
- Second-stage regulators.
- Integral two-stage regulators.
- Line-pressure regulators.
- 2-psi regulators.



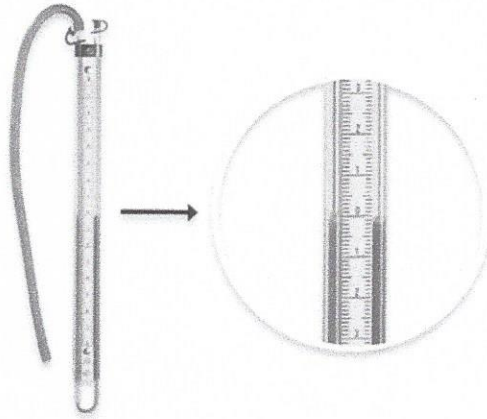
REGULATORS

Lock-up tests must be performed on all new regulators in the piping system. Lock-up tests may be performed on existing regulators if you suspect an elevated downstream line pressure or if required by your company policy.

To ensure that the lock-up test is valid, the regulator flow pressure test is typically done first, making output pressure adjustments if needed. Then the lock-up test is performed with the regulator set for proper flow pressure requirements.

Flow Test Using a Manometer

- Ensure the manometer is set to zero reading before starting the flow test.



FLOW TEST USING A MANOMETER

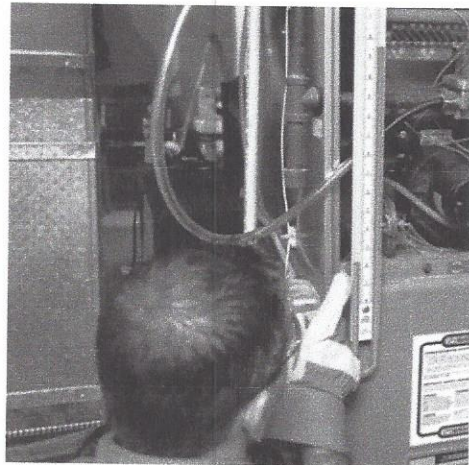
A water manometer is used to measure gas flow pressure of low-pressure regulators with output pressures of 11" to 14" w.c. Therefore, this flow test is performed downstream of either the two-stage regulator outlet or second-stage regulator outlet of a two-stage regulator system.

Make sure the manometer you use starts out at a zero reading as indicated by the manufacturer's instructions.

The manometer should be located in a piping test tap downstream of the line regulator and, ideally, at the appliance farthest from the regulator.

Flow Test Procedures

1. Install a water manometer in the test tap of the appliance shutoff valve farthest from the regulator.
2. Operate all available propane appliances at full operating capacity.
3. Check the delivered pressure shown on the manometer while the appliances are operating.



FLOW TEST PROCEDURE

Step 1: Install a water manometer or other company approved pressure-measuring device in the test tap of the appliance shutoff valve farthest from the regulator. Many appliance gas control valves have an inlet test port that can be used as well to measure the flow and lock up.

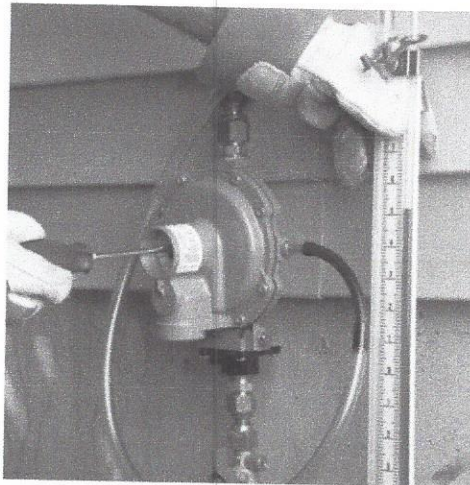
Step 2: Operate all available propane appliances at full operating capacity, or in accordance with your company policy.

Step 3: Check the delivered pressure shown on the manometer while the appliances are operating. If necessary, adjust the delivery pressure of the second- stage or line regulator to 11" w.c. or to the manufacturer's specifications.

Flow Test at Second-Stage or Line Regulator

If pressure is *incorrect* :

- Verify that the regulator output capacity adequately supplies all connected appliances.
- Verify the proper sizing and output pressure adjustment of upstream pressure regulators.



