LP-10

LP-GAS SERVICEMAN'S HANDBOOK

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The Fisher Controls LP-Gas Serviceman's Handbook serves as a general reference of information on LP-Gas and for the installation, operation and maintenance of LP-Gas equipment. It provides key data and answers important questions that are relevant to management and field servicemen in the LP-Gas industry.

Users of this handbook should consult applicable federal, state and local laws as well as pertinent industry regulations, including National Fire Protection Association (NFPA) Pamphlets No. 54 and 58.

Fisher Controls shall have no responsibility for any misinterpretation of the information contained in this handbook or any improper installation or repair work or other deviation from the procedures recommended in this handbook.

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APPROXIMATE PROPERTIES OF LP-GASES

Table 1	**PROPANE**	**BUTANE**
Formula	C_3H_8	C_4H_{10}
Initial Boiling Point, °F	-44	31
Specific Gravity of Liquid (Water = 1.0) at 60°F	0.504	0.582
Weight per Gallon of Liquid at 60°F, LB	4.20	4.81
Specific Heat of Liquid, BTU/LB at 60°F	0.630	0.549
Cubic feet of Vapor per Gallon at 60°F	36.38	31.26
Cubic feet of Vapor per Pound at 60°F	8.66	6.51
Specific Gravity of Vapor (Air = 1.0) at 60°F	1.50	2.01
Ignition Temperature in Air, °F	920 - 1,120	900 - 1,000
Maximum Flame Temperature in Air, °F	3,595	3,615
Cubic feet of Air Required to Burn One Cubic Foot of Gas	23.86	31.02
Limits of Flammability in Air, % of Vapor in Air-Gas Mix:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) BTU per Pound	184	167
(b) BTU per Gallon	773	808
Total Heating Values After Vaporization:		
(a) BTU per Cubic Foot	2,488	3,280
(b) BTU per Pound	21,548	21,221
(c) BTU per Gallon	91,502	102,032

APPROXIMATE PROPERTIES OF LP-GASES

Table 1 (Metric)	PROPANE	BUTANE
Formula	C_3H_8	C_4H_{10}
Initial Boiling Point, °C	-42	-1
Specific Gravity of Liquid (Water = 1.0) at 15.56°C	0.504	0.582
Weight per Cubic Meter of Liquid at 15.56°C, kg	504	582
Specific Heat of Liquid, Kilojoule/Kilogram at 15.56°C	1.464	1.276
Cubic Meter of Vapor per Liter at 15.56°C	0.271	0.235
Cubic Meter of Vapor per Kilogram at 15.56°C	0.539	0.410
Specific Gravity of Vapor (Air = 1.0) at 15.56°C	1.50	2.01
Ignition Temperature in Air, °C	493-549	482-538
Maximum Flame Temperature in Air, °C	1,980	2,008
Cubic Meters of Air Required to Burn 1 Cubic Meter of Gas	0.676	0.878
Limits of Flammability in Air, % of Vapor in Air-Gas Mix:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) Kilojoule per Kilogram	428	388
(b) Kilojoule per Liter	216	226
Total Heating Values After Vaporization:		
(a) Kilojoule per Cubic Meter	92,430	121,280
(b) Kilojoule per Kilogram	49,920	49,140
(c) Kilojoule per Liter	25,140	28,100

VAPOR PRESSURE OF LP-GASES

Vapor pressure can be defined as the force exerted by a gas or liquid attempting to escape from a container. This pressure moves gas along the pipe or tubing to the appliance burner.

Outside temperature greatly affects container pressure. Lower temperature means lower container pressure. Too low a container pressure means that not enough gas is able to get to the appliance.

The Table below shows vapor pressures for propane and butane at various outside temperatures.

TEMPERATURE		TABLE 2 APPROXIMATE VAPOR PRESSURE, PSIG PROPANE → TO → BUTANE						
°F	°C	100%	80/20	60/40	50/50	40/60	20/80	100%
-40	-40	3.6	—	—	—	—	—	—
-30	-34.4	8	4.5	—	—	—	—	—
-20	-28.9	13.5	9.2	4.9	1.9	—	—	—
-10	-23.3	20	16	9	6	3.5	—	—
0	-17.8	28	22	15	11	7.3	—	—
10	-12.2	37	29	20	17	13	3.4	—
20	-6.7	47	36	28	23	18	7.4	—
30	-1.1	58	45	35	29	24	13	—
40	4.4	72	58	44	37	32	18	3
50	10	86	69	53	46	40	24	6.9
60	15.6	102	80	65	56	49	30	12
70	21.1	127	95	78	68	59	38	17
80	26.7	140	125	90	80	70	46	23
90	32.2	165	140	112	95	82	56	29
100	37.8	196	168	137	123	100	69	36
110	43.3	220	185	165	148	130	80	45

DETERMINING TOTAL LOAD

The best way to determine BTU input is from the appliance nameplate or from the manufacturer's catalog. Add the input of all the appliances for the total load. If specific appliance capacity information is not available, the Table below will be useful. Remember to allow for appliances which may be installed at a later date.

If the propane load in standard cubic feet per hour (SCFH) is desired, divide the BTU/HR load by 2488 to get SCFH. Conversely, the BTU/HR capacity can be obtained from SCFH by multiplying the SCFH figure by 2488.

Figuring the total load accurately is most important because of the size of the pipe and tubing, the tank (or the number of cylinders), and the regulator will be based on the capacity of the system to be served.

