CHAPTER IX
LP GAS REGULATORS

BASIC CONCEPTS FOR LP GAS REGULATORS

LP gas regulators reduce container pressure which can range from 8 to 220 psig to intermediate pressures of 10 psig or typical appliance pressure, nominal 11" w.c. They must be installed in accordance with the National Fuel Gas Code NFPA 54, Standard for the Storage and Handling of Liquefied Petroleum Gases Code NFPA 58 and any local requirements.

There are a few terms, units and concepts that are useful when discussing LP gas regulating equipment. These are described as follows:

psig - pounds per square inch gauge. The unit of measure that uses the actual atmospheric pressure as a zero point in a specific geographic area. It is used to describe container pressure and delivery pressure from first-stage and high pressure regulators.

Psig is typically measured with a spring loaded gauge that can be attached to a container outlet connection and downstream of first-stage or high pressure regulators.

w.c. - inches of water column. Unit of measure for delivery pressure from single, second and integral twin stage regulators (27.71"w.c.=1.0 psig). Inches of water column are measured with the use of a U-Tube device called a water manometer (see Figure IX-1) that is filled with water with 1" markings typically up to 16". As pressure is introduced in one side of the tube, the water is forced up the other side; the end reading is then doubled to get the measured delivery pressure.

Inches of water column are typically measured at regulator pressure ports and inlet ports at appliance control valves.

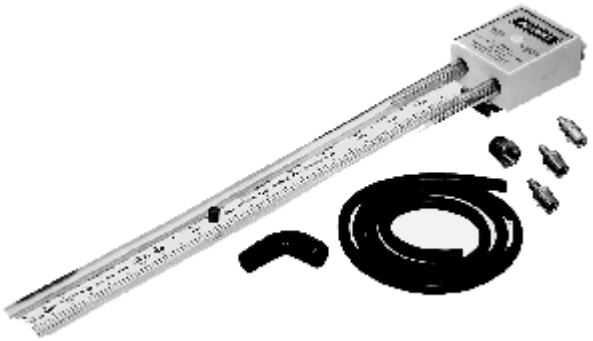

Figure IX-1 Water manometer

Btu - British thermal unit. Measure of heat value. One Btu will raise the temperature ofone pound of water one degree Fahrenheit. Btu is used to describe gas input to an appliance and the capacity of the LP gas regulator. Regulators are rated at the amount of Btu's per hour they can deliver at a specific inlet and outlet pressure. See Figure IX-2.

Set point - a point where the regulator is set for a specific pressure, either psig or inches of water column at a specific inlet pressure and a Btu delivery to downstream appliance(s). See Figure IX-2.

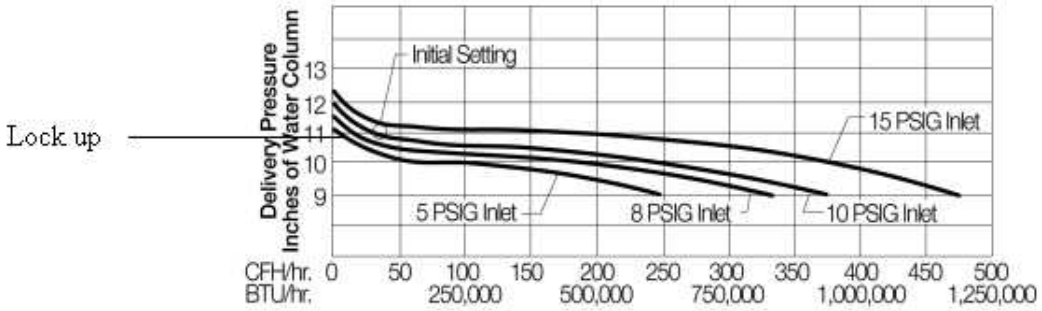

Figure IX-2

Lock up- a point where there is no demand from the appliances and the regulator stops flow. It will always be higher than the set point. On single, second and integral twin stage regulators, it is 120% of the set point, i.e., set point of 10 psig inlet, 11"w.c. at 75,000 Btu/hr is 13.2"w.c. See Figure IX-2.

