ECII® Engineered Controls International, Inc.

REGO® PRODUCTS

# LP-Gas Serviceman's Manual

# The LP-Gas Serviceman's Manual

Engineered Controls International, Inc., ECII®, has prepared this LP-Gas Serviceman's Manual for use by installation servicemen and others requiring a handy reference for field service work. It deals with subjects that can be useful to field servicemen striving for greater efficiency and safer installations. For the more technical problems and theories, the many texts and manuals concerning the particular subject should be consulted.

This manual is not intended to conflict with federal, state, or local ordinances and regulations. These should be observed at all times.

***This information is intended to be forwarded throughout the product distribution chain. Additional copies are available from Engineered Controls International, Inc. and RegO® Products Master Distributors.***

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# Contents

# Information About LP-Gas*

| | Propane | Butane |
|---|---|---|
| Formula | $C_3H_8$ | $C_4H_{10}$ |
| Boiling Point, ºF | -44 | 15 |
| Specific Gravity of Gas (Air=1.00) | 1.50 | 2.01 |
| Specific Gravity of Liquid (Water=1.00) | 0.504 | 0.582 |
| Lbs. per Gallon of Liquid at 60º F | 4.20 | 4.81 |
| BTU per Gallon of Gas at 60º F | 91502 | 102032 |
| BTU per Lb. of Gas | 21548 | 21221 |
| BTU per Cu. Ft. of Gas at 60º F | 2488 | 3280 |
| Cu. Ft. of Vapor (at 60º F) Gal. | 36.38 | 31.26 |
| Cu. Ft. of Vapor (at 60º F) Lb. | 8.66 | 6.51 |
| Latent Heat of Vaporization at Boiling Point BTU/Gal. | 773 | 808 |
| Combustion Data: | | |
| Cu. Ft. Air Required to Burn 1 Cu. Ft. Gas | 23.86 | 31.02 |
| Flash Point, ºF | -156 | N.A. |
| Ignition Temperature in Air, ºF | 920-1120 | 900-1000 |
| Maximum Flame Temperature in Air, ºF | 3595 | 3615 |
| Limits of Flammability Percentage of Gas in Air Mixture; | | |
| At Lower Limit – % | 2.15 | 1.55 |
| At Upper Limit – % | 9.6 | 8.6 |
| Octane Number (ISO-Octane=100) | Over 100 | 92 |

*Commercial quality. Figures shown in this chart represent average values.

# Vapor Pressures of LP-Gases*

| Temperature | | Approximate Pressure (PSIG) | |
|---|---|---|---|
| (ºF) | (ºC) | Propane | Butane |
| -40 | -40 | 3.6 | |
| -30 | -34 | 8 | |
| -20 | -29 | 13.5 | |
| -10 | -23 | 23.3 | |
| 0 | -18 | 28 | |
| 10 | -12 | 37 | |
| 20 | -7 | 47 | |
| 30 | -1 | 58 | |
| 40 | 4 | 72 | 3.0 |
| 50 | 10 | 86 | 6.9 |
| 60 | 16 | 102 | 12 |
| 70 | 21 | 127 | 17 |
| 80 | 27 | 140 | 23 |
| 90 | 32 | 165 | 29 |
| 100 | 38 | 196 | 36 |
| 110 | 43 | 220 | 45 |

*Conversion Formula:
Degrees C = (ºF - 32) X $^5/_9$
Degrees F = $^9/_5$ X ºC + 32

## Propane Storage Vessels

The withdrawal of propane vapor from a vessel lowers the contained pressure. This causes the liquid to "boil" in an effort to restore the pressure by generating vapor to replace that which was withdrawn. The required "latent heat of vaporization" is surrendered by the liquid and causes the temperature of the liquid to drop as a result of the heat so expended.

The heat lost due to the vaporization of the liquid is replaced by the heat in the air surrounding the container. This heat is transferred from the air through the metal surface of the vessel into the liquid. The area of the vessel in contact with vapor is not considered because the heat absorbed by the vapor is negligible. The surface area of the vessel that is bathed in liquid is known as the "wetted surface." The greater this wetted surface, or in other words the greater the amount of liquid in the vessel, the greater the vaporization capacity of the system. A larger container would have a larger wetted surface area and therefore would have greater vaporizing capacity. If the liquid in the vessel receives heat for vaporization from the outside air, the higher the outside air temperature, the higher the vaporization rate of the system. How all this affects the vaporization rate of 100-pound cylinders is shown on page 6. It will be noted from this chart that the worst conditions for vaporization rate are when the container has a small amount of liquid in it and the outside air temperature is low.

With the principles stated above in mind, simple formulae for determining the proper number of DOT cylinders and proper size of ASME storage containers for various loads where temperatures may reach 0ºF will be found on pages 6 and 7 respectively.

## Determining Total Load

In order to properly size the storage container, regulator, and piping, the total BTU load must be determined. The total load is the sum of all gas usage in the installation. It is arrived at by adding up the BTU input of all appliances in the installation. The BTU input may be obtained from the nameplate on the appliance or from the manufacturers' literature.

Future appliances which may be installed should also be considered when planning the initial installation to eliminate the need for a later revision of piping and storage facilities.

Where it may be more desirable to have ratings expressed in CFH, divide the total BTU load by 2488 for CFH of propane.

## Approximate BTU Input For Some

| Appliance | Approx. Input (BTU per Hour) |
|---|---|
| Range, free standing, domestic | 65,000 |
| Built-in oven or broiler unit, domestic | 25,000 |
| Built-in top unit, domestic | 40,000 |
| Water Heater, (Quick Recovery) automatic storage– | |
| 30 Gallon Tank | 30,000 |
| 40 Gallon Tank | 38,000 |
| 50 Gallon Tank | 50,000 |
| Water Heater, automatic instantaneous | |
| Capacity (2 gal. per minute) | 142,800 |
| Capacity (4 gal. per minute) | 285,000 |
| Capacity (6 gal. per minute) | 428,400 |
| Refrigerator | 3,000 |
| Clothes Dryer, Domestic | 35,000 |
| Gas Light | 2,500 |
| Gas Logs | 30,000 |

# 100 LB. Cylinders

How Many Are Required

"Rule of Thumb" Guide for
Installing 100 Lb. Cylinders

For continuous draws where temperatures may reach 0ºF. Assume the vaporization rate of a 100 lb. cylinder as approximately 50,000 BTU per hour.

$$\text{Number of cylinders per side} = \frac{\text{Total load in BTU}}{50{,}000}$$

Example:

Assume total load = 200,000 BTU/hr.

$$\text{Cylinders } \underline{\text{per side}} = \frac{200{,}000}{50{,}000} = 4 \text{ cylinders } \underline{\text{per side}}$$

## Vaporization Rate - 100 Lb. Propane Cylinders

(Approximate)

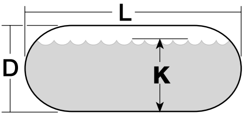
| Lbs. of Propane In Cyl. | Maximum Continuous Draw In BTU Per Hour At Various Temperatures In Degrees F. | | | | |
|---|---|---|---|---|---|
| | 0ºF | 20ºF | 40ºF | 60ºF | 70ºF |
| 100 | 113,000 | 167,000 | 214,000 | 277,000 | 300,000 |
| 90 | 104,000 | 152,000 | 200,000 | 247,000 | 277,000 |
| 80 | 94,000 | 137,000 | 180,000 | 214,000 | 236,000 |
| 70 | 83,000 | 122,000 | 160,000 | 199,000 | 214,000 |
| 60 | 75,000 | 109,000 | 140,000 | 176,000 | 192,000 |
| 50 | 64,000 | 94,000 | 125,000 | 154,000 | 167,000 |
| 40 | 55,000 | 79,000 | 105,000 | 131,000 | 141,000 |
| 30 | 45,000 | 66,000 | 85,000 | 107,000 | 118,000 |
| 20 | 36,000 | 51,000 | 68,000 | 83,000 | 92,000 |
| 10 | 28,000 | 38,000 | 49,000 | 60,000 | 66,000 |

This chart shows the vaporization rate of containers in terms of the temperature of the liquid and the wet surface area of the container. When the temperature is lower of if the container has less liquid in it, the vaporization rate of the container is a lower value.

# ASME Storage Containers

Determining Propane Vaporization Capacity

"Rule of Thumb" Guide for
ASME LP-Gas Storage Containers




Where
D = Outside diameter in inches
L = Overall length in inches
K = Constant for percent volume of liquid in container

| Percentage of Container Filled | K Equals | *Propane Vaporization Capacity at 0ºF (in BTU/hr.) |
|---|---|---|
| 60 | 100 | D X L X 100 |
| 50 | 90 | D X L X 90 |
| 40 | 80 | D X L X 80 |
| 30 | 70 | D X L X 70 |
| 20 | 60 | D X L X 60 |
| 10 | 45 | D X L X 45 |

*These formulae allow for the temperature of the liquid to refrigerate to -20ºF (below zero), producing a temperature differential of 20ºF for the transfer of heat from the air to the container's "wetted" surface and then into the liquid. The vapor space area of the vessel is not considered. Its effect is negligible.

# Vaporizing Capacities For Other Air Temperatures

Multiply the results obtained with the above formulae by one of the following factors for the prevailing air temperature.

| Prevailing Air Temperature | Multiplier | Prevailing Air Temperature | Multiplier |
|---|---|---|---|
| -15ºF | 0.25 | +5ºF | 1.25 |
| -10ºF | 0.50 | +10ºF | 1.50 |
| -5ºF | 0.75 | +15ºF | 1.75 |
| 0ºF | 1.00 | +20ºF | 2.00 |

# Proper Purging of LP-Gas Containers

## The Importance of Purging

A very important step which must not be overlooked by LP-Gas distributors is the importance of properly purging new LP-Gas containers. Attention to this important procedure will promote customer satisfaction and greatly reduce service calls on new installations. Consider the following:

- Both ASME and DOT specifications require hydrostatic testing of vessels after fabrication. This is usually done with water.
- Before charging with propane, the vessel will contain the normal amount of air.

### Both water and air are contaminants

They seriously interfere with proper operation of the system and the connected appliances. If not removed, they will result in costly service calls and needless expense far exceeding the nominal cost of proper purging.

## Neutralizing Moisture

Even if a careful inspection (using a pen flashlight) reveals no visible moisture, the container must still be neutralized, since dew may have formed on the walls; additionally, the contained air may have relative humidity up to 100%.