Table 3 Gas Required for Common Appliances

APPLIANCE	APPROX. INPUT BTU/HR
Range, Free Standing, Domestic	65,000
Built-In Oven or Broiler Unit, Domestic	25,000
Built-In Top Unit, Domestic	40,000
Water Heater, Automatic Storage, 30 to 40 gal. Tank	45,000
Water Heater, Automatic Storage, 50 gal. Tank	55,000
Water Heater, Automatic Instantaneous	
Capacity: 2 gal. per minute	142,800
Capacity: 4 gal. per minute	285,000
Capacity: 6 gal. per minute	428,000
Water Heater, Domestic, Circulating or Side-Arm	35,000
Refrigerator	3,000
Clothes Dryer, Type 1 (Domestic)	35,000
Gas Light	2,500
Incinerator, Domestic	35,000

Table Reprinted From NFPA Pamphlet 54

VAPORIZATION RATE

The rate of vaporization of a container is dependent upon the temperature of the liquid and the amount of “wetted surface” area of the container.

The temperature of the liquid is proportional to the outside air temperature and the wetted surface area is the tank surface area in contact with the liquid. Therefore, when the outside air temperature is lower or the container has less liquid in it, the vaporization rate of the container is a lower value.

To determine the proper size of ASME storage tanks or the proper number of DOT cylinders for various loads, it is important to consider the lowest winter temperature at the location.

Multiple cylinders or tanks may be manifolded to give the required vaporization capacity. Withdrawal of gas from one or two containers can lower the container pressure substantially due to the refrigeration of the vaporization gas. Regulator capacity is then reduced because of the lower inlet pressure. Where any reasonably heavy gas load is expected, put sufficient cylinders on each side of an automatic changeover system.

See pages 7 and 8 for more information.

VAPORIZATION RATES FOR ASME STORAGE TANKS

A number of assumptions were made in calculating the BTU figures listed in the Table below:

1) The tank is one-half full.

2) Relative humidity is 70%.

3) The tank is under intermittent loading.

Although none of these conditions may apply, the Table can still serve as a good rule-of-thumb in estimating what a particular tank size will provide under various temperatures. Continuous loading is not a very common occurrence on domestic installations, but under continuous loading the withdrawal rates in the Table should be multiplied by 0.25.

Table 4 Max. Intermittent Withdrawal Rate (BTU/HR) Without Tank Frosting* if Lowest Outdoor Temperature (Average For 24 Hours) Reaches . . .

TEMPERATURE	TANK SIZE (GALLONS)			
	150	250	500	1,000
40°F	214,900	288,100	478,800	852,800
30°F	187,900	251,800	418,600	745,600
20°F	161,800	216,800	360,400	641,900
10°F	148,000	198,400	329,700	587,200
0°F	134,700	180,600	300,100	534,500
-10°F	132,400	177,400	294,800	525,400
-20°F	108,800	145,800	242,300	431,600
-30°F	107,100	143,500	238,600	425,000

* Tank frosting acts as an insulator, reducing the vaporization rate.

Vaporization Rates for 100 Pound DOT Cylinders

"Rule of Thumb" Guide

For continuous draws, where temperatures may reach 0°F, assume the vaporization rate of a 100 lb. cylinder to be approximately 50,000 BTU/HR Therefore the:

Number of cylinders per side = total load in BTU/HR / 50,000

Example:

If a total load requirement of 200,000 BTU/HR is to be supplied from 100 pound DOT cylinders and winter temperatures may drop to 0°F, then how many cylinders are needed per side?

Number of cylinders per side = 200,000/50,000 = 4

* When using a changeover regulator, 4 cylinders per side are required.

Vaporization Rate Table for 100 Lb. DOT Cylinders

TABLE 5 VAPORIZATION RATES IN BTUH FOR VARIOUS TEMPERATURES AND LIQUID LEVELS				
LBS. OF PROPANE IN CYL.	**-20°F**	**0°F**	**20°F**	**40°F**
100	65,000	71,000	79,000	94,000
90	60,000	65,000	72,000	85,000
80	54,000	59,000	66,000	77,000
70	48,000	52,000	59,000	69,000
60	43,000	46,000	52,000	61,000
50	37,000	40,000	45,000	53,000
40	31,000	34,000	38,000	45,000
30	26,000	28,000	31,000	37,000
20	20,000	22,000	25,000	29,000
10	15,000	16,000	18,000	21,000

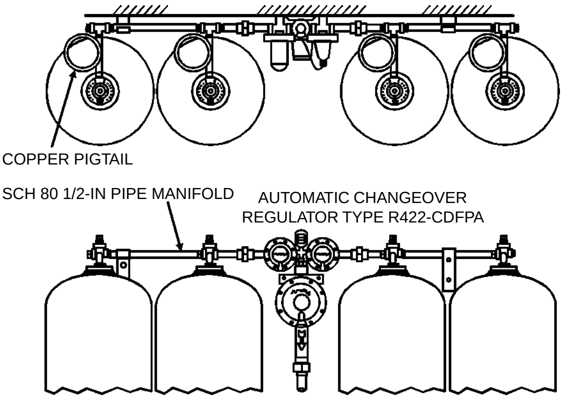
CYLINDER AND TANK MANIFOLDING

Often it is necessary to manifold cylinders or tanks to obtain the required capacity needed for the installation. Multiple cylinder hookups are most frequently used on commercial applications and at many residential jobs, even though tank manifolding is common in certain areas.

On certain multi-cylinder or tank installations, an automatic changeover regulator can be used. These regulators change from the supply cylinder (when the gas is exhausted) to the reserve cylinder automatically without having to shutdown the system to refill.