FLOW TEST AT SECOND-STAGE OR LINE REGULATOR

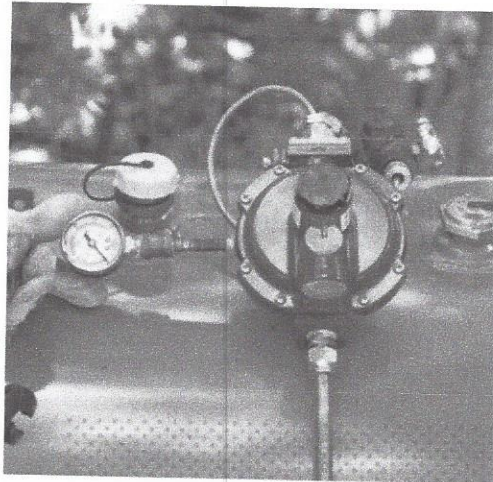
If adequate flow pressure is not maintained with all connected gas appliances operating, perform the flow test at the second-stage regulator or line regulator by repeating the three steps on the previous slide, but with the manometer installed at the regulator outlet.

If the pressure is *incorrect*:

- Verify that the regulator output capacity adequately supplies all connected appliances. If it does not, install a larger capacity regulator, if trained, or contact your propane supplier for assistance. Then leak check the system and repeat the flow pressure test. Verify that the new regulator has adequate capacity for the load.
- If the regulator is sized adequately, then adjust it to the desired flow pressure in accordance with the manufacturer's recommendations.
- Verify the proper sizing and output pressure adjustment of upstream pressure regulators. The service regulator upstream of the regulator being flow pressure tested may not be properly sized or may not be providing sufficient output pressure for gas appliance demand.

Flow Test at Two-PSI or First-Stage Regulator

1. Install pressure-measuring device on the outlet side of the first-stage regulator.
2. Operate all available propane appliances at full capacity.
3. Check the delivered pressure shown on the gauge with the appliances operating.



FLOW TEST AT TWO-PSI OR FIRST-STAGE REGULATOR

If you test the pressure at the inlet side of a second-stage regulator and find the pressure to be inadequate under normal flow conditions, you will need to test the flow at the two-psi or first-stage regulator.

Step 1: Install a suitable pressure-measuring device on the outlet side of the first-stage regulator that measures in pounds, such as a 0-30 pounds per square inch gauge (psig).

Step 2: Operate all available propane appliances at full capacity, or as prescribed by your company policy.

Step 3: Check the delivered pressure shown on the gauge with the appliances operating. If necessary, adjust the delivery pressure of the first-stage regulator to the manufacturer's specifications. You may need to install a different first-stage regulator.

Lock-Up Test for Second or Integral Two-Stage Regulator

1. Place the pressure-measuring device downstream of the regulator being measured.
2. Turn all appliance controls off.
3. Close the appliance shutoff valves to any appliance without a 100% pilot safety shutoff device.
4. Leave the container service valve open to maintain system pressure.
5. Watch the pressure for at least one minute or until there is a steady reading.
6. If you do not see an increase in pressure downstream of the regulator, then the regulator has adequate pressure for lock up.

LOCK-UP TEST FOR SECOND OR INTEGRAL TWO-STAGE REGULATOR

Once you have performed the flow test and established that the regulator is allowing adequate pressure in the piping system when the appliance is turned on, you can perform the lock-up test to ensure the regulator will close properly when the appliance is turned off.

To perform the lock-up test for a second or integral two-stage regulator:

Step 1: Place the pressure-measuring device anywhere in the system downstream of the regulator being measured. Selecting the appropriate test tap location will depend on the type of regulator being tested, its output pressure, and the pressure measuring device. Often, this test is performed at the same test location as the flow test previously discussed.

Step 2: Turn all appliance controls off.

Step 3: Close the appliance shutoff valves to any appliance without a 100% pilot safety shutoff device.

Step 4: Leave the container service valve open to maintain system pressure. With no gas

flowing through the appliances, the pressure will increase slightly and then stop, which indicates the lock-up pressure. The lock-up pressure should not exceed 14" w.c. Verify the regulator manufacturer's pressure lock-up specifications.