A rule of thumb for neutralizing moisture in an ASME container calls for the introduction of at least one pint of genuine absolute anhydrous methanol* (99.85% pure) for each 100 gal. of water capacity of the container. On this basis, the minimum volumes for typical containers would be as shown below:

| Container Type | Minimum Volume Methanol Required |
|---|---|
| 100 lb. ICC cylinder | 1/8 pt. (2 fl. ozs.) |
| 420 lb. ICC cylinder | 1/2 pt. (8 fl. ozs.) |
| 500 gal. tank | 5 pts. (2 1/2 qts.) |
| 1000 gal. tank | 10 pts. (1 1/4 gal.) |

* IMPORTANT-Avoid substitutes - they will not work. The secret of the effectiveness of methanol over all other alcohols is its high affinity for water plus a boiling point lower than all other alcohols, and most important: a boiling point lower than water.

# Proper Purging of LP-Gas Containers

## The Importance of Purging Air

If the natural volume of atmosphere in the vessel is not removed before the first fill, these problems will result:

- Installations made in spring and summer will experience excessive and false container pressures. This will cause the safety relief valve to open, blowing off the excess pressure.
- The air mixture present in the vapor space will be carried to the appliances. This may result in as many as 5 or more service calls from pilot light extinguishment.
- If a vapor return equalizing hose is not used, the contained air will be compressed above the liquid level, resulting in slow filling.
- If a vapor equalizing hose is used, the air, and any moisture it contains, will be transferred from the storage tank to the transport.

Additionally, if atmospheric air is properly purged from the storage tank;

- the storage tank will fill faster,
- appliances will perform more consistently
- relief valves will be less likely to pop off at consumer installations.

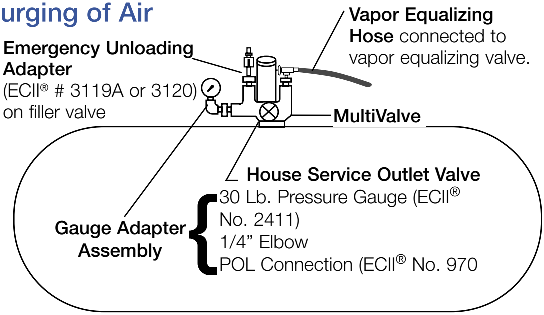
## Never Purge with Liquid

The wrong way is of course the easiest way. Never purge a container with liquid propane. To do so causes the liquid to flash into vapor, chilling the container, and condensing any moisture vapor on the walls where it remains while the pressure is being blown down. Additionally, less than 50% or as little as 25% of the air will be removed by this easy but wrong method.

The correct procedure for purging air is shown on the following page.

# Proper Purging of LP-Gas Containers

## Purging of Air




1. Install an unloading adapter on the double check filler valve, leaving it in the closed position.
2. Install a gauge adapter assembly on the service valve POL outlet connection. Exhaust to atmosphere any air pressure in the container.*(See page 11)
3. Attach a truck vapor equalizing hose to the vapor return valve on the container.
4. Open the valve on the outlet end of the vapor equalizing hose, throttling it to avoid slugging the excess flow valve on the truck. Carefully observe the pressure gauge.
5. When the gauge reading shows 15 psig, shut off the vapor valve on the hose.
6. Switch the lever on the unloading adapter to open the double check filler valve and blow down to exhaustion.
7. Close unloading adapter lever, allowing the double check filler valve to close.
8. Repeat steps (4), (5), (6), and (7) FOUR MORE TIMES. Total required time is 15 minutes or less.

CAUTION:

Never purge the container in this manner on the customer's property. Discharge of the vapor into the atmosphere can seriously contaminate the surrounding area. It should in all cases be done on the bulk plant site.

# Proper Purging of LP-Gas Containers

## Here's What Happened

While performing the operations shown on the preceding page, the percent of air in the container was reduced as shown in the table below:

| | % Air Remaining | % Propane Remaining |
|---|---|---|
| 1st Purging | 50 | 50 |
| 2nd Purging | 25 | 75 |
| 3rd Purging | 12.5 | 87.5 |
| 4th Purging | 6.25 | 93.75 |
| 5th Purging | 3.13 | 96.87 |
| 6th Purging | 1.56 | 98.44 |

Experience indicates that a reduction of the residual air content to 6.25% is adequate. The resulting mixture will have a thermal value of about 2400 BTU. In this case, the serviceman can adjust the burners for a slightly richer product. Moreover, the slight volume of air will to some extent dissolve in the propane if the installation stands unused for a few days.

### How much Product was Consumed

If instructions on the preceding page were carefully followed and the vapor was purged five times, a total of 670 cu. ft. (18.4 gal) would have been used for a 1000 gallon tank. In a 500 gallon tank, a total of 9.2 gallons would have been used.

### DOT Cylinder Purging

1. Exhaust to atmosphere any air pressure in the container*
2. Pressurize the cylinder to 15 psig propane vapor
3. Exhaust vapor to atmosphere
4. Repeat four more times

### * Pre-Purged containers

For LP-Gas containers that are purchased pre-purged it is not necessary to follow the purging procedure previously shown in this handbook. Simply attach an adapter onto the POL service connection and introduce propane vapor into the container. Allow container pressure to reach at least 15 psig before disconnecting the adapter. Air and moisture have already been removed from pre-purged containers.

For more information, contact your local container supplier.

## Proper Placement of Cylinders and Tanks

After the proper number of DOT cylinders or proper size of ASME storage containers has been determined, care must be taken in selecting the most accessible, but "safety approved" site for their location.

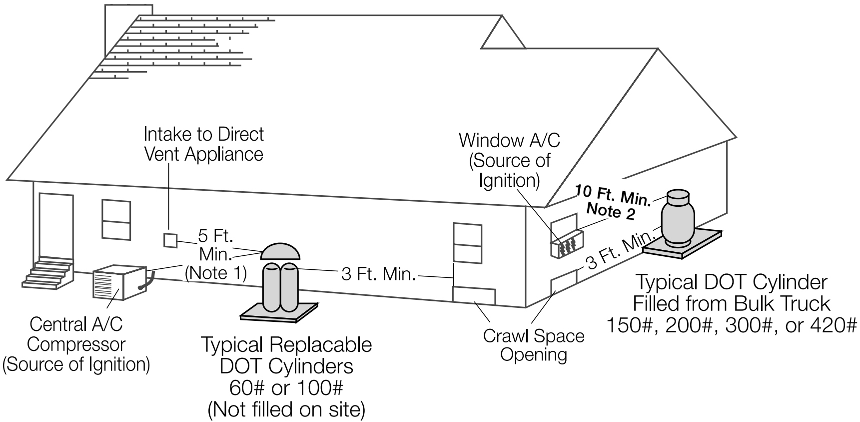
Consideration should be given to the customer's desires as to location of LP-Gas containers, and the ease of exchanging cylinders of refilling the storage tanks with the delivery truck—BUT precedence must be given to state and local regulations and NFPA 58, Liquefied Petroleum Gas Code. Refer to this standard when planning placement of LP-Gas containers. Copies are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

The charts on the following pages are reprinted with permission of NFPA 58-1998, LP-Gas Code, Copyright © 1998, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the NFPA on the referenced subject which is represented only by the standard in its entirety.

# Location of DOT Cylinders

## From NFPA 58, Appendix I

**Federal, state, and local ordinances and regulations should be observed at all times.**



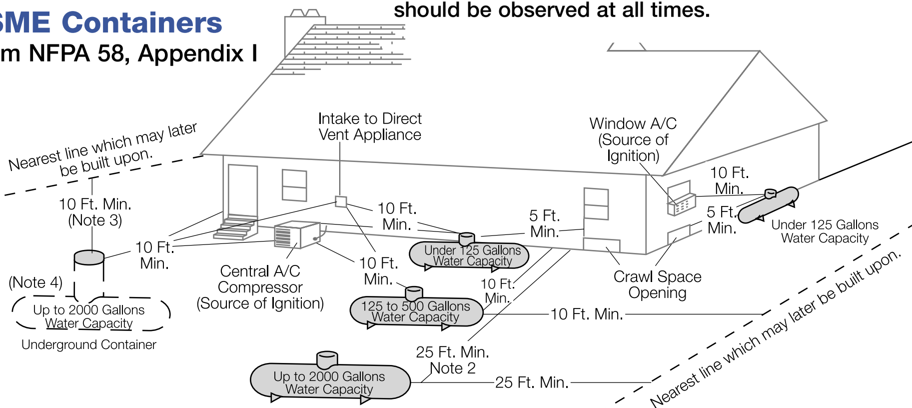

**Notes: 1) 5 foot minimum between relief valve discharge and external source of ignition (air conditioner), direct vent, or mechanical ventilation system. (attic fan).**

**2. If the DOT cylinder is filled on-site from a bulk truck, the filling connection and vent valve must be at least 10 feet from any external source of ignition, direct vent. or mechanical ventilation system.**

# Location of ASME Containers

## From NFPA 58, Appendix I

**Federal, state, and local ordinances and regulations should be observed at all times.**




**Notes:**

1) Regardless of its size, any ASME tank filled on-site must be located so that the filling connection and fixed liquid level gauge are at least 10 feet from external source of ignition (i.e. open flame, window A/C, compressor, etc.), intake to direct vented gas appliance, or intake to a mechanical ventilation system.

2) May be reduced to 10 feet minimum for a single container of 1200 gallons water capacity or less if it is located at least 25 feet from any other LP-Gas container of more than 125 gallons water capacity.

3) Minimum distances from underground containers shall be measured from the relief valve and filling or level gauge vent connection at the container, except that no part of an underground container shall be less than 10 feet from a building or line of adjoining property which may be built upon.

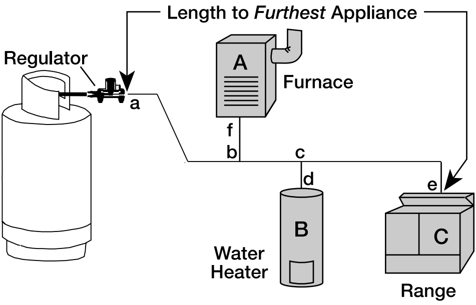
4) Where the container may be subject to abrasive action or physical damage due to vehicular traffic or other causes it must be either a) placed not less than 2 feet below grade or b) otherwise protected against such physical damage.

# Pipe And Tubing Selection

Use the following simple method to assure the selection of the correct sizes of piping and tubing for LP-Gas vapor systems. Piping between first and second stage regulators is considered, as well as low pressure (inches water column) piping between second stage, single stage, or integral twin stage regulators and appliances.

Instructions:

1. Determine the total gas demand for the system by adding up the BTU/hr input from the appliance nameplates and adding demand as appropriate for future appliances.
2. For second stage or integral twin stage piping:
   A. Measure length of piping required from outlet of regulator to the appliance furthest away. No other length is necessary to do the sizing.
   B. Make a simple sketch of the piping, as shown.
   C. Determine the capacity to be handled by each section of piping. For example, the capacity of the line between a and b must handle the total demand of appliances A, B, and C; the capacity of the line from c to d must handle only appliance B, etc.