A typical cylinder manifold using an automatic changeover regulator can be installed in line with multiple cylinders. (See Figure 1 below.)

Figure 1

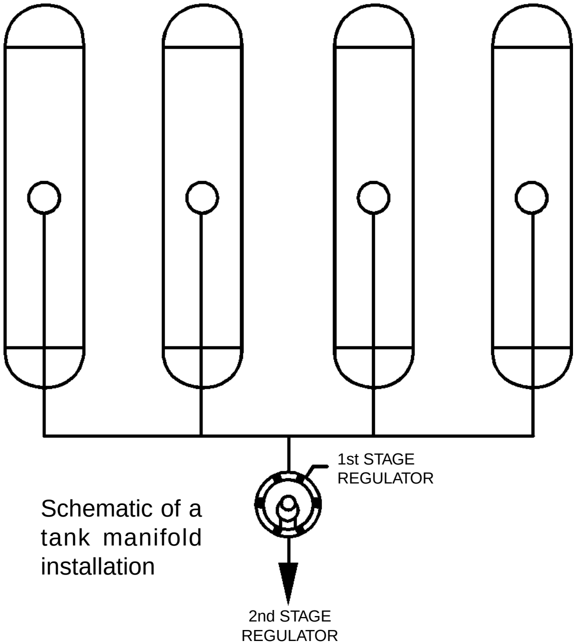


CYLINDER AND TANK MANIFOLDING

When manifolding cylinders or tanks, do not use a regulator at each container. When this is done, the required capacity for the particular installation may not be obtained. It is impossible to set all of the regulators at the same outlet pressure. The regulator delivering the highest outlet pressure will backpressure the other regulators, keeping them from operating. In effect, only one container would be supplying gas in this sort of situation.

The answer on manifold installations is to run high pressure piping from the containers into a common line, as shown in the Figure below. Then, install a regulator that can handle the required capacity. Two-stage regulation is the most effective system on tank manifold installations.

Figure 2



Schematic of a tank manifold installation

CONTAINER LOCATION AND INSTALLATION

Once the proper size of ASME storage tank or the proper number of DOT cylinders has been determined, careful attention must be given to the most convenient, yet safe, place for their location on the customer's property.

Containers should be placed in a location pleasing to the customer that does not conflict with state and local regulations or NFPA Pamphlet No. 58, Storage and Handling of Liquefied Petroleum Gases. Refer to this standard to determine the appropriate placement of LP-gas containers.

In general, storage tanks should be placed in an accessible location for filling, supported by concrete blocks of appropriate size and reinforcement, and located away from vehicular traffic.

Cylinders should be placed with ease of replacement or refilling in mind, secured on a firm base, and protected from vehicular traffic, animals and the elements.

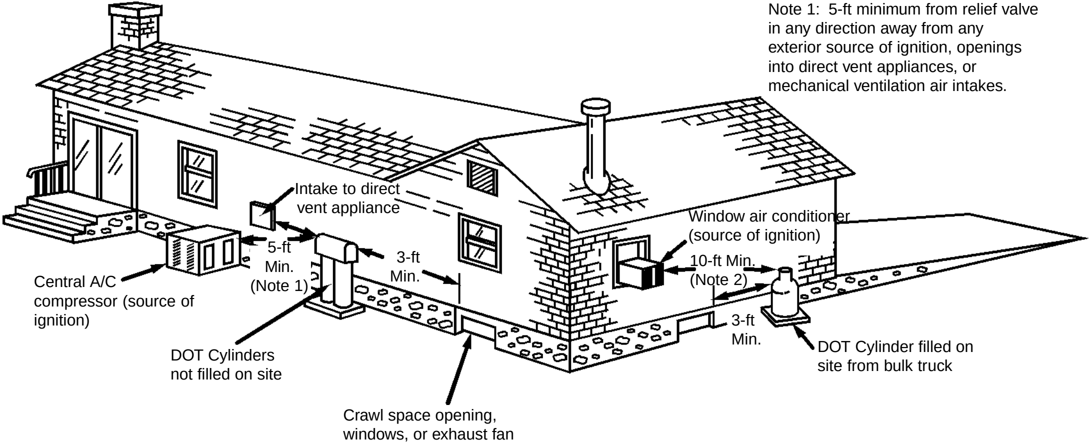
For both ASME and DOT containers, the distance from any building openings, external sources of ignition, and intakes to direct vented gas appliances or mechanical ventilation systems are a critical consideration. See Figures 3, 4 and 5 on pages 12, 13 and 14.

Refer to NFPA No. 58 for the minimum distances that these containers must be placed from the building or other objects.

CONTAINER LOCATION (cont)

Figure 3 DOT Cylinders

Note 1: 5-ft minimum from relief valve in any direction away from any exterior source of ignition, openings into direct vent appliances, or mechanical ventilation air intakes.