Step 5: Watch the pressure for at least one minute or until there is a steady reading. If the flow pressure was 11" w.c., then the lock-up pressure should not exceed the maximum rating on the gas control valve, typically 14" w.c.

Step 6: If you do not see an increase in pressure downstream of the regulator, then the regulator has adequate pressure for lock up. If the outlet pressure of the regulator is too high, then either the regulator is malfunctioning or the regulator inlet pressure is too high. In this case, you will need to perform a lock-up test at the first-stage regulator to determine the problem.

Lock-Up Test for First-Stage or Two-PSI Regulator

1. Locate the pressure measuring device on the outlet side of the first-stage or 2-psi regulator.
2. Turn all appliance controls off.
3. Close the appliance shutoff valves to any appliance without a 100% pilot safety shutoff device.
4. Leave the container service valve open to maintain system pressure.
5. If the pressure is too high:
 - The regulator spring may have been set too high.
 - The regulator is not setting properly.

LOCK-UP TEST FOR FIRST-STAGE OR TWO-PSI REGULATOR

To perform the lock-up test for a first-stage or two-psi regulator:

Step 1: Locate the pressure measuring device on the outlet side of the first-stage or 2-psi regulator.

Step 2: Turn all appliance controls off.

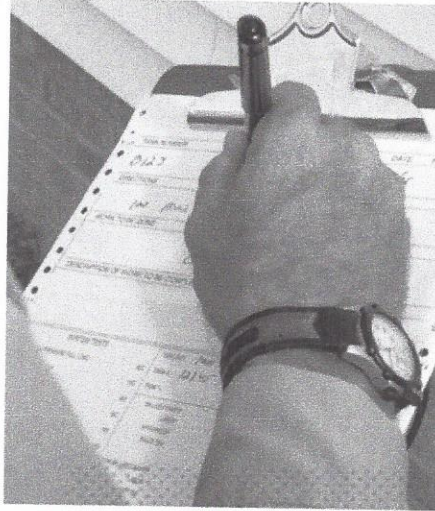
Step 3: Close the appliance shutoff valves to any appliance without a 100% pilot safety shutoff device.

Step 4: Leave the container service valve open to maintain system pressure. With no gas flowing through the appliances, the pressure will increase slightly and then stop. This indicates the lockup pressure. Watch the pressure for at least one minute or long enough to acquire a steady reading. The lock-up pressure should not exceed the regulator manufacturer's pressure lock-up specification.

Step 5: If the pressure exceeds the manufacturer's specifications, the regulator spring may have been set too high during the flow test or the regulator is not setting properly

and it must be replaced or repaired according to the manufacturer's instructions and your company policy.

Documenting System Tests and Checks



DOCUMENTING SYSTEM TESTS AND CHECKS

All system checks and tests performed at any time and by any employee should be documented showing the:

- Date and time the test or check was performed.
- Pressure data and duration.
- Signature or name of the employee performing the test.
- Signature or name of the customer, if available. (If the customer is not available to sign, you should document this.)

Purging

- Air or inert gas must be removed, or purged, from a piping system before placing gas appliances and the vapor distribution system itself into service.



PURGING

Air or inert gas must be removed, or purged, from a piping system before placing gas appliances and the vapor distribution system itself into service.

This is especially true when placing a system into operation after a new piping installation as the lines may be full of air from a pressure test.

Failing to purge will make it difficult for you to light the pilots, produce an improper flame at the main burner, and may result in the improper operation of electronic control ignition systems.

If you do not follow proper purging procedures, propane vapor and combustible gas-air mixtures could escape into the indoor atmosphere of a building causing an explosion or fire if an ignition source is present.

Requirements for Placing Appliances into Initial Operation

Appliance requirements vary widely when placing them into initial operation.

- Consult the following resources:
 - NFPA 54.
 - The appliance manufacturer's instructions.
 - Any applicable company policies.



REQUIREMENTS FOR PLACING APPLIANCES INTO INITIAL OPERATION

Appliance requirements vary widely when placing them into initial operation. For this reason, only qualified personnel should place appliances into operation.