Components of a Typical Regulator

Figure IX-3 LP regulator

Underwriters Laboratories – Listing - Underwriter Laboratories (UL) is a not-for-profit organization that maintains laboratories for the examination and testing of devices, systems and materials to determine their relation to hazards to life and property. They also publish standards for materials, devices, products, equipment, etc. that affect the above described hazards.

UL-144 is the Standard for LP-Gas Regulators. It defines temperature/pressure ratings, relief valve performance, materials of construction, lock-up ranges, adjustment range, operation/performance and marking requirements to name a few items covered. UL listed regulators conform to the requirements of NFPA 58. Look for the UL mark before installing on a system. On large commercial or industrial systems, UL listed regulators are not always available. The local authority having jurisdiction acts as final approval in these cases.

How a Regulator Works

Typical positive back pressure regulator

Gas enters through the inlet and flows through an orifice **A.** As pressure builds under the diaphragm **B**, which moves upward, the adjustment spring compresses **C** and pushes the seat disc attached to the lever assembly **D** against the inlet nozzle or orifice **A**. If there is no gas demand, the seat disc will stay against the nozzle and gas flow will stop. This is called **lock-up**. When gas demand from the appliance begins, pressure under the diaphragm **B** is reduced, the adjustment spring pushes the lever/seat disc away from the seat and gas flow is allowed through the seat. The diaphragm will continue to sense the pressure under it, and will compress or relax the adjustment spring, which will move the seat lever/seat disc assembly against or away from the seat. This constant movement controls the pressure to downstream regulators or appliances. The design of the adjustment spring determines the pressure setting. See Figure IX-4.

Relief operation

A relief valve is installed in all first, second and integral twin-stage regulators and operates with the requirements of UL-144. It is designed to protect downstream equipment and appliances from overpressure.

When gas enters through orifice **A**, as described above, and downstream demand is reduced or stops, the lever/seat disc **D** will move toward the nozzle to the lock-up position. If the regulator seat disc cannot fully contact the orifice **A**, pressure will continue to build until diaphragm **B** moves up to the point where relief spring **E** begins to compress, allowing gas flow through the relief area into the bonnet and out through the vent **G**. The relief valve will automatically close once the pressure under the diaphragm is reduced to a nominal pressure. See Figure IX-4.

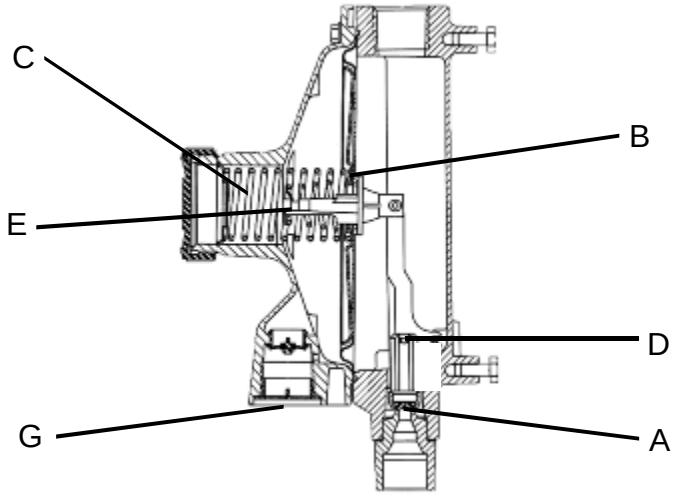

Figure IX-4

There are two designs of LP-gas regulators typically used in systems across the country:

Positive back pressure regulators

This style is a positive back pressure regulator, Figures IX-3 and IX-4**.** It is used as a first stage, second stage, single stage, integral twin-stage and, in some cases, a high pressure regulator. The positive back pressure regulator provides good flow characteristics over a wide range of inlet pressures. LP-Gas vapor pressures change based on temperature. Figure IX-2.