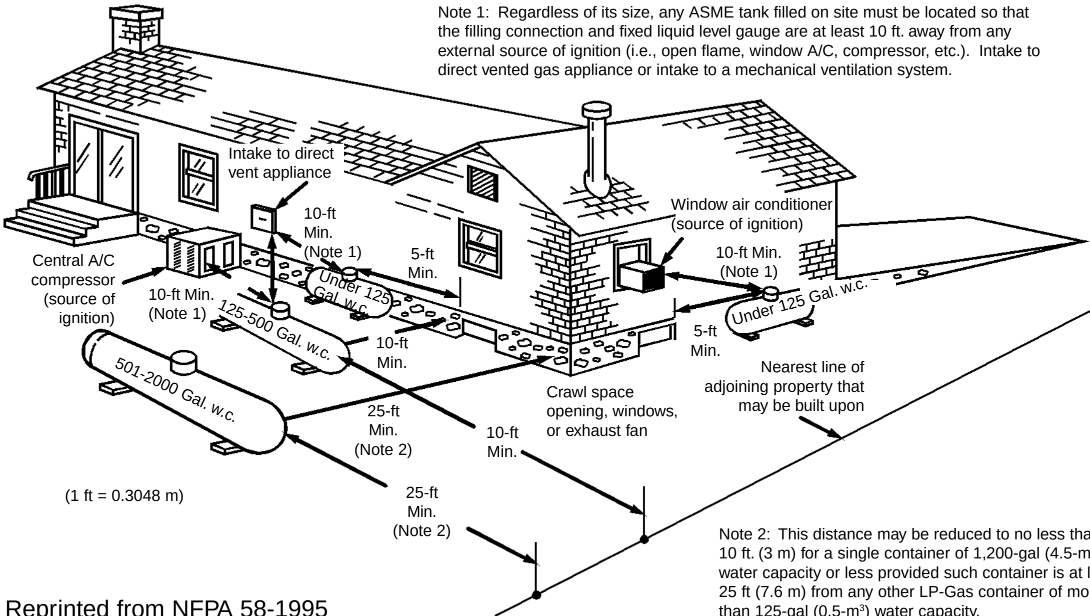


Note 2: If the DOT cylinder is filled on site from a bulk truck, the filling connection and vent valve must be at least 10-ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes.

Reprinted from NFPA 58-1995

Figure 4 Above Ground ASME Containers

Note 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 ft. away from any 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.



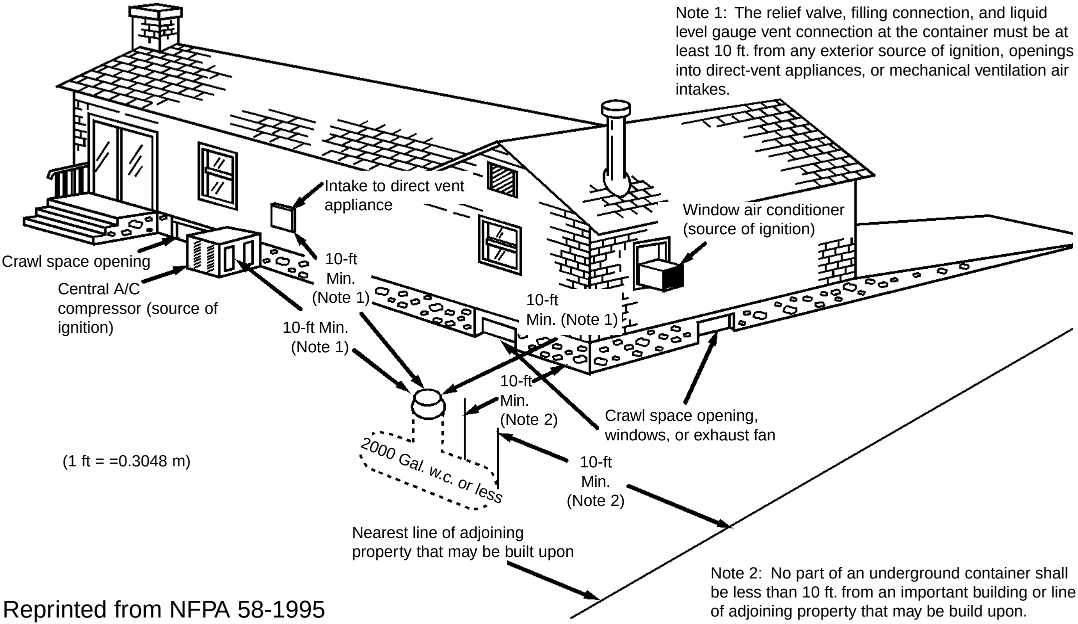
(1 ft = 0.3048 m)

Note 2: This distance may be reduced to no less than 10 ft. (3 m) for a single container of 1,200-gal (4.5-m^3) water capacity or less provided such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125-gal (0.5-m^3) water capacity.

Reprinted from NFPA 58-1995

CONTAINER LOCATION (cont)

Figure 5 Below Ground ASME Containers



Note 1: The relief valve, filling connection, and 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.

Note 2: No part of an underground container shall be less than 10 ft. from an important building or line of adjoining property that may be build upon.

(1 ft = =0.3048 m)

Reprinted from NFPA 58-1995

CONTAINER PREPARATION FOR REMOVAL OF WATER AND AIR CONTAMINANTS

Both water and air are contaminants that can seriously hinder the proper operation of the LP-Gas system and the connected appliances if not effectively removed. The following procedures will help increase system performance and decrease the number of service calls.

REMOVING WATER FROM CONTAINERS

Water in LP-Gas cylinders and tanks can contaminate the gas, causing regulator freezeups and erratic appliance performance. Neutralize any moisture in the container by adding anhydrous methanol (99.85% pure) according to the amount shown in the Table below.

This will minimize freezeup problems for normal amounts of water in a container. However, this water may still cause corrosion or sediment problems. Large amounts of water should be drained from the tank.

Table 6

CONTAINER SIZE	MINIMUM AMMOUNT OF METHANOL REQUIRED
100 lb. cylinder	1/8 Pint (2 fluid ounces)
150 gal. tank	1 pint
250 gal. tank	1 quart
500 gal. tank	2 quarts
1000 gal. tank	1 gallon

Warning: Do not substitute other alcohols in place of methanol.