## Pipe And Tubing Selection

D. Using Table 3 select proper size of tubing or pipe for each section of piping, using values in BTU/hr for the length determined from step #2-A. If exact length is not on chart, use next longer length. Do not use any other length for this purpose! Simply select the size that shows at least as much capacity as needed for each piping section.

3. For piping between first and second stage regulators

A. For a simple system with only one second stage regulator, merely measure length of piping required between outlet of first stage regulator and inlet of second stage regulator. Select piping or tubing required from Table 1.

B. For systems with multiple second stage regulators, measure length of piping required to reach the second stage regulator that is furthest away. Make a simple sketch, and size each leg of piping using Table 1, 2, or 3 using values shown in column corresponding to the length as measured above, same as when handling second stage piping.

# Pipe And Tubing Selection

Example 1.

Determine the sizes of piping or tubing required for the twin-stage LP-Gas installation shown.

Total piping length = 84 feet (use Table 3 @90 feet)

From a to b, demand = 38,000 + 35,000 + 30,000

= 103,000 BTU/hr; use 3/4" pipe

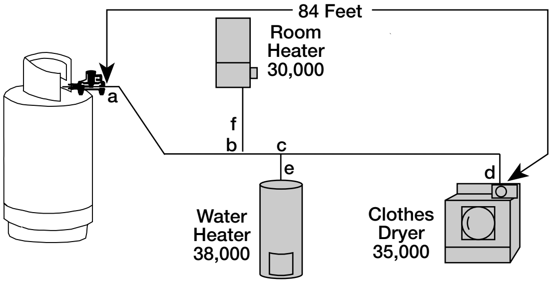
From b to c, demand = 38,000 + 35,000

= 73,000 BTU/hr; use 1/2" pipe or 3/4" tubing

From c to d, demand = 35,000 BTU/hr; use 1/2" pipe or 5/8" tubing

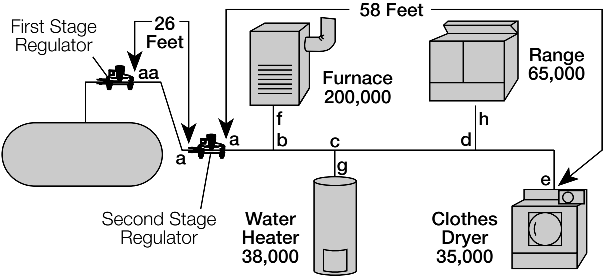
From c to e, demand = 38,000 BTU/hr; use 1/2" pipe or 5/8" tubing

From b to f, demand = 30,000 BTU/hr; use 1/2" pipe or 1/2" tubing



# Pipe And Tubing Selection

Example 2.
Determine the sizes of piping or tubing required for the two-stage LP-Gas installation shown.




Total first stage piping length = 26 feet; first stage regulator setting is 10psig (use Table 1 or 2 @ 30 feet)

From aa to a, demand = 338,000 BTU/hr; use 1/2" pipe, 1/2" tubing, or 1/2" T plastic pipe.

Total second stage piping length = 58 feet (use Table 3 @ 60 feet)

From a to b, demand = 338,000 BTU/hr; use 1" pipe

From b to c, demand = 138,000 BTU/hr; use 3/4" pipe or 7/8" tubing

From c to d, demand = 100,000 BTU/hr; use 1/2" pipe or 3/4" tubing

From d to e, demand = 35,000 BTU/hr; use 1/2" pipe or 1/2" tubing

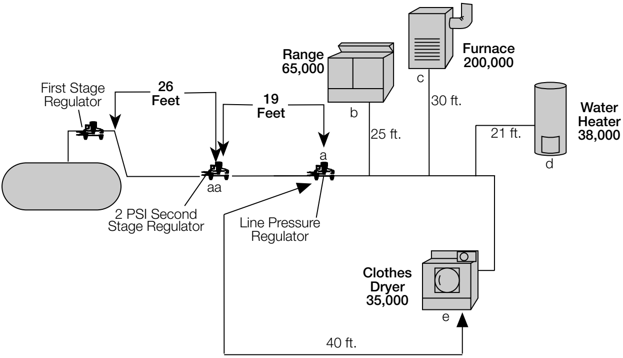
From b to f, demand = 200,000 BTU/hr; use 3/4" pipe or 7/8" tubing

From c to g, demand = 38,000 BTU/hr; use 1/2" pipe or 1/2" tubing

From d to h, demand = 65,000 BTU/hr; use 1/2" pipe or 5/8" tubing

# Pipe And Tubing Selection

Example 3
Determine the sizes of piping or tubing required for the 2 PSI LP-Gas installation shown.




Total first stage piping length = 26 feet; first stage regulator setting is 10psig (use Table 1 or 2 @ 30 feet)

Total 2 PSI Piping Length = 19 ft. (use Table 4 @ 20 ft. or Table 6 @ 20 ft.)

From aa to a, demand = 338,000 BTU
use 3/8" CSST or 1/2" copper tubing or 1/2" pipe

From Regulator a to each appliance:

From a to b, demand = 65,000 BTU; length = 25 ft. (Table 5),
use 1/2" CSST

From a to c, demand = 200,000 BTU; length = 30 ft. (Table 5)
use 3/4" CSST

From a to d, demand = 38,000 BTU; length = 21 ft.* (Table 5)
use 3/8" CSST *use 25 ft. column

From a to e, demand = 35,000 BTU; length = 40 ft. (Table 5)
use 1/2" CSST

# Table 1 – First Stage Pipe Sizing (Between First and Second Stage Regulators)

10 PSIG Inlet with a 1 PSIG Pressure Drop
Maximum capacity of pipe or tubing, in thousands of BTU/hr or LP-Gas

| Size of Pipe or Copper Tubing, Inches | | Length of Pipe or Tubing, Feet* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Copper Tubing (O.D.) | 3/8 | 558 | 383 | 309 | 265 | 235 | 213 | 196 | 182 | 171 | 161 |
| | 1/2 | 1387 | 870 | 700 | 599 | 531 | 481 | 443 | 412 | 386 | 365 |
| | 5/8 | 2360 | 1622 | 1303 | 1115 | 988 | 896 | 824 | 767 | 719 | 679 |
| | 3/4 | 3993 | 2475 | 2205 | 1887 | 1672 | 1515 | 1394 | 1297 | 1217 | 1149 |
| Pipe Size | 1/2 | 3339 | 2295 | 1843 | 1577 | 1398 | 1267 | 1165 | 1084 | 1017 | 961 |
| | 3/4 | 6982 | 4799 | 3854 | 3298 | 2923 | 2649 | 2437 | 2267 | 2127 | 2009 |
| | 1 | 13153 | 9040 | 7259 | 6213 | 5507 | 4989 | 4590 | 4270 | 4007 | 3785 |
| | 1-1/4 | 27004 | 18560 | 14904 | 12756 | 11306 | 10244 | 9424 | 8767 | 8226 | 7770 |
| | 1-1/2 | 40461 | 27809 | 22331 | 19113 | 16939 | 15348 | 14120 | 13136 | 12325 | 11642 |
| | 2 | 77924 | 53556 | 43008 | 36809 | 32623 | 29559 | 27194 | 25299 | 23737 | 22422 |

| | | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper Tubing (O.D.) | 3/8 | 142 | 130 | 118 | 111 | 104 | 90 | 89 | 89 | 82 | 76 |
| | 1/2 | 323 | 293 | 269 | 251 | 235 | 222 | 211 | 201 | 185 | 172 |
| | 5/8 | 601 | 546 | 502 | 467 | 438 | 414 | 393 | 375 | 345 | 321 |
| | 3/4 | 1018 | 923 | 843 | 790 | 740 | 700 | 664 | 634 | 584 | 543 |
| Pipe Size | 1/2 | 852 | 772 | 710 | 660 | 619 | 585 | 556 | 530 | 488 | 454 |
| | 3/4 | 1780 | 1613 | 1484 | 1381 | 1296 | 1224 | 1162 | 1109 | 1020 | 949 |
| | 1 | 3354 | 3039 | 2796 | 2601 | 2441 | 2305 | 2190 | 2089 | 1922 | 1788 |
| | 1-1/4 | 6887 | 6240 | 5741 | 5340 | 5011 | 4733 | 4495 | 4289 | 3945 | 3670 |
| | 1-1/2 | 10318 | 9349 | 8601 | 8002 | 7508 | 7092 | 6735 | 6426 | 5911 | 5499 |
| | 2 | 19871 | 18005 | 16564 | 15410 | 14459 | 13658 | 12971 | 12375 | 11385 | 10591 |

* Total length of piping from outlet of first stage regulator to inlet of second state regulator (or to inlet of second stage regulator furthest away).

Notes: 1) To allow 2 PSIG pressure drop, multiply total gas demand by .707, and use capacities from table.

2) For different first stage pressures, multiply total gas demand by the following factors, and use capacities from table.

Ex: 1,000,000 BTU load at 5 PSI: 1,000,000 (1.12) = 1,200,000 BTU then use chart bases on 1,200,000 BTU

| First Stage Pressure PSIG | Multiply By |
|---|---|
| 20 | .844 |
| 15 | .912 |
| 5 | 1.120 |

Data Calculated per NFPA #54 & 58

# Table 2 – First Stage Plastic Tubing Sizing

10 PSIG Inlet with a 1 PSIG Pressure Drop

Maximum capacity of plastic tubing in thousands of BTU/hr of LP-Gas

| Size of Plastic Tubing | | Length of Tubing, Feet* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NPS | SDR | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 1/2T | 7.00 | 1387 | 954 | 766 | 655 | 581 | 526 | 484 | 450 | 423 | 399 |
| 1/2 | 9.33 | 3901 | 2681 | 2153 | 1843 | 1633 | 1480 | 1361 | 1267 | 1188 | 1122 |
| 3/4 | 11.00 | 7811 | 5369 | 4311 | 3690 | 3270 | 2963 | 2726 | 2536 | 2379 | 2248 |
| 1T | 11.50 | 9510 | 6536 | 5249 | 4492 | 3981 | 3607 | 3319 | 3088 | 2897 | 2736 |
| 1T | 12.50 | 10002 | 6874 | 5520 | 4725 | 4187 | 3794 | 3490 | 3247 | 3046 | 2878 |
| 1 | 11.00 | 14094 | 9687 | 7779 | 6658 | 5901 | 5346 | 4919 | 4578 | 4293 | 4055 |
| 1-1/4 | 10.00 | 24416 | 16781 | 13476 | 11534 | 10222 | 9262 | 8521 | 7927 | 7438 | 7026 |
| 2 | 11.00 | 66251 | 45534 | 36566 | 31295 | 27737 | 25131 | 23120 | 21509 | 20181 | 19063 |

| | | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2T | 7.00 | 354 | 321 | 295 | 274 | 257 | 243 | 231 | 220 | 203 | 189 |
| 1/2 | 9.33 | 995 | 901 | 829 | 772 | 724 | 684 | 649 | 620 | 570 | 530 |
| 3/4 | 11.00 | 1992 | 1805 | 1660 | 1545 | 1499 | 1369 | 1300 | 1241 | 1141 | 1062 |
| 1T | 11.50 | 2425 | 2197 | 2022 | 1881 | 1765 | 1667 | 1583 | 1510 | 1389 | 1293 |
| 1T | 12.50 | 2551 | 2311 | 2126 | 1978 | 1856 | 1753 | 1665 | 1588 | 1461 | 1359 |
| 1 | 11.00 | 3594 | 3257 | 2996 | 2787 | 2615 | 2470 | 2346 | 2238 | 2059 | 1916 |
| 1-1/4 | 10.00 | 6226 | 5642 | 5190 | 4829 | 4531 | 4280 | 4064 | 3878 | 3567 | 3318 |
| 2 | 11.00 | 16895 | 15308 | 14084 | 13102 | 12293 | 11612 | 11028 | 10521 | 9680 | 9005 |