The regulator delivery pressure is affected by the changes in inlet pressure, as well as demand from a downstream appliance(s)**.** The seat disc is on the downstream side of the seat. As inlet pressure rises, the delivery pressure rises; as inlet pressure drops, delivery pressure drops. See Figure IX-2.

Negative direct acting regulators

This style is a negative direct acting regulator. See Figure IX-5**.** It may be used as a high pressure, first stage or even a second stage regulator. The negative acting regulator provides high flow through a large orifice area and a smaller diaphragm area. The seat disc is on the upstream side of the seat. As inlet pressure increases, delivery pressure decreases a small amount; as inlet pressure decreases, delivery pressure increases. The seat disc retainer assembly is directly attached to the stem.

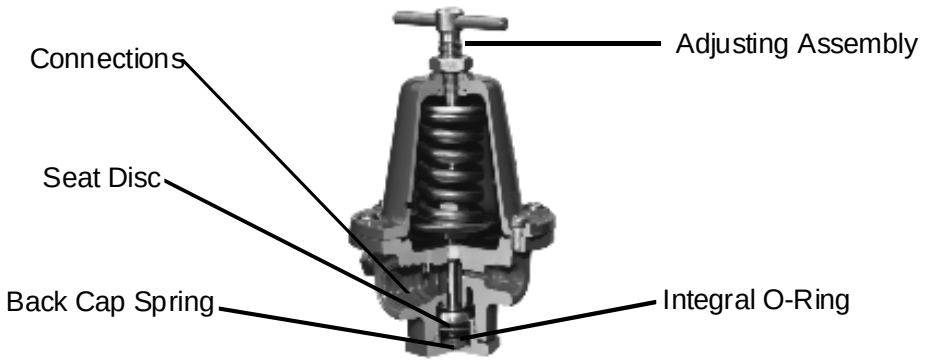

Figure IX-5

TYPES OF REGULATOR SYSTEMS

Regulators and systems control gas pressure from the container to the appliance, reducing the tank pressure which can range from 10-250 psig to the required outlet pressure. There are several types that can range in style and combinations of regulators that can be used to accomplish this task.

Single Stage : One regulator mounted on a container with a line running directly to the appliance(s) (limited to small portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr maximum per NFPA 58, 1995 Edition.) This single regulator is designed for LP gas vapor service to reduce container pressure to 1.0 psig or less (typically 11" water column.) Figure IX-6. These regulators are listed by Underwriters Laboratory or equivalent for use in LP gas with an inlet pressure rating of 250 psig. They utilize a type I relief valve which has a limited capacity; operating range is from 18.7" to 33" w.c.

Per the 1995 Edition of NFPA 58, single stage regulators may no longer be installed on fixed piping systems.

Figure IX-6

First stage : A pressure regulator for LP gas vapor service designed to reduce container pressure to 10 psig or less. It is used as the container regulator in a two stage system. See Figure IX-7A. This regulator can be either of the two styles described above and is UL listed for use as a first stage regulator with an inlet pressure rating of 250 psig. This regulator utilizes a type I relief valve which is a limited capacity; operating range is from 14 psig to 25 psig.

Second Stage : A pressure regulator for LP gas vapor service designed to reduce first stage regulator outlet pressure to 14" water column or less (typically 11" w.c.) See Figure IX-7B. This may be either of the two styles and is UL listed for use in LP gas with an inlet pressure marked at 10 psig, but a rating of 250 psig. This regulator utilizes a type II relief valve - a high capacity type for final stage regulators; operating range is from 18.7" to 33" WC.

Figure IX-7A

Figure IX-7B

High pressure regulator - a pressure regulator for either LP gas vapor or liquid service designed to reduce pressure in excess of 1 psig. The liquid regulating style is usually negative direct acting; the vapor style can be either. Both are usually UL listed with at least a 250 psig inlet pressure rating. This regulator may utilize a type I relief valve or may not. In some cases an additional external relief valve might be required. See NFPA 58 for more information. See Figure IX-5.