PURGING AIR FROM CONTAINERS

Air in the LP-Gas can cause appliance pilot lights to be extinguished easily. It can also lead to excessive container pressure, making the safety relief valve open. Since nearly all containers are shipped from the fabricator under air pressure, it is extremely important to get rid of the air **before** the container is put in service.

DOT Cylinders

First, open the cylinder or service valves for several minutes to allow air to bleed to atmosphere. Then, pressure the cylinder with LP-Gas vapor and again open the cylinder or service valve (repeat this step at least two times).

ASME Storage Tanks

Depending on the type of valves in the tank, (see Figure 6 on page 17), purge the container as follows:

1) Bleed the air to atmosphere by opening the multi-purpose valve or the service valve for several minutes until air pressure is exhausted. Close the valve.

2) If a pressure gauge has not been installed in the multi-purpose valve side outlet, install a 0-300 psig gauge (Fisher Type J506). On tanks with service valves, install a POL x 1/4” FNPT pipe coupling and 0-300 psig gauge in the service valve outlet.

3) Attach the truck vapor equalizing hose to the multi-purpose valve’s vapor equalizing valve or the separate vapor-equalizing valve.

4) Slowly open the shutoff valve on the end of the hose so that the truck excess flow check valve does not slam shut.

PURGING AIR FROM CONTAINERS (Cont.)

ASME Storage Tanks (cont.)

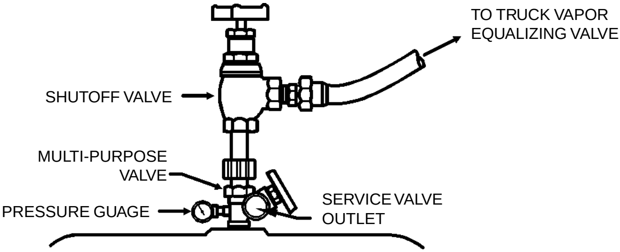
(5) Closely watch the pressure, and when the gauge reaches 15 psig, close the shutoff valve.

(6) Open the vapor service valve on the multi-purpose valve (or the separate service valve, after removing the adapter). Allow all pressure to be exhausted before closing the multi-purpose valve or the service valve.

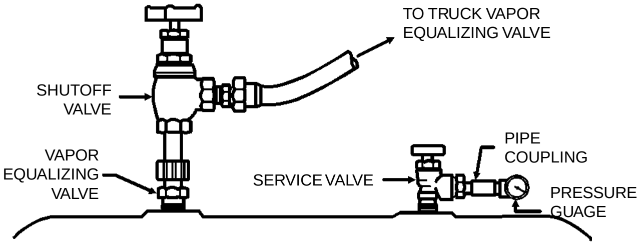
(7) Repeat steps 4 through 6 at least **three** more times to make certain air has been purged from the tank.

Figure 6

PURGING METHOD WITH MULTI-PURPOSE VALVE



PURGING METHOD WITH SEPARATE VALVES



Note: Do not purge tanks in this way on the customer's property. Purge them in a safe place at the bulk plant site.

PIPE AND TUBING SIZING

The proper selection of pipe and tubing sizes is essential for the efficient operation of the LP-Gas appliance. General consideration must be given to the maximum gas demand requirements of the system and the allowable pressure loss from the point of delivery to the inlet connection of the gas appliance.

Four different areas of sizing requirements must be addressed:

1) Sizing between First-Stage and Second-Stage Regulators
2) Sizing between Second-Stage Regulator and Appliance
3) Sizing between 2 PSI Service and Line Pressure Regulators
4) Sizing between Line Pressure Regulator and Appliance

The following directions and examples, as well as tables 7-10 starting on page 23, will assist you in determining the proper selection of pipe and tubing sizing for these different areas. All data in the tables are calculated per NFPA Pamphlet Nos. 54 and 58.

PIPE AND TUBING SIZING (Cont.)

Directions for Sizing between First-Stage and Second-Stage Regulators

1) Measure the required length of pipe or tubing from the outlet of the first-stage regulator to the inlet of the second-stage regulator.
2) Determine the maximum gas demand requirements of the system by adding the BTU/HR inputs from the nameplates of all the appliances or by referring to Table 3 on page 5.
3) Select the pipe or tubing required from Tables 7a, b, and c on pages 23-26.

Directions for Sizing Between Second-Stage Regulator and Appliance

1) Measure the length of pipe or tubing from the outlet of the second-stage regulator to the most remote appliance. (Note: This is the only length needed to size the second-stage system.)
2) For each outlet and section of pipe, determine the specific gas demand requirements by adding the BTU/HR inputs from the nameplates of each appliance or by referring to Table 3 on page 5.
3) Select the pipe or tubing required for each section from Table 8 on page 27.

Example (cont.)

Determine the sizes of pipe or tubing required for this two-stage LP-Gas installation.

For First-Stage:

1) Length of first-stage piping = 25 feet (round up to 30 ft. for use in Table 7a, b, c.).
2) Total gas demand = 40,000 + 75,000 + 120,000 = 235,000 BTU/HR.
3) From Tables 7a, b, c, use 1/2” iron pipe, 3/8” copper tubing or 1/2” plastic tubing. (Assume a 10 psig first-stage regulator setting and 1 psig pressure drop.)