* Total length of piping from outlet of first stage regulator to inlet of second state regulator or to inlet of second stage regulator furthest away.

| First Stage Pressure PSIG | Multiply By |
|---|---|
| 20 | .844 |
| 15 | .912 |
| 5 | 1.120 |

Data Calculated per NFPA #54 & 58

# Table 3 – Second Stage or Integral Twin Stage Pipe Sizing

11 Inches Water Column Inlet with a 1/2 Inch Water Column Drop
Maximum capacity of pipe or tubing in thousands of BTU/hr of LP-Gas

| Size of Pipe or Copper Tubing, Inches | | Length of Pipe or Tubing, Feet* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Copper Tubing (O.D.) | 3/8 | 49 | 34 | 27 | 23 | 20 | 19 | — | — | — | — |
| | 1/2 | 110 | 76 | 61 | 52 | 46 | 42 | 38 | 36 | 33 | 32 |
| | 5/8 | 206 | 151 | 114 | 97 | 86 | 78 | 71 | 67 | 62 | 59 |
| | 3/4 | 348 | 239 | 192 | 164 | 146 | 132 | 120 | 113 | 105 | 100 |
| | 7/8 | 536 | 368 | 296 | 253 | 224 | 203 | 185 | 174 | 161 | 154 |
| Pipe Size | 1/2 | 291 | 200 | 161 | 137 | 122 | 110 | 102 | 94 | 87 | 84 |
| | 3/4 | 608 | 418 | 336 | 287 | 255 | 231 | 212 | 198 | 185 | 175 |
| | 1 | 1146 | 788 | 632 | 541 | 480 | 435 | 400 | 372 | 349 | 330 |
| | 1-1/4 | 2353 | 1617 | 1299 | 1111 | 985 | 892 | 821 | 764 | 717 | 677 |
| | 1-1/2 | 3525 | 2423 | 1946 | 1665 | 1476 | 1337 | 1230 | 1144 | 1074 | 1014 |
| | 2 | 6789 | 4666 | 3747 | 3207 | 2842 | 2575 | 2369 | 2204 | 2068 | 1954 |

| | | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper Tubing (O.D.) | 3/8 | — | — | — | — | — | — | — | — | — | — |
| | 1/2 | — | — | — | — | — | — | — | — | — | — |
| | 5/8 | — | — | — | — | — | — | — | — | — | — |
| | 3/4 | — | — | — | — | — | — | — | — | — | — |
| | 7/8 | — | — | — | — | — | — | — | — | — | — |
| Pipe Size | 1/2 | 74 | 67 | 62 | 58 | 54 | 51 | 48 | 46 | 43 | 40 |
| | 3/4 | 155 | 141 | 129 | 120 | 113 | 107 | 101 | 97 | 89 | 83 |
| | 1 | 292 | 265 | 244 | 227 | 213 | 201 | 191 | 182 | 167 | 156 |
| | 1-1/4 | 600 | 544 | 500 | 465 | 437 | 412 | 392 | 374 | 344 | 320 |

* Total length of piping from outlet of regulator to appliance furthest away.

Data Calculated per NFPA #54 & 58

## Table 4-Maximum Capacity of CSST

In Thousands of BTU per hour of undiluted LP-Gases
Pressure of 2 psi and a pressure drop of 1 psi (Based on a 1.52 Specific Gravity Gas)*

| Size | EHD** Flow Designation | Length of Tubing, Feet | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 25 | 30 | 40 | 50 | 75 | 80 | 110 | 150 | 200 | 250 | 300 | 400 | 500 |
| 3/8 | 13 | 426 | 262 | 238 | 203 | 181 | 147 | 140 | 124 | 101 | 86 | 77 | 69 | 60 | 53 |
| | 15 | 558 | 347 | 316 | 271 | 243 | 196 | 189 | 169 | 137 | 118 | 105 | 96 | 82 | 72 |
| 1/2 | 18 | 927 | 591 | 540 | 469 | 420 | 344 | 333 | 298 | 245 | 213 | 191 | 173 | 151 | 135 |
| | 19 | 1106 | 701 | 640 | 554 | 496 | 406 | 393 | 350 | 287 | 248 | 222 | 203 | 175 | 158 |
| 3/4 | 23 | 1735 | 1120 | 1027 | 896 | 806 | 663 | 643 | 578 | 477 | 415 | 373 | 343 | 298 | 268 |
| | 25 | 2168 | 1384 | 1266 | 1100 | 986 | 809 | 768 | 703 | 575 | 501 | 448 | 411 | 355 | 319 |
| | 30 | 4097 | 2560 | 2331 | 2012 | 1794 | 1457 | 1410 | 1256 | 1021 | 880 | 785 | 716 | 616 | 550 |
| 1 | 31 | 4720 | 2954 | 2692 | 2323 | 2072 | 1685 | 1629 | 1454 | 1182 | 1019 | 910 | 829 | 716 | 638 |

Table does not include effect of pressure drop across the line regulator. If regulator loss exceeds 1/2 psi (based on 13 in. water column outlet pressure), **DO NOT USE THIS TABLE.** Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

*Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation: L-1.3n where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

**EHD — Equivalent Hydraulic Diameter — A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

# Table 5-Maximum Capacity of CSST

In Thousands of BTU per hour of undiluted LP-Gases
Pressure of 11 Inch Water Column and a Pressure Drop of 0.5 Inch Water Column
(Based on a 1.52 Specific Gravity Gas)*

| Size | EHD** Flow Designation | Length of Tubing, Feet | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 150 | 200 | 250 | 300 |
| 3/8 | 13 | 72 | 50 | 39 | 34 | 30 | 28 | 23 | 20 | 19 | 17 | 15 | 15 | 14 | 11 | 9 | 8 | 8 |
| | 15 | 99 | 69 | 55 | 49 | 42 | 39 | 33 | 30 | 26 | 25 | 23 | 22 | 20 | 15 | 14 | 12 | 11 |
| 1/2 | 18 | 181 | 129 | 104 | 91 | 82 | 74 | 64 | 58 | 53 | 49 | 45 | 44 | 41 | 31 | 28 | 25 | 23 |
| | 19 | 211 | 150 | 121 | 106 | 94 | 87 | 74 | 66 | 60 | 57 | 52 | 50 | 47 | 36 | 33 | 30 | 26 |
| | 23 | 355 | 254 | 208 | 183 | 164 | 151 | 131 | 118 | 107 | 99 | 94 | 90 | 85 | 66 | 60 | 53 | 50 |
| 3/4 | 25 | 426 | 303 | 248 | 216 | 192 | 177 | 153 | 137 | 126 | 117 | 109 | 102 | 98 | 75 | 69 | 61 | 57 |
| | 30 | 744 | 521 | 422 | 365 | 325 | 297 | 256 | 227 | 207 | 191 | 178 | 169 | 159 | 123 | 112 | 99 | 90 |

*Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation: $L = 1.3n$ where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

**EHD — Equivalent Hydraulic Diameter — A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

# Table 6 – Copper Tube Sizing or Schedule 40 Pipe Sizing*

In Thousands of BTU per hour of undiluted LP-Gases

2 PSIG inlet with a 1PSIG pressure drop

| Size of Pipe or Copper Tubing, Inches | | Length of Pipe or Tubing, Feet* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Copper | 3/8 | 451 | 310 | 249 | 213 | 189 | 171 | 157 | 146 | 137 | 130 |
| Tubing | 1/2 | 1020 | 701 | 563 | 482 | 427 | 387 | 356 | 331 | 311 | 294 |
| (O.D.) | 5/8 | 1900 | 1306 | 1049 | 898 | 795 | 721 | 663 | 617 | 579 | 547 |
| | 3/4 | 3215 | 2210 | 1774 | 1519 | 1346 | 1219 | 1122 | 1044 | 979 | 925 |
| Pipe Size | 1/2 | 2687 | 1847 | 1483 | 1269 | 1125 | 1019 | 938 | 872 | 819 | 773 |
| | 3/4 | 5619 | 3862 | 3101 | 2654 | 2352 | 2131 | 1961 | 1824 | 1712 | 1617 |
| | 1 | 10585 | 7275 | 5842 | 5000 | 4431 | 4015 | 3694 | 3436 | 3224 | 3046 |
| | 1-1/4 | 21731 | 14936 | 11994 | 10265 | 9098 | 8243 | 7584 | 7055 | 6620 | 6253 |
| | 1-1/2 | 32560 | 22378 | 17971 | 15381 | 13632 | 12351 | 11363 | 10571 | 9918 | 9369 |
| | 2 | 62708 | 43099 | 34610 | 29621 | 26253 | 23787 | 21884 | 20359 | 19102 | 18043 |

| | | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 700 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 3/8 | 104 | 89 | 79 | 72 | 66 | 61 | 58 | 54 | 49 | 45 |
| Tubing | 1/2 | 236 | 202 | 179 | 162 | 149 | 139 | 130 | 123 | 111 | 102 |
| (O.D.) | 5/8 | 439 | 376 | 333 | 302 | 278 | 258 | 242 | 229 | 207 | 191 |
| | 3/4 | 743 | 636 | 563 | 511 | 470 | 437 | 410 | 387 | 351 | 323 |
| Pipe Size | 1/2 | 621 | 531 | 471 | 427 | 393 | 365 | 343 | 324 | 293 | 270 |
| | 3/4 | 1298 | 1111 | 985 | 892 | 821 | 764 | 717 | 677 | 613 | 564 |
| | 1 | 2446 | 2093 | 1855 | 1681 | 1546 | 1439 | 1350 | 1275 | 1155 | 1063 |
| | 1-1/4 | 5021 | 4298 | 3809 | 3451 | 3175 | 2954 | 2771 | 2618 | 2372 | 2182 |
| | 1-1/2 | 7524 | 6439 | 5707 | 5171 | 4757 | 4426 | 4152 | 3922 | 3554 | 3270 |
| | 2 | 14490 | 12401 | 10991 | 9959 | 9162 | 8523 | 7997 | 7554 | 6844 | 6297 |

# LP-Gas Regulators

The regulator truly is the heart of an LP-Gas installation. It must compensate for variations in tank pressure from as low as 8 psig to 220 psig – and still deliver a steady flow of LP-Gas at 11” w.c. to consuming appliances. The regulator must deliver this pressure despite a variable load from intermittent use of the appliances.