Basic Guidelines:

- Lighting the pilot is the first step in placing an appliance into operation.
- It involves operating the appliance through a number of "calls-for-heat," sometimes referred to as "start up" and "shutdown" cycles, to verify proper operation and adjustment of the burner and proper venting.
- If your service call requires you to put an appliance into service, be sure to look for any documentation that confirms required tests were performed on the piping system.

During the process of placing gas appliances into service you should consult the following resources:

- NFPA 54.
- The appliance manufacturer's instructions.
- Any applicable company policies.

Code Requirements

NFPA 54:

- Do not overfire an appliance.
- Know the input rating of the gas appliance.

APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES	
APPLIANCE	INPUT Btu/hr (APPROX)
Space Heating Units	
Warm air furnace	
Single Family	100,000
Multifamily, per unit	60,000
Hydronic boiler	
Single Family	100,000
Multifamily, per unit	60,000

CODE REQUIREMENTS

NFPA 54 outlines some code requirements for placing appliances into initial operation. These requirements state the following:

- Do not overfire an appliance.
- Know the input rating of the gas appliance.

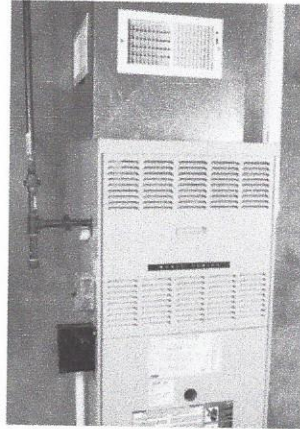
These ratings are based on sea-level operation and do not need to be changed when operating appliances at an elevation of up to 2,000 feet.

Lighting Appliance Pilots

Standing pilot



Electronic ignition



LIGHTING APPLIANCE PILOTS

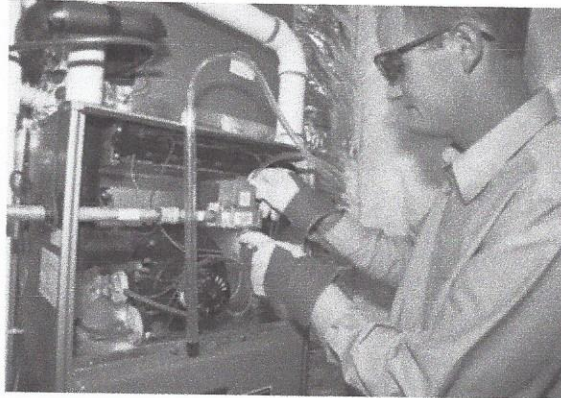
Before lighting any appliance pilot, be sure to do a “sniff test.” If possible, walk around the appliance and sniff repeatedly. If you smell propane, you may have a gas leak. Do not light any appliance until you have found the source of the leak and fixed the problem.

There are two basic forms of burner ignition devices or pilots:

- **Standing pilot:** A small flame that burns constantly, usually with a safety device.
- **Electronic ignition:** A mechanism that provides a source of ignition to an appliance that does not burn constantly.

Verifying Manifold Pressure

- Connect a manometer to the pressure tap located on the outlet side of the appliance control valve or the burner manifold assembly.



VERIFYING MANIFOLD PRESSURE

Once an appliance is installed and ready to be started, the gas control valve regulator spring will most likely need to be adjusted to supply the correct gas pressure to the appliance burners. If the appliance burner is equipped with an adjustable air shutter, it will need to be adjusted as well.

To check the manifold pressure, a manometer is connected to the pressure tap located on the outlet side of the appliance control valve or the burner manifold assembly. The pressure tap is generally 1/8" National Pipe Thread (NPT); the same size used on regulators and gas supply valves. This outlet will only have gas pressure when the appliance control's main burner valve is open.

The appliance should be turned off during connection or disconnection of the manometer to the manifold pressure tap.

Only appliances that are designed for use with either fuel with the correct orifices and pressure regulator setting should be converted from one fuel to the other by a qualified technician.

Proper Burner Operation

- Rapid ignition.
- No flame lift.
- Uniformity.
- Silence.