For Second-Stage:

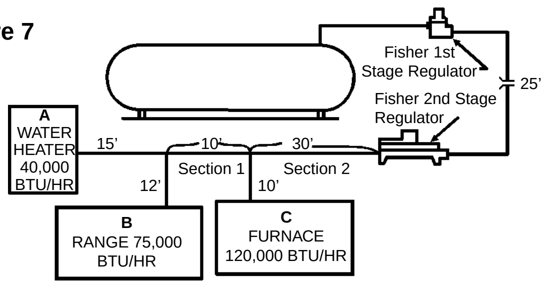
1) Total second-stage piping length = 30 + 10 + 15 = 55 feet (round up to 60 ft. for use in Table 8).
2) Gas demand requirements and pipe selection from Table 8 (Assume a 11” w.c. setting and 1/2 psig pressure drop):

For Outlet A, demand = 40,000 BTU/HR, use 1/2” iron pipe
For Outlet B, demand = 75,000 BTU/HR, use 1/2” iron pipe
For Outlet C, demand = 120,000 BTU/HR, use 3/4” iron pipe
For Section 1, demand = 40,000 + 75,000 = 115,000 BTU/HR, use 3/4” iron pipe
For Section 2, demand = 40,000 + 75,000 + 120,000 = 235,000 BTU/HR, use 1” iron pipe

Example:

A private home is to be supplied with a propane system serving a central furnace, range and water heater. The gas demand and piping lengths are shown on the sketch below.

Figure 7



PIPE AND TUBING SIZING

Directions for Sizing Between 2 PSI Service Regulator and Line Pressure Regulator

1) Measure the length of CSST tubing from the outlet of the 2 PSI service regulator to the inlet of the line pressure regulator.
2) Determine the maximum gas demand requirements of the system by adding the BTU/HR inputs from the nameplates of all the appliances or by referring to Table 3 on page 5.
3) Use the correct footage column, or next higher column in Table 9. Select CSST tubing size when capacity in column exceeds gas demand.

Directions for Sizing Between Line Pressure Regulator and Appliance

1) Measure the length of CSST tubing from the outlet of the line pressure regulator to each of the appliances.
2) For each outlet and section of CSST tubing, determine the specific gas demand requirements by adding the BTU/HR inputs from the nameplates of each appliance or by referring to Table 3 on page 5.
3) Use the correct footage column, or next higher column in Table 10. Select CSST tubing size when capacity in column exceeds gas demand.

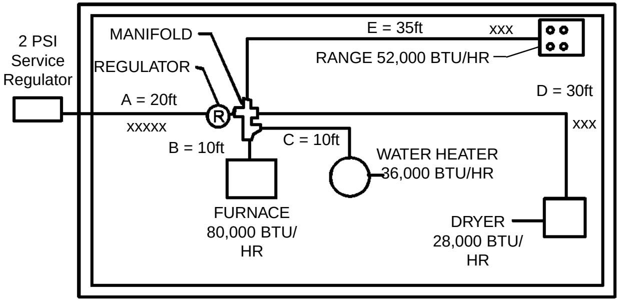
Example:

A typical single family home with four appliances is to be supplied with a propane system. The piping is arranged in parallel with a distribution manifold branching CSST runs to the appliances. The supply pressure (downstream of the service regulator) is 2 psig and the outlet pressure of the line pressure regulator is set to 11” w.c. (see next page).

PIPE AND TUBING SIZING

Determine the sizes of pipe or tubing required for this in-house LP-Gas installation.

Figure 8



From 2 PSI Service Regulator to Line Regulator:

1) Length of section A tubing = 20 feet

2) Total gas demand = 80,000 + 36,000 + 28,000 + 52,000 = 196,000 BTU/HR

3) From Table 9, use 25' column. Select 3/8" CSST for run A, as it has capacity over 196,000 BTU/HR (262,000). (Assume a 2 psig second-stage regulator setting and 1 psig pressure drop)

From Line Pressure Regulator to Each Appliance:

1) For line B, length= 10 feet; gas demand = 80,000 BTU
For line C, length= 10 feet; gas demand = 36,000 BTU
For line D, length= 30 feet; gas demand = 28,000 BTU
For line E, length= 35 feet; gas demand = 52,000 BTU

2) CSST Tubing selection from Table 10 (Assume a 11" w.c. setting and 0.5" w.c. pressure drop):

LINE	LENGTH FT	LOAD 1000 BTU/HR	CSST CAPACITY 1000 BTU/HR	SELECT CSST SIZE
B	10	80	129	1/2
C	10	36	50	3/8
D	30	28	28	3/8
E	35*	52	64	1/2

* Use 40' column in Table 10

Table 7a Pipe Sizing Between First-Stage (High Pressure Regulator and Second-Stage (Low Pressure Regulator)

Maximum undiluted propane capacities based on 10 psig first stage setting and 1 psig pressure drop. Capacities in 1000 BTUH.

SCHEDULE 40 IRON PIPE

Length of Pipe or Tubing, Feet	1/2" 0.622	3/4" 0.824	1" 1.049	1-1/4" 1.38	1-1/2" 1.61	2" 2.067	3" 3.068
30	1843	3854	7259	14904	22331	43008	121180
40	1577	3298	6213	12756	19113	36809	103714
50	1398	2923	5507	11306	16939	32623	91920
60	1267	2649	4989	10244	15348	29559	83286
70	1165	2437	4590	9424	14120	27194	76622
80	1084	2267	4270	8767	13136	25299	71282
90	1017	2127	4007	8226	12325	23737	66882
100	961	2009	3785	7770	11642	22422	63176
150	772	1613	3039	6240	9349	18005	50733
200	660	1381	2601	5340	8002	15410	43421
250	585	1224	2305	4733	7092	13658	38483
300	530	1109	2089	4289	6426	12375	34868
350	488	1020	1922	3945	5911	11385	32078
400	454	949	1788	3670	5499	10591	29843
450	426	890	1677	3444	5160	9938	28000
500	402	841	1584	3253	4874	9387	26449
600	364	762	1436	2948	4416	8505	23965
700	335	701	1321	2712	4063	7825	22047
800	312	652	1229	2523	3780	7279	20511
900	293	612	1153	2367	3546	6830	19245
1000	276	578	1089	2236	3350	6452	18178
1500	222	464	875	1795	2690	5181	14598
2000	190	397	748	1537	2302	4434	12494

Table Reprinted From Table 10-25 in NFPA Pamphlet 54-1996.