The use of a two-stage system offers the ultimate in pin-point regulation. Two-stage regulation can result in a more profitable LP-Gas operation for the dealer resulting from less maintenance and fewer installation call-backs.

## Single Stage/Twin-Stage Regulation

NFPA 58 (1998) states that single stage regulators shall not be installed in fixed piping systems. This requirement includes systems for appliances on RVs, motor homes, manufactured housing, and food service vehicles. In these cases a twin-stage regulator must be used. The requirements do not apply to small outdoor cooking appliances, such as gas grills, provided the input rating is 100,000 BTU/hr or less.

## Two Stage Regulation

### Two-Stage regulation has these advantages:

### Uniform Appliance Pressures

The installation of a two-stage system–one high pressure regulator at the container to compensate for varied inlet pressures, and one low pressure regulator at the building to supply a constant delivery pressure to the appliances–helps ensure maximum efficiency and trouble-free operation year round. Two-stage systems keep pressure variations within 1” w.c. at the appliances.

### Reduced Freeze-ups/Service Calls

Regulator freeze-up occurs when moisture in the gas condenses and freezes on cold surfaces of the regulator nozzle. The nozzle becomes chilled when high pressure gas expands across it into the regulator body.

Two-stage systems can greatly reduce the possibility of freeze-ups and resulting service calls as the expansion of gas from tank pressure to 11” w.c. is divided into two steps, with less chilling effect at each regulator. In addition, after the gas exits the first-stage regulator and enters the first-stage transmission line, it picks up heat from the line, further reducing the possibility of second-stage freeze-up.

### Economy of Installation

In a twin-stage system, transmission line piping between the container and the appliances must be large enough to accommodate the required volume of gas at 11"w.c.. In contrast, the line between the first and second-stage regulators in two-stage systems can be much smaller as it delivers gas at 10 psig to the second stage regulator. Often the savings in piping cost will pay for the second regulator.

In localities where winter temperatures are extremely low, attention should be given to the setting of the first stage regulator to avoid the possibility of propane vapors recondensing into liquid in the line downstream of the first-stage regulator. For instance, if temperatures reach as low as -20ºF, the first-stage regulator should not be set higher than 10 psig. If temperatures reach as low as -35ºF, the setting of the first-stage regulator should not be higher than 5 psig.

As an additional benefit, older single-stage systems can be easily converted to two-stage systems using existing supply lines when they prove inadequate to meet added loads.

### Allowance for Future Appliances

A high degree of flexibility is offered in new installations of two-stage systems. Appliances can be added later to the present load– provided the high pressure regulator can handle the increase– by the addition of a second low pressure regulator. Since appliances can be regulated independently, demands from other parts of the installation will not affect their individual performances.

## Regulator Lockup Troubleshooting

### The Problem:

A new, properly installed ECII® regulator has a high lock-up, does not lock up, or is creeping.

This is often caused by foreign material on the regulator seat disc. Foreign material usually comes from system piping upstream of the regulator. This material prevents the inlet nipple from properly seating on the seat disc.

### The Solution:

There is a simple procedure that can be completed in the field that will resolve the problems in most cases. This procedure should be

# LP-Gas Regulators

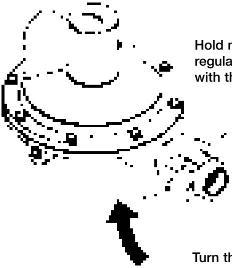
done by qualified service personnel only.

Once it has been determined that a new regulator has not properly locked up, the following steps should be followed:

## Step 1

Hold the neck of the regulator bod
inlet with a second wrench by turr
(left hand thread).

Save the inlet nipple and gasket fc



Hold neck of regulator securely with this wrench

Turn this wrench clockwise

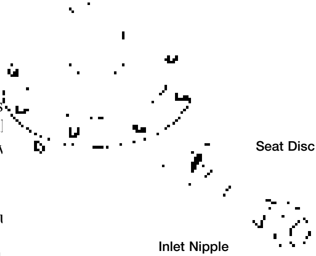
## Step 2

Inspect the regulator seat disc. Wi

Inspect the inlet nipple to be sure
aged.

## Step 3

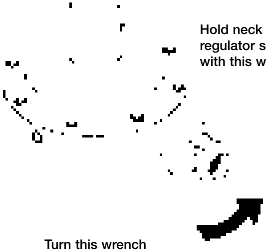
Reinstall the inlet nipple and
gasket by turning counterclockwis
thread). Hold the neck of the regul
the inlet nipple into the regulator v
torque–do not overtighten.



Seat Disc

Inlet Nipple

Be careful not to damage threads.
After completing these steps, be su
pigtails are being used.
Reinstall the regulator, check for l
system.



Hold neck of regulator securely with this wrench

Turn this wrench counterclockwise

# LP-Gas Regulators

## Pigtails

If you are replacing an old regulator, remember to replace the copper pigtail. The old pigtail may contain corrosion which can restrict flow. In addition, corrosion may flake off and wedge between the regulator orifice and seat disc–preventing proper lock-up at zero flow.

## Regulator Vents/Installation

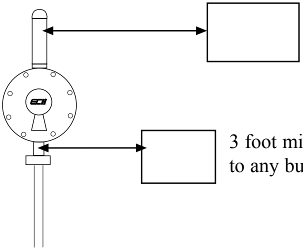
The elements, such as freezing rain, sleet, snow, ice, mud, or debris, can obstruct the vent and prevent the regulator from operating properly. This can result in high pressure gas at the appliances resulting in explosion or fire.

Regulator vents must be clear and fully open at all times. Regulators installed in accordance with NFPA #58 will meet these requirements.

In general, regulators should be installed with the vent facing down and under a protective cover. Screened vents must be checked to see that the screen is in place at all times. If the vent is clogged or screen missing, cleaning of the vent and screen replacement is necessary. If there is evidence of foreign material inside the vent, the regulator should be replaced.

In applications where the regulator employs a vent discharge pipe, be sure it is installed with the outlet down and protected with a screen or suppressor. See RegO® Products Safety Warning WB-1 for important warning information on regulators.

## Second Stage Regulator Installation Minimum Distances



5 foot minimim from relief discharge to an source of ignition or mechanical air intake.

3 foot minimum from relief discharge to any building opening.

per NFPA 58

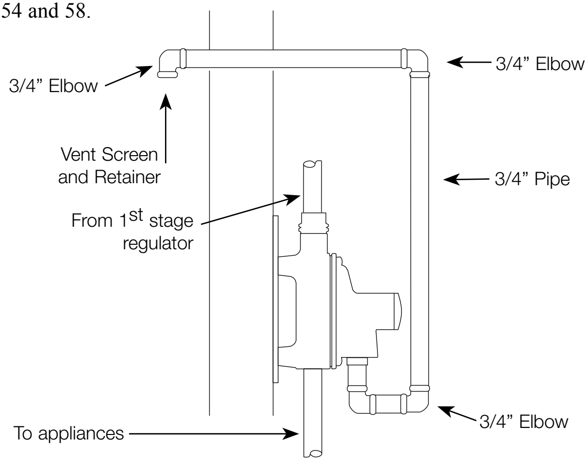
# LP-Gas Regulators

## Indoor Installation of Regulators

Regulators installed inside a building must have the bonnet vent piped away. To maintain the large vent capacity relief feature of the regulator, the vent piping should be at least as large as the vent opening on the regulator bonnet.

To pipe away the LV4404B regulator, for example, remove the vent screen from the bonnet vent and install 3/4" pipe into the bonnet vent threads and pipe to the outside of building. Install vent protection on the outlet of the pipe away vent line. To utilize the vent screen and retainer supplied with the regulator, use a 3/4" NPT 90º elbow. Insert screen into 3/4" F.NPT outlet of elbow. Thread retainer into outlet at least 1 turn. Install the elbow with vent screen pointing down. The vent line must be installed in a manner to prevent the entry of water, insects, or foreign material that could cause blockage. The discharge opening must be at least 3 feet from any opening below it.

NOTE: Do not use regulators with over 5 PSIG inlet pressure indoors. Follow all local codes and standards as well as NFPA 54 and 58.



# LP-Gas Regulators

## Selecting LP-Gas Regulators

| Type of System | Maximum Load BTU/hr. | Suggested Regulator |
|---|---|---|
| First Stage in a Two Stage System | 1,500,000 (a) | LV3303TR |
| | 2,500,000 (b) | LV4403SR Series<br>LV4403TR Series |
| Second Stage in a Two Stage System | 935,000 (c) | LV4403B Series |
| | 1,600,000 (c) | LV5503B4/B6 |
| | 2,300,000 (c) | LV5503B8 |
| | 9,800,000 | LV6503B Series |
| Second Stage in a Two PSIG System | 1,000,000 | LV4403Y4/Y46R |
| | 2,200,000 | LV5503Y6/Y8 |
| Integral Twin Stage | 200,000 (d) | LV404B23 Series |
| | 525,000 (d) | LV404B4 Series<br>LV404B9 Series |
| Automatic Chnageover | 200,000 (d) | 7525B23 Series |
| | 450,000 (d) | 7525B4 Series |

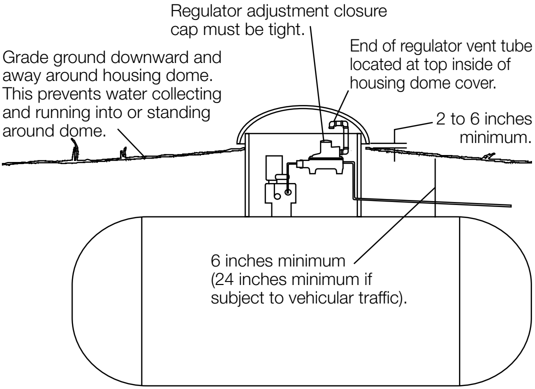
(a) Maximum load based on 25 PSIG inlet, 8 PSIG delivery pressure.
(b) Maximum load based on inlet pressure 20 PSIG higher than setting and delivery pressure 20% lower than setting.
(c) Maximum load based on 10 PSIG inlet, 9" w.c. delivery pressure.
(d) Maximum load based on 25 PSIG inlet, 9" w.c. delivery pressure.