Integral two-stage regulator - a pressure regulator that combines both a high pressure and a second stage regulator into a single unit. It is UL listed with a 250 psig inlet pressure rating, no relief in the high pressure section and a type II relief valve in the second stage section. High capacity type for final stage regulators have an operating range from 18.7 inches w.c. to 33 inches w.c. See Figure IX 8.

Figure IX-8

Automatic Changeover : An integral two stage regulator that combines two high pressure regulators and a second stage regulator into a single unit. There are two inlet connections and a service/reserve indicator designed for use with dual- or multiple-cylinder installation. The system automatically changes the LP gas vapor withdrawal from empty designated service cylinder(s) to the designated reserve cylinders, without interruption of service. The service/reserve indicator gives a visual indication of which cylinders are supplying the system. The second stage in an UL listed automatic changeover contains a type II relief valve with the same setting parameters as in the integral twin-stage unit. See Figure IX-9.

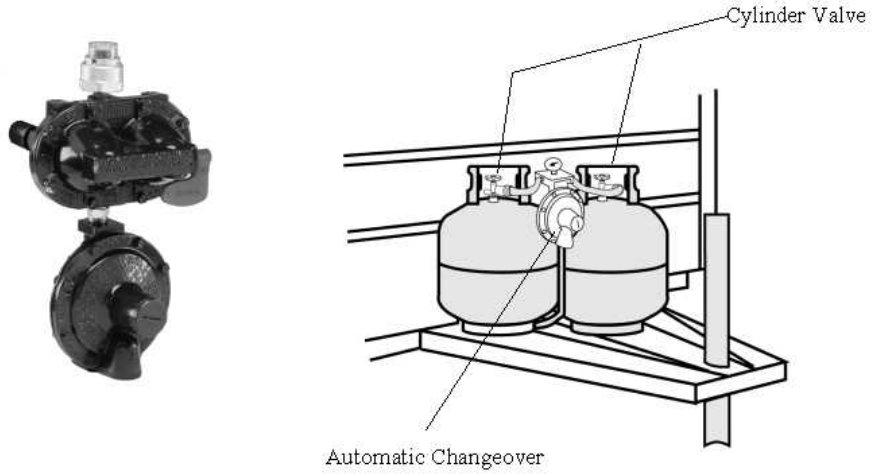

Figure IX-9

Two-Stage Regulator System : An LP gas vapor delivery system that combines a first stage regulator and second stage regulator, Figure IX-10, integral two stage regulator, Figure IX-8, or an automatic changeover regulator Figure IX-9**.**

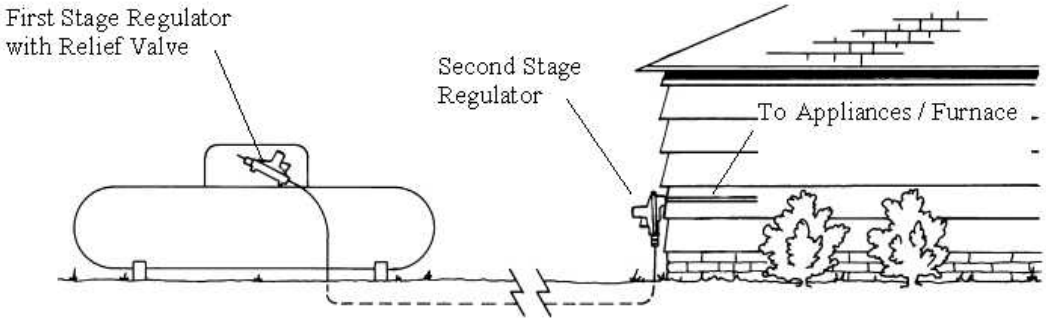

Figure IX-10

Two stage regulator system, Figure IX-11, with a first stage regulator rated at more than 500,000 BTU/HR set at 10 psig or less, with no integral relief valve. In this case the first

stage regulator is permitted to have a separate relief valve. It must operate within specified start-to-discharge limits of UL #144 (140%-200%) of the regulator set pressure.