Table 7b Pipe Sizing Between First-Stage and Second-Stage Regulators

Minimum undiluted propane capacities listed are based on a 10 psig first stage setting and 1 psig pressure drop. Capacities in 1,000 BTU/HR.

Tubing Length (Ft.)	REFRIGERATION TUBING Nominal Size (Outside Diameter)					COPPER TUBING TYPE L Nominal Size (Outside Diameter)				
	3/8" (0.375)	1/2" (0.500)	5/8" (0.625)	3/4" (0.750)	7/8" (0.875)	1/4" (0.375)	3/8" (0.500)	1/2" (0.625)	5/8" (0.750)	3/4" (0.875)
30	299	726	1367	2329	3394	309	700	1303	2205	3394
40	256	621	1170	1993	2904	265	599	1115	1887	2904
50	227	551	1037	1766	2574	235	531	988	1672	2574
60	206	499	939	1600	2332	213	481	896	1515	2332
70	189	459	864	1472	2146	196	443	824	1394	2146
80	176	427	804	1370	1996	182	412	767	1297	1996
90	165	401	754	1285	1873	171	386	719	1217	1873
100	156	378	713	1214	1769	161	365	679	1149	1769
150	125	304	572	975	1421	130	293	546	923	1421
200	107	260	490	834	1216	111	251	467	790	1216
250	95	230	434	739	1078	90	222	414	700	1078
300	86	209	393	670	976	89	201	375	634	976
350	79	192	362	616	898	82	185	345	584	898
400	74	179	337	573	836	76	172	321	543	836
450	69	168	316	538	784	71	162	301	509	784
500	65	158	298	508	741	68	153	284	481	741
600	59	144	270	460	671	61	138	258	436	671
700	54	132	249	424	617	56	127	237	401	617
800	51	123	231	394	574	52	118	221	373	574
900	48	115	217	370	539	49	111	207	350	539
1000	45	109	205	349	509	46	105	195	331	509
1500	36	87	165	281	409	37	84	157	266	409
2000	31	75	141	240	350	32	72	134	227	350

To convert to capacities at 5 psig setting with 10 percent (0.5 psig) pressure drop, multiply values by 0.606. To convert to capacities at 15 psig setting with 10 percent (1.5 psig) pressure drop, multiply values by 1.380.
Table Reprinted From NFPA Pamphlet 54-1996.

Table 7c Polyethylene Plastic Tube Sizing Between First-Stage and Second-Stage Regulators

Maximum undiluted propane capacities listed are based on 10 psig first stage setting and 1 psi pressure droop. Capacities in 1000 BTU/HR.

PLASTIC TUBING LENGTH (FEET)	PLASTIC TUBING SIZE (CTS) (DIMENSIONS IN PARENTHESIS ARE INSIDE DIAMETER)				
	1/2 in. CTS SDR 7.00 (.445)	1in. CTS SDR 11.00 (.927)	1/2 in. IPS SDR 9.33 (.660)	3/4 in. IPS SDR 11.0 (.860)	1 in. IPS SDR 11.00 (1.077)
30	762	5225	2143	4292	7744
40	653	4472	1835	3673	6628
50	578	3964	1626	3256	5874
60	524	3591	1473	2950	5322
70	482	3304	1355	2714	4896
80	448	3074	1261	2525	4555
90	421	2884	1183	2369	4274
100	397	2724	1117	2238	4037
125	352	2414	990	1983	3578
150	319	2188	897	1797	3242
175	294	2013	826	1653	2983
200	273	1872	678	1539	2775
225	256	1757	721	1443	2603
250	242	1659	681	1363	2459
275	230	1576	646	1294	2336
300	219	1503	617	1235	2228
350	202	1383	567	1136	2050
400	188	1287	528	1057	1907
450	176	1207	495	992	1789
500	166	1140	468	937	1690
600	151	1033	424	849	1531
700	139	951	390	781	1409
800	129	884	363	726	1311
900	121	830	340	682	1230
1000	114	784	322	644	1162
1500	92	629	258	517	933
2000	79	539	221	443	798

Table Reprinted From Tables 10-32 & 10-33 in NFPA Pamphlet 54-1996.

Table 8 Pipe Sizing Between Second-Stage and Appliance

Maximum undiluted propane capacities listed are based on 11 inch water column pressure drop. Capacities in 1000 BTUH.