See RegO® Products Catalogs for complete ordering information.

# LP-Gas Regulators

## Underground Installations

In underground installations the vent tube opening must be above the maximum water table and kept free from water, insects, and foreign material. NOTE: if the water mark in the dome of an underground tank is above the regulator vent tube end or regulator vent opening, the regulator should be replaced and the situation corrected.




## Reading a Regulator Performance Chart

Refer to the capacity chart for the size and type regulator which fits your particular application. Check the performance of this regulator with your actual load at the inlet pressure corresponding to your lowest winter temperatures (as shown on Page 3).

## Example for a Two Stage System

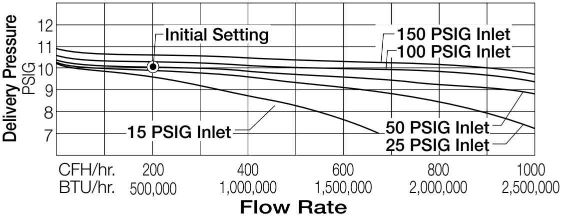
### Selecting the First Stage Regulator

1. Assume a load of 500,000 BTUs per hour
2. Assume a minimum delivery pressure of 9.5 psig.

# LP-Gas Regulators

3. Assume a minimum tank pressure of 15 psig.
4. For these conditions, refer to chart for the LV4403TR Series, First Stage Regulator, shown below.
5. Find the line on the chart corresponding to the lowest anticipated winter tank pressure (note that each performance line corresponds to and is marked with a different inlet pressure in PSI).
6. Draw a vertical line upward from the point of assumed load (500,000 BTUs per hour) to intersect with the line corresponding to the lowest tank pressure.
7. Read horizontally from the intersection of these lines to the delivery pressure at the left side of the chart. In this example the delivery pressure will be 9.7 psig. Since the delivery pressure will be 9.7 psig at the maximum load conditions and lowest anticipated tank pressure, the regulator will be sized properly for the demand.

### LV4403TR Series First Stage Regulator




## Example For a Two Stage System

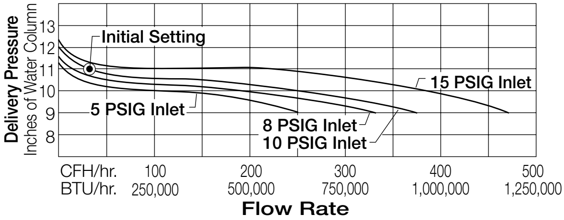
### Selecting the Second Stage Regulator

1. Assume a load of 250,000 BTUs per hour.
2. Assume a minimum delivery pressure of 10” w.c.
3. Assume a minimum inlet pressure of 10 psig.
4. For these conditions, refer to chart for the LV4403B Series, Second Stage Regulator, shown on next page.

# LP-Gas Regulators

5. Find the line on the chart corresponding to the anticipated inlet pressure.
6. Draw a vertical line upward from the point of assumed load (250,000 BTUs per hour) to intersect with the line corresponding to the lowest inlet pressure.
7. Read horizontally from the intersection of these lines to the delivery pressure at the left side of the chart. In this example the delivery pressure will read 10.6" w.c.. Since the delivery pressure will be 10.6" w.c. at the maximum load condition and lowest anticipated inlet pressure, the regulator is sized properly for the demand.

**LV4403B Series Second Stage Regulator**




# Leak Testing the Installation

According to NFPA 54:

> A leak test should be performed on new installation and on existing systems that are being placed back into service. The test should include all piping, fittings, regulators, and control valves in the system.

**Over the years, the pressure test and leak test have been confused with each other. A pressure test is required for new piping installation and additions to piping installation, while a leak test is required whenever the gas system is initially placed into service, or when the gas is turned back on after being turned off. In this handbook we discuss the leak test only. For further information regarding the pressure test, consult NFPA 54, 1999, 4.1.**

# Leak Testing the Installation

## A. Manometer Method (Low Pressure Testing Procedure)

In this method a low pressure test gauge (ECII® 2434A) or a water manometer (1212Kit) is used to detect pressure loss due to leaks.

Step 1. Inspect all connections and appliance valves to be sure such connections are wrench tight and that all appliance connections are closed including pilot valves and all line shutoff valves.

Step 2. Connect low pressure test gauge or manometer to a range top burner orifice. If a range is not available a special tee may be installed between the appliance shutoff and inlet to the appliance. Several shutoff valves have a pressure tap port that may be used.

Step 3. Open container valve to pressure piping system. Leave it open for two or three seconds then close tightly. Return to appliances and open each appliance piping shutoff valve slowly. If the pressure drops below 10 inches water column repeat step 3.

Step 4. Observe indicated pressure on low pressure test set of manometer. This reading should be at least 11 inches water column. Now slowly open one burner valve on an appliance or bleed through a pilot valve enough gas to reduce pressure reading on the test set or water manometer to exactly 9 inches water column.

A 10 minute constant pressure indicates a leak tight system. A drop in pressure indicates a leak in the system. If a drop occurs, check joints and other possible points of leakage with an approved combustible gas detector, soap and water, or an equivalent nonflammable solution. CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping should be rinsed with water after testing, unless it is determined the leak test solution is noncorrosive. Never test with an open flame. If there is an increase in pressure it indicates the container valve is not shut off completely. Shut off container valve tightly and repeat step 4.

# Leak Testing the Installation

## B. Gauge Adapter Method (High Pressure Testing Procedure)

Step 1. Inspect all connections and appliance valves to be sure such connections are wrench tight and that all appliance valves are closed including the pilot valves.

Step 2. Install an ECII® 2962 high pressure test gauge adapter on the tank service valve and connect the other end of the gauge adapter to the pigtail and regulator inlet.

Step 3. Open container valve to allow the system to pressurize while observing indicated pressure on 300 pound testing gauge.

Step 4. Close service valve tightly. Note pressure reading on the pressure gauge, then slowly bleed gas between service valve and gauge adapter, reduce pressure to 10 PSIG less than the original reading on the gauge and retighten gauge adapter into service valve or close bleeder port. Note reading on gauge.

If gauge reading remains constant for 10 minutes, it can be assumed the system is leak tight. If the pressure reading drops, it indicates a leak somewhere in the high or low pressure piping system. NOTE: A pressure drop of 15 psig in 10 minutes time indicates a leak as little as 10 BTU of gas per hour. Check joints and other possible points of leakage with an approved combustible gas detector, soap and water, or an equivalent nonflammable solution. CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping should be rinsed with water after testing, unless it is determined the leak test solution is noncorrosive. Never test with an open flame. If there is an increase in pressure it indicates the container valve is not shut off completely. Shut off container valve tightly and repeat step 4.

Step 5. Disconnect the 2962 test gauge adapter from the service shut off valve. Reconnect pigtail, tighten and test with soap and water or an appropriate leak detector solution (refer to caution in step 4., above).

Step 6. Proceed with manometer method, steps 2 through 4. Never check for leaks with an open flame.

# Leak Testing the Installation

NOTE: After the piping system and appliance connections have been proven to be leak tight, the air may be purged from lines. Refer to NPGA Propane Safety and Technical Support Manual Bulletin T403 and NFPA 54 for more information.

## Regulator Delivery Pressure

Check the regulator delivery pressure with approximately half the total appliance load in use. Your gauge should read 11 inches water column at the appliance. Adjust regulator if necessary. Following this, turn on all appliances to make sure that pressure is maintained at full load. If an excessive pressure drop occurs, inspect line for “kinks,” “flats,” or other restrictions.

CAUTION: Appliance regulators are installed on most appliances and may be preset by the manufacturer for flow pressure lower than 11 inches water column. It is recommended the manometer or test gauge be installed at a location other than the range orifice or appliance pressure tap when performing lockup and delivery pressure checks.

## Regulator Lock-up and Leakage

After this, shut off all appliance valves to determine if the regulator has a worn seat or if it has been set too high to compensate for line losses due to undersize piping. A slight rise in pressure will occur under these conditions. This is called the “lock-up” pressure. The lock-up pressure should not exceed 130% of the regulator set delivery pressure. A quick rise in pressure above this point will indicate undersize piping.

Continue this same test for 5 minutes or more. If a creeping rise is noticed in the pressure, the regulator seat is not closing off properly. Inspect regulator inlet nozzle for dirt, scratches, or dents, and seat disc for signs of wear. Replace where necessary.

For more information, refer to NFPA 54, Section on Inspection, Testing and Purging, NPGA Propane Safety and Technical Support Manual Bulletin 403, “Pressure testing and leak checking LP Gas piping systems.” For more information on setting single stage regulators, request RegO® Products Technical Guide 107.

# Proper Use of Excess Flow Valves

The primary purpose of an excess flow valve is to protect against excessive flow when breakage of pipe lines or hose rupture takes place. When we refer to breakage or rupture, a clean and complete separation is assumed. It is obvious that, if the damage is only a crack or if the piping is crushed at the point of failure, the escaping flow will be restricted and may or may not pass sufficient vapor or liquid to cause the excess flow valve to close.

An excess flow valve, while in its normal open position, permits the flow of liquid or gas in either direction. Flow is controlled in one direction only. Each excess flow valve is stamped with an arrow showing the direction in which the flow is controlled. If the flow in that direction exceeds a predetermined rate the valve automatically closes. Manufacturers' catalogs show the closing flow rating both in terms of liquid and vapor.

Since excess flow valves depend on flow for closure, the line leading away from the excess flow valve should be large enough so that it will not excessively restrict the flow. If the pipe run is unusually long or restricted by numerous elbows, tees, or other fittings, consideration should be given to the use of larger size pipe and fittings. Never use a pipe size smaller than that of the excess flow valve.

It is considered good practice to select an excess flow valve with a rated closing flow approximately 50% greater than the anticipated normal flow. This is important because valves which have a closing flow very close to the normal flow may chatter or slug closed when surges in the line occur either during normal operation or due to the rapid opening of a control valve.

Excess flow valves should be tested and proven at the time of installation and at periodic intervals not to exceed one year. The tests should include a simulated break in the line by the quick opening of a shutoff valve at the farthest possible point in the piping which the excess flow valve is intended to protect. If the valve closes under these conditions, it is reasonable to assume that it will close in the event of accidental breakage of the piping at any point closer to the excess flow valve.