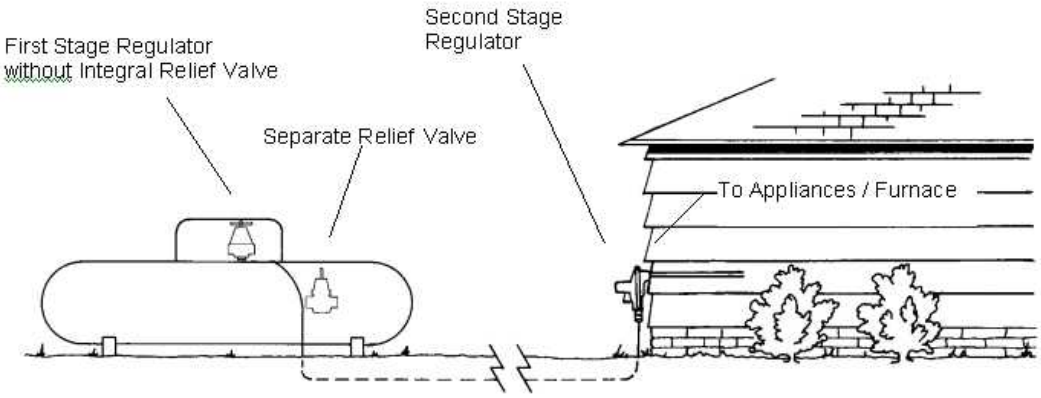

Figure IX-11

Two stage regulator system, Figure IX-12, with a first stage regulator rated at more than 500,000 BTU/HR, set at a pressure higher than 10 psig with no integral relief valve supplying second stage regulator(s). **Note: These systems are usually found where a number of second stage regulators are connected to a single container utilizing one first stage regulator.** In order to comply with NFPA 58 overpressure requirements for second stage regulators, an integral twin-stage regulator can be used for the second stage regulator. This will reduce the higher delivery pressure from the first stage regulator to 10 psig or less. The second stage will supply the required appliance pressure.

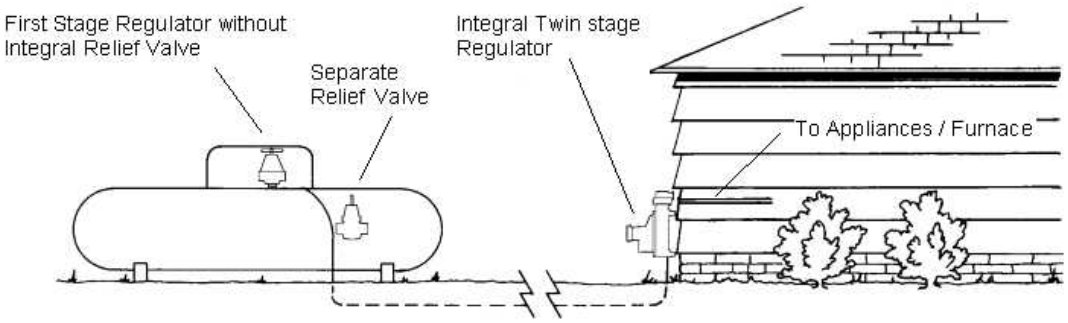

Figure IX-12

REGULATOR SELECTION

1. Determine the total Btu load that the system will require. This can be accomplished by reading the Btu input from each appliance and adding them up. This information can be found on the appliance name plate or from the manufacturers' literature. For example:

Range	65,000 Btu/HR
Water heater	30,000 Btu/HR
Furnace	150,000 Btu/HR
Total	245,000 Btu/HR

2. Determine regulator system type: integral twin stage or two stage? As a general guideline, if the container is going to be over 20 feet from the building, a two stage system is generally used, due to ability to use a smaller line between the first and second stage regulators. When installing containers near or next to the building, integral twin stage are typically used, since this reduced distance does not call for as large a diameter line from the outlet of the integral twin stage regulator. Proper pipe sizing is critical; refer to NFPA 58 1998 edition chapter 11 or the regulator manufacturers' pipe sizing instructions.