PROPER BURNER OPERATION

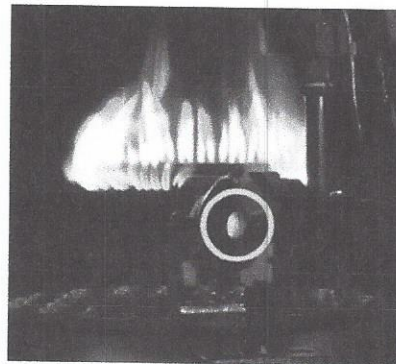
In order for an atmospheric burner to operate properly there must be:

- **Rapid ignition:** Ignition should take place readily and the flame should travel from port to port rapidly.
- **No flame lift:** The flames must not lift away from the ports.
- **Uniformity:** Burner operation should produce uniform distribution of heat over the area being heated, with uniform flame height and good flame distribution.
- **Silence:** The burner should light, burn, and shut off quietly.

Although a flame that is burning properly is typically blue, some appliances are designed to burn yellow flames for decorative purposes.

Inadequate Air Supply

- Too much or too little air supplied to a burner must be avoided.



INADEQUATE AIR SUPPLY

Too little primary air:

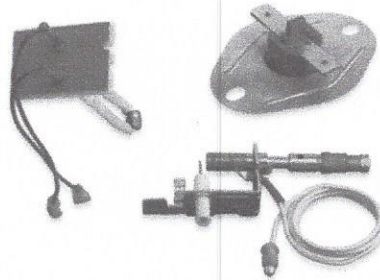
If too little primary air is mixed with the propane, the flame will be yellow. Yellow flames do not necessarily indicate the presence of carbon monoxide. However, when yellow tipped flames are allowed to impinge on cool surfaces, soot will build up where the impingement takes place. This must be avoided, because soot buildup in enclosed combustion spaces can block the vent openings. Which, in turn, results in improper venting and an inadequate supply of fresh air for combustion, which in turn results in incomplete combustion that gives off carbon monoxide.

Too much primary air:

Too much primary air gives a "hard" flame with a short sharp inner cone. It may make the flame lift off the ports, extinguish itself, or become noisy when lighted or turned off. Also, too much air may cause "flashback," which occurs when the gas-air mixture ignites inside the burner to burn near the orifice. If gas burns at the burner orifice, the results will be improper combustion creating a hazardous condition. Aldehydes and carbon monoxide can be formed by incomplete combustion and flame impingement.

Safety Devices

- Oxygen Depletion Sensors (ODS).
- Electronic control ignition system flame sensors.
- Flame roll out and Energy Cut-Off (ECO) devices.
- High-limit switches.
- Additional safety devices.
- Fan control switches.



SAFETY DEVICES

Appliances generally have built-in safety devices that ensure their safe operation. When placing appliances into operation, it is important for you to recognize the purpose of these safety devices and identify their proper operation.

Types of Safety Devices:

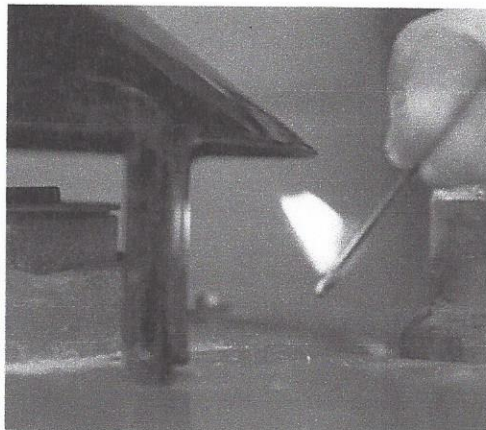
There are several sensors built into an appliance that monitor events within the appliance. These sensors are designed to shut the appliance off if unsafe conditions are detected.

Safety devices include:

- Oxygen Depletion Sensors (ODS)
- Electronic control ignition system flame sensors
- Flame roll out and Energy Cut-Off (ECO) devices
- High-limit switches
- Additional safety devices
- Fan control switches

Spillage Test

- This final step to placing an appliance into operation is a spillage test.



SPILLAGE TEST

The final step to placing an appliance into operation requires you to perform a spillage test.

Spillage refers to improperly vented flue gases entering a room where an appliance is located.

Natural draft vented appliances should be checked for spillage at the draft diverter or draft hood with the appliance operating. If these flue gases were to backflow or spill inside

a structure, products of combustion could accumulate inside causing a potentially hazardous situation.