See RegO® Products Safety Warning WB-3 for important warning information

# Pressure Relief Valves

Minimum required rate of discharge in cubic feet per minute of air at 120% of the maximum permitted start to discharge pressure for safety relief valves to be used on containers other than those constructed in accordance with Department of Transportation specification.

| Surface Area Sq. Ft. | Flow Rate CFM Air | Surface Area Sq. Ft. | Flow Rate CFM Air | Surface Area Sq. Ft. | Flow Rate CFM Air |
|---|---|---|---|---|---|
| 20 or less | 626 | 170 | 3620 | 600 | 10170 |
| 25 | 751 | 175 | 3700 | 650 | 10860 |
| 30 | 872 | 180 | 3790 | 700 | 11550 |
| 35 | 990 | 185 | 3880 | 750 | 12220 |
| 40 | 1100 | 190 | 3960 | 800 | 12880 |
| 45 | 1220 | 195 | 4050 | 850 | 13540 |
| 50 | 1330 | 200 | 4130 | 900 | 14190 |
| 55 | 1430 | 210 | 4300 | 950 | 14830 |
| 60 | 1540 | 220 | 4470 | 1000 | 15470 |
| 65 | 1640 | 230 | 4630 | 1050 | 16100 |
| 70 | 1750 | 240 | 4800 | 1100 | 16720 |
| 75 | 1850 | 250 | 4960 | 1150 | 17350 |
| 80 | 1950 | 260 | 5130 | 1200 | 17960 |
| 85 | 2050 | 270 | 5290 | 1250 | 18570 |
| 90 | 2150 | 280 | 5450 | 1300 | 19180 |
| 95 | 2240 | 290 | 5610 | 1350 | 19780 |
| 100 | 2340 | 300 | 5760 | 1400 | 20380 |
| 105 | 2440 | 310 | 5920 | 1450 | 20980 |
| 110 | 2530 | 320 | 6080 | 1500 | 21570 |
| 115 | 2630 | 330 | 6230 | 1550 | 22160 |
| 120 | 2720 | 340 | 6390 | 1600 | 22740 |
| 125 | 2810 | 350 | 6540 | 1650 | 23320 |
| 130 | 2900 | 360 | 6690 | 1700 | 23900 |
| 135 | 2990 | 370 | 6840 | 1750 | 24470 |
| 140 | 3080 | 380 | 7000 | 1800 | 25050 |
| 145 | 3170 | 390 | 7150 | 1850 | 25620 |
| 150 | 3260 | 400 | 7300 | 1900 | 26180 |
| 155 | 3350 | 450 | 8040 | 1950 | 26750 |
| 160 | 3440 | 500 | 8760 | 2000 | 27310 |
| 165 | 3530 | 550 | 9470 | | |

# Pressure Relief Valves

Surface area = Total outside surface area of container in square feet.

When the surface area is not stamped on the nameplate or when the marking is not legible, the area can be calculated by using one of the following formulas:

(1) Cylindrical container with hemispherical heads
Area = Overall length X outside diameter X 3.1416

(2) Cylindrical container with semi-ellipsoidal heads
Area = (Overall length + .3 outside diameter) X outside diameter X 3.1416

(3) Spherical container
Area = Outside diameter squared X 3.1416

Flow Rate-CFM Air = Required flow capacity in cubic feet per minute of air at standard conditions, 60ºF and atmospheric pressure (14.7 psig).

The rate of discharge may be interpolated for intermediate values of surface area. For containers with total outside surface area greater than 2000 square feet, the required flow rate can be calculated using the formula:

$$\text{Flow Rate - CFM Air} = 53.632\ A^{0.82}$$

Where A = total outside surface area of the container in square feet.

Valves not marked "Air" have flow rate marking in cubic feet per minute of liquefied petroleum gas. These can be converted to ratings in cubic feet per minute of air by multiplying the liquefied petroleum gas ratings by the factors listed below. Air flow ratings can be converted to ratings in cubic feet per minute of liquefied petroleum gas by dividing the air ratings by the factors listed below.

Air Conversion Factors

| Container Type | 100 | 125 | 150 | 175 | 200 |
|---|---|---|---|---|---|
| Air Conversion Factor | 1.162 | 1.142 | 1.113 | 1.078 | 1.010 |

See RegO® Products Safety Warning WB-6 for important warning information.

# Repair of the MultiBonnet®

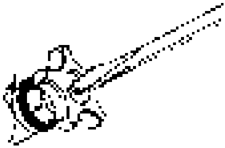
The MultiBonnet® is designed to allow quick and easy repair of bonnet packings in MultiValves® and Service Valves on active propane systems. It eliminates the need to evacuate tanks or cylinders to repair the MultiBonnet® packing. The two section design allows repair on MultiBonnet® assembly without any interruption in gas service.

The following illustrates the repair of a MultiBonnet® in a RegO® MultiValve® or Service Valve that is on an active pressurized propane system. It is important that when actual repairs are conducted, the individual doing the repairs be completely familiar with and follow the 19104-800 instruction sheet included with the 19104-80 repair kit. These instructions MUST be followed. ONLY qualified personnel should attempt installation of the MultiBonnet® repair kit.

Follow all federal, state, and local regulations.

**1**

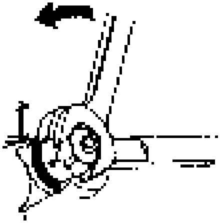
Turn handwheel counterclockwise as far as possible to assure valve is completely open and backseated.



**2**

Remove self tapping screw and handwheel.

# Repair of the MultiBonnet®

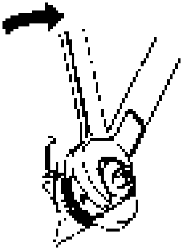


**3**

Holding the lower section of the MultiBonnet® in place with a wrench, use a second wrench to remove the upper bonnet packing assembly.

**4**

Thread the new upper bonnet packing assembly into the lower section of the MultiBonnet®.



**5**

Tighten upper packing assembly with 50 to 75 inch/ pounds torque.

**6**

Reassemble the handwheel and check valve for leaks.

# Flow of LP-Gas Through Fixed Orifices

## BTU Per Hour at 11" w.c. at Sea Level

| Orifice or Drill Size | Propane | Butane | Orifice or Drill Size | Propane | Butane |
|---|---|---|---|---|---|
| .008 | 519 | 589 | 51 | 36,531 | 41,414 |
| .009 | 656 | 744 | 50 | 39,842 | 45,168 |
| .010 | 812 | 921 | 49 | 43,361 | 49,157 |
| .011 | 981 | 1,112 | 48 | 46,983 | 53,263 |
| .012 | 1,169 | 1,326 | 47 | 50,088 | 56,783 |
| 80 | 1,480 | 1,678 | 46 | 53,296 | 60,420 |
| 79 | 1,708 | 1,936 | 45 | 54,641 | 61,944 |
| 78 | 2,080 | 2,358 | 44 | 60,229 | 68,280 |
| 77 | 2,629 | 2,980 | 43 | 64,369 | 72,973 |
| 76 | 3,249 | 3,684 | 42 | 71,095 | 80,599 |
| 75 | 3,581 | 4,059 | 41 | 74,924 | 84,940 |
| 74 | 4,119 | 4,669 | 40 | 78,,029 | 88,459 |
| 73 | 4,678 | 5,303 | 39 | 80,513 | 91,215 |
| 72 | 5,081 | 5,760 | 38 | 83,721 | 94,912 |
| 71 | 5,495 | 6,230 | 37 | 87,860 | 99,605 |
| 70 | 6,375 | 7,227 | 36 | 92,207 | 104,532 |
| 69 | 6,934 | 7,860 | 35 | 98,312 | 111,454 |
| 68 | 7,813 | 8,858 | 34 | 100,175 | 113,566 |
| 67 | 8,320 | 9,433 | 33 | 103,797 | 117,672 |
| 66 | 8,848 | 10,031 | 32 | 109,385 | 124,007 |
| 65 | 9,955 | 11,286 | 31 | 117,043 | 132,689 |
| 64 | 10,535 | 11,943 | 30 | 134,119 | 152,046 |
| 63 | 11,125 | 12,612 | 29 | 150,366 | 170,466 |
| 62 | 11,735 | 13,304 | 28 | 160,301 | 181,728 |
| 61 | 12,367 | 14,020 | 27 | 168,580 | 191,144 |
| 60 | 13,008 | 14,747 | 26 | 175,617 | 199,092 |
| 59 | 13,660 | 15,486 | 25 | 181,619 | 205,896 |
| 58 | 14,333 | 16,249 | 24 | 187,828 | 212,935 |
| 57 | 15,026 | 17,035 | 23 | 192,796 | 218,567 |
| 56 | 17,572 | 19,921 | 22 | 200,350 | 227,131 |
| 55 | 21,939 | 24,872 | 21 | 205,525 | 232,997 |
| 54 | 24,630 | 27,922 | 20 | 210,699 | 238,863 |
| 53 | 28,769 | 32,615 | 19 | 233,945 | 253,880 |
| 52 | 32,805 | 37,190 | 18 | 233,466 | 264,673 |

# Line Sizing Chart for Liquid Propane

**(Based on Pressure Drop of 1 PSI)**

| Liquid Propane Flow GPH | Iron Pipe (Feet) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/4" | | 3/8" | | 1/2" | | 3/4" | | 1" | | 1-1/4" | | 1-1/2" | | 2" | |
| | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | | Schedule | |
| | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 |
| 10 | 729 | 416 | | | | | | | | | | | | | | |
| 15 | 324 | 185 | | | | | | | | | | | | | | |
| 20 | 182 | 104 | 825 | 521 | | | | | | | | | | | | |
| 40 | 46 | 26 | 205 | 129 | 745 | 504 | | | | | | | | | | |
| 60 | 20 | 11 | 92 | 58 | 331 | 224 | | | | | | | | | | |
| 80 | 11 | 6 | 51 | 32 | 187 | 127 | 735 | 537 | | | | | | | | |
| 100 | 7 | 4 | 33 | 21 | 119 | 81 | 470 | 343 | | | | | | | | |
| 120 | | | 23 | 15 | 83 | 56 | 326 | 238 | | | | | | | | |
| 140 | | | 15 | 9 | 61 | 41 | 240 | 175 | 813 | 618 | | | | | | |
| 160 | | | 13 | 8 | 47 | 32 | 184 | 134 | 623 | 473 | | | | | | |
| 180 | | | | | 37 | 25 | 145 | 106 | 491 | 373 | | | | | | |
| 200 | | | | | 30 | 20 | 118 | 86 | 399 | 303 | | | | | | |
| 240 | | | | | 21 | 14 | 81 | 59 | 277 | 211 | | | | | | |
| 280 | | | | | 15 | 10 | 60 | 44 | 204 | 155 | | | | | | |
| 300 | | | | | 13 | 9 | 52 | 38 | 177 | 135 | 785 | 623 | | | | |
| 350 | | | | | | | 38 | 28 | 130 | 99 | 578 | 459 | | | | |
| 400 | | | | | | | 30 | 22 | 99 | 75 | 433 | 344 | 980 | 794 | | |
| 500 | | | | | | | 19 | 14 | 64 | 49 | 283 | 225 | 627 | 508 | | |
| 600 | | | | | | | | | 44 | 33 | 197 | 156 | 435 | 352 | | |
| 700 | | | | | | | | | 32 | 24 | 144 | 114 | 320 | 259 | | |
| 800 | | | | | | | | | 25 | 19 | 110 | 87 | 245 | 198 | 965 | 795 |
| 900 | | | | | | | | | 19 | 14 | 87 | 69 | 194 | 157 | 764 | 630 |
| 1000 | | | | | | | | | 16 | 12 | 71 | 56 | 157 | 127 | 618 | 509 |
| 1500 | | | | | | | | | | | 31 | 25 | 70 | 57 | 275 | 227 |
| 2000 | | | | | | | | | | | 18 | 14 | 39 | 32 | 154 | 127 |
| 3000 | | | | | | | | | | | 8 | 6 | 17 | 14 | 69 | 57 |
| 4000 | | | | | | | | | | | | | 10 | 8 | 39 | 32 |
| 5000 | | | | | | | | | | | | | | | 25 | 21 |
| 10000 | | | | | | | | | | | | | | | 6 | 5 |