3. To select the correct size first stage, second or integral twin stage regulator, refer to the published information in the regulator manufacturers' catalogs. Always select a regulator that meets or exceeds the system demand; if in doubt, go to the next larger size.

In the example of the system requiring 245,000 Btu/HR, selecting a integral twin stage with 300,000 to 500,000 Btu/HR capacity or a first and second stage regulator of 500,000 to 700,000 Btu/HR would be typical.

INSTALLATION

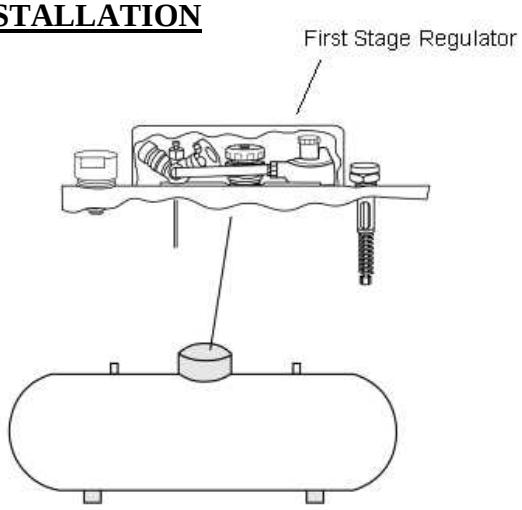

Figure IX-13

LP gas regulators must be installed in conformance with NFPA 54 National Fuel Gas Code, NFPA 58 Liquefied Petroleum Gas Code and any local requirements.

First stage/high pressure/integral twin stage/automatic changeover regulators may not be installed inside buildings unless specifically permitted by NFPA 58, such as certain buildings under construction. When installed outdoors the vent should be down and/or under a protective cover. See Figure IX-13.

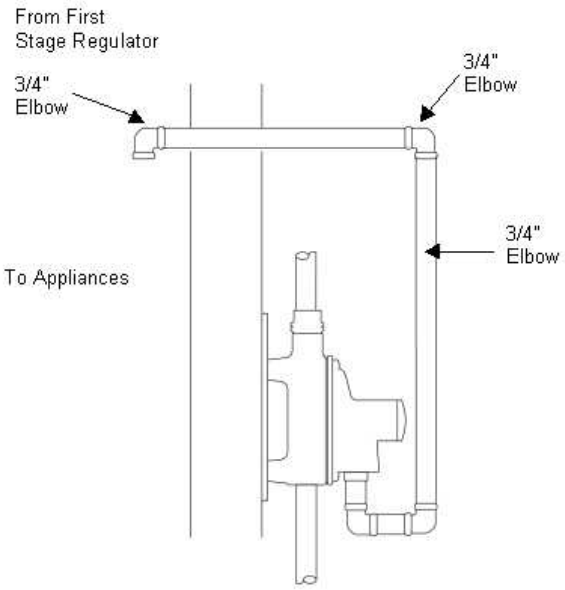

Figure IX-14

Second stage regulators may be installed indoors if the vent is piped to the outside of the building, the vent termination point is down and the outlet is protected by a vent screen, Figure IX-14. When installing second stage regulators outdoors, make sure the vent is pointed down and/or under protective cover. See Figure IX-10.

For more information on LP gas regulator installation, consult the National LP-Gas Association Safety Handbook, the manufacturers' catalogs, servicemen's handbooks, installation instructions and warning information, NFPA 54 and NFPA 58.