**To Use Chart**

1. Having determined the required flow at point of use, locate this flow in the left hand column. If this falls between two figures, use the larger of the two.
2. Determine total length of piping required from source to point of use.
3. Read across chart from left (required flow) to right to find the total length which is equal to or exceeds the distance from source to use.
4. From this point read up to find the correct size of pipe required.

# Representative Equivalent Lengths of Pipe for Various Valves and Fittings

| Fitting | Equivalent Length of Steel Pipe (Feet) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nominal Pipe Size (NPT) | | | | | | | | | | | | | |
| | 3/4” Schedule | | 1” Schedule | | 1-1/4” Schedule | | 1-1/2” Schedule | | 2” Schedule | | 2-1/2” Schedule | | 3” Schedule | |
| | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 | 40 | 80 |
| 45º Screwed Elbow | 1.2 | 0.9 | 1.3 | 1.2 | 1.7 | 1.5 | 2.0 | 1.8 | 2.6 | 2.4 | 3.0 | 2.8 | 3.8 | 3.7 |
| 90º Screwed Elbow | 1.8 | 1.6 | 2.3 | 2.1 | 3.1 | 2.9 | 3.7 | 3.4 | 4.6 | 4.4 | 5.3 | 5.1 | 6.9 | 6.5 |
| Screwed Tee Through Run | 1.4 | 1.3 | 1.7 | 1.6 | 2.4 | 2.3 | 2.8 | 2.6 | 3.6 | 3.3 | 4.2 | 4.0 | 5.4 | 5.0 |
| Screwed Tee Through Branch | 4.6 | 4.0 | 5.6 | 5.3 | 7.9 | 7.3 | 9.3 | 8.6 | 12.0 | 11.0 | 15.0 | 14.0 | 17.0 | 16.0 |
| Screwed Globe Valve* | 14.0 | 10.0 | 21.0 | 16.0 | 24.0 | 19.0 | 39.0 | 27.0 | 42.0 | 34.5 | 24.0 | 20.0 | 46.0 | 39.0 |
| Screwed Angle Valve* | 11.0 | 8.0 | 13.0 | 10.0 | 10.5 | 8.5 | 20.0 | 16.0 | 32.0 | 26.5 | 7.5 | 6.0 | 19.0 | 16.0 |
| Flanged Globe Valve* | — | — | — | — | — | — | 30.0 | 24.0 | 41.0 | 34.0 | — | — | 46.0 | 39.0 |
| Flanged Angle Valve* | — | — | — | — | — | — | 12.0 | 10.0 | 14.5 | 12.0 | — | — | 19.0 | 16.0 |

*** RegO® A7500 Series Valves**

# Determining Age of RegO® Products

## *1960 to 1985 — Two-Letter Date Code*

**First letter in date code is the month**

| | |
|---|---|
| A — January | G — July |
| B — February | H — August |
| C— March | I — September |
| D— April | J — October |
| E—May | K — November |
| F—June | L — December |

Relief valves used on ASME tanks carry a numerical code indicating month and year such as 1-75 means January, 1975.

**Second letter in date code is the year**

| | | |
|---|---|---|
| R — 1960 | A — 1969 | J — 1978 |
| S — 1961 | B — 1970 | K — 1979 |
| T — 1962 | C — 1971 | L — 1980 |
| U — 1963 | D — 1972 | M — 1981 |
| V — 1964 | E — 1973 | N — 1982 |
| W — 1965 | F — 1974 | O — 1983 |
| X — 1966 | G — 1975 | P — 1984 |
| Y — 1967 | H — 1976 | Q — 1985 |
| Z — 1968 | I — 1977 | |

**EXAMPLE:** DL = April of 1980

## *From 1985 to 1990 — Digit Date Code*

**First digit in date code is the month**

| | |
|---|---|
| 1 — January | 7 — July |
| 2 — February | 8 — August |
| 3 — March | 9 — September |
| 4 — April | 10 — October |
| 5 — May | 11 — November |
| 6 — June | 12 — December |

**Second 2 digits in date code are the year**

| | |
|---|---|
| 86 — 1986 | 89 — 1989 |
| 87 — 1987 | 90 — 1990 |
| 88 — 1988 | |

**EXAMPLE:** 5-87 = May of 1987

# Determining Age of RegO® Products

### *After 1990 — Digit-Letter-Digit Date Code*

**First digit in date code is the month**

| | | | |
|---|---|---|---|
| 1 — | January | 7 — | July |
| 2 — | February | 8 — | August |
| 3 — | March | 9 — | September |
| 4 — | April | 10 — | October |
| 5 — | May | 11 — | November |
| 6 — | June | 12 — | December |

**Letter in date code is the week**

A — $1^{st}$ week
B — $2^{nd}$ week
C — $3^{rd}$ week
D — $4^{th}$ week
E — $5^{th}$ week

**Second 2 digits in date code are the year**

| | | | |
|---|---|---|---|
| 91 — | 1991 | 98 — | 1998 |
| 92 — | 1992 | 99 — | 1999 |
| 93 — | 1993 | 00 — | 2000 |
| 94 — | 1994 | 01 — | 2001 |
| 95 — | 1995 | etcetera . . . | |
| 96 — | 1996 | | |
| 97 — | 1997 | | |

**EXAMPLE:** 6A92 = First week of June, 1992

# Converting Volumes of Gas

**(CFH to CFH or CFM to CFM)**

| Multiply Flow Of: | By | To Obtain Flow Of: |
|---|---|---|
| Air | 0.707 | Butane |
| | 1.290 | Natural Gas |
| | 0.816 | Propane |
| Butane | 1.414 | Air |
| | 1.826 | Natural Gas |
| | 1.154 | Propane |
| Natural Gas | 0.775 | Air |
| | 0.547 | Butane |
| | 0.632 | Propane |
| Propane | 1.225 | Air |
| | 0.866 | Butane |
| | 1.580 | Natural Gas |

# Conversion Units

| Multiply | By | To Obtain |
|---|---|---|
| **Pressure** | | |
| Atmospheres | 1.0332 | kilograms per sq. centimeter |
| Atmospheres | 14.70 | pounds per square inch |
| Atmospheres | 407.14 | inches water |
| Grams per sq. centimeter | 0.0142 | pounds per square inch |
| Inches of mercury | .4912 | pounds per square inch |
| Inches of mercury | 1.133 | feet of water |
| Inches of water | 0.0361 | pounds per square inch |
| Inches of water | 0.0735 | inches of mercury |
| Inches of water | 0.5781 | ounces per square inch |
| Inches of water | 5.204 | pounds per square foot |
| bar | 100 | kPa |
| Kilograms per sq. centimeter | 14.22 | pounds per square inch |
| Kilograms per square meter | 0.2048 | pounds per square foot |
| Pounds per square inch | 0.0680 | atmospheres |
| Pounds per square inch | 0.07031 | kilograms per sq. centimeter |
| Pounds per square inch* | 6.89 | kPa |
| Pounds per square inch | 2.036 | inches of mercury |
| Pounds per square inch | 2.307 | feet of water |
| Pounds per square inch | .06897 | bar |
| Pounds per square inch | 27.67 | inches of water |
| kPa | .145 | PSI |
| **Length** | | |
| Centimeters | 0.3937 | inches |
| Feet | 0.3048 | meters |
| Feet | 30.48 | centimeters |
| Feet | 304.8 | millimeters |
| Inches | 2.540 | centimeters |
| Inches | 25.40 | millimeters |
| Kilometer | 0.6214 | miles |
| Meters | 1.094 | yards |
| Meters | 3.281 | Feet |
| Meters | 39.37 | inches |
| Miles (nautical) | 1,853.0 | meters |
| Miles (statute) | 1,609.0 | meters |
| Yards | 0.9144 | meters |
| Yards | 91.44 | centimeters |

# Conversion Units

| Multiply | By | To Obtain |
|---|---|---|
| **Volume** | | |
| Cubic centimeter | 0.06103 | cubic inch |
| Cubic feet | .0276 | gallons (US) |
| Cubic feet | 28.316 | liters |
| Cubic feet | 1728 | cubic inches |
| Cubic feet | .03704 | cubic yards |
| Cubic feet | .02832 | cubic meters |
| Gallons (Imperial) | 1.201 | gallons (US) |
| Gallons (US)* | 0.1337 | cubic feet |
| Gallons (US) | 0.8326 | gallons (Imperial) |
| Gallons (US) | 3.785 | liters |
| Gallons (US) | 231 | cubic inches |
| Liters | 0.0353 | cubic feet |
| Liters | 0.2642 | gallons (US) |
| Liters | 1.057 | quarts (US) |
| Liters | 2.113 | pints (US) |
| Pints (US) | 0.4732 | liters |
| **Miscellaneous** | | |
| BTU | .252 | calories |
| Calories | 3.968 | BTU |
| Ton (US) | 2000 | pounds |
| Kilogram | 2.205 | pounds |
| Kilowatt Hour | 3412 | BTU |
| Ounces | 28.35 | grams |
| Pounds | 0.4536 | kilograms |
| Pounds | 453.5924 | grams |
| Ton (US) | .908 | tonne |
| Therm | 100,000 | BTU |
| API Bbls | 42 | gallons (US) |

*Ex. 200 US gallons (.1337) = 26.74 cubic feet

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