Length of Pipe or Tubing, Feet	SCHEDULE 40 PIPE Nominal Size (Inside Diameter)									COPPER TUBING TYPE L Nominal Size (Outside Diameter)				
	1/2" (0.622)	3/4" (0.824)	1" (1.049)	1-1/4" (1.38)	1-1/2" (1.61)	2" (2.067)	3" (3.068)	3-1/2" (3.548)	4" (4.026)	1/4"" (0.375)	3/8" (0.500)	1/2" (0.625)	5/8" (0.750)	3/4" (0.875)
10	291	608	1146	2353	3525	6789	19130	28008	39018	49	110	206	348	536
20	200	418	788	1617	2423	4666	13148	19250	26817	34	76	141	239	368
30	161	336	632	1299	1946	3747	10558	15458	21535	27	61	114	192	296
40	137	287	541	1111	1665	3207	9036	13230	18431	23	52	97	164	253
50	122	255	480	985	1476	2842	8009	11726	16335	20	46	86	146	224
60	110	231	435	892	1337	2575	7256	10625	14801	19	42	78	132	203
80	94	198	372	764	1144	2204	6211	9093	12668	16	36	67	113	174
100	84	175	330	677	1014	1954	5504	8059	11227	14	32	59	100	154
125	74	155	292	600	899	1731	4878	7143	9950	12	28	52	89	137
150	67	141	265	544	815	1569	4420	6472	9016	11	26	48	80	124
200	58	120	227	465	697	1343	3783	5539	7716	10	22	41	69	106
250	51	107	201	412	618	1190	3353	4909	6839	9	19	36	61	94
300	46	97	182	374	560	1078	3038	4448	6196	8	18	33	55	85
350	43	89	167	344	515	992	2795	4092	5701	7	16	30	51	78
400	40	83	156	320	479	923	2600	3807	5303	7	15	28	47	73

Table Reprinted From Tables 10-26 & 10-28 in NFPA Pamphlet 54-1996.

Table 9 Maximum Capacity of CSST

CSST TUBE SIZE	In thousands of BTU per hour of undiluted liquefied petroleum gases at a pressure of 2 psi and a pressure drop of 1 psi. (Based on a 1.52 specific gravity gas)														
	EHD** FLOW DESIGNATION	TUBING LENGTH (FEET)													
		10	25	30	40	50	70	80	100	150	200	250	300	400	500
3/8 Inch	13	426	262	238	203	181	146	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 Inch	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 Inch	23	1735	1120	1027	896	806	665	643	578	477	415	373	343	298	268
– – –	25	2168	1384	1266	1100	986	809	7684	703	575	501	448	411	355	319
– – –	30	4097	2560	2331	2012	1794	1457	1410	1256	1021	880	785	716	616	550
1 Inch	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. w.c. 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 numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n where L is the additional length (ft) of tubing and n is the number of additional fittings and/or bends.

**EDH – 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 Reprinted From Table 10-30 in NFPA Pamphlet 54-1996.

Table 10 Maximum Capacity of CSST*

In Thousands of BTU per Hour of Undiluted Liquefied petroleum gases at a pressure of 11 In. W.C. and a pressure drop of 0.5-in. w.c. (Based on a 1.52 specific gravity gas.)

CSST TUBE SIZE	EHD** FLOW DESIGNATIO-N	TUBING LENGTH (FEET)																
		5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
3/8 Inch	13	72	50	39	34	30	28	23	20	19	17	15	15	14	11	9	8	8
– – –	14	99	69	55	49	42	39	33	30	26	25	23	22	20	15	14	12	11
1/2 Inch	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
3/4 Inch	23	355	254	208	183	164	151	131	118	107	99	94	90	85	66	60	53	50
– – –	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
1 Inch	31	863	605	490	425	379	344	297	265	241	222	208	197	186	143	129	117	107

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

**EDH – 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 Reprinted From Table 10-29 in NFPA Pamphlet 54-1996.

SELECTING THE REGULATOR

Regulator performance curves show the capacity of a regulator at different inlet pressures, given the factory setting for outlet pressure.

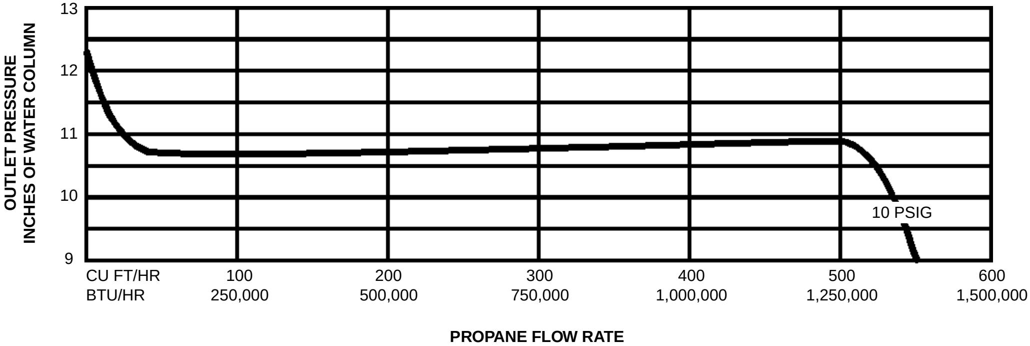
Figure 9 on page 30 shows a performance curve for a Fisher R522 Second-Stage Regulator. Gas flow rate is plotted horizontally and regulator outlet pressure vertically. The curved line represents an inlet pressure of 10 psig. For the appliance to operate efficiently, the regulator outlet pressure must not fall below 9” w.c.

Fisher rates this particular regulator at the point the 10-psig-inlet curve crosses the 9” w.c. horizontal line. Thus, the Fisher catalog literature would rate this regulator at 1,375,000 BTU/HR. or more - if the inlet pressure stays above 10 psig.

What you must know to select a regulator:

1. Appliance Load
2. Pipe Size
3. Inlet Pressure
4. Outlet Pressure
5. Gas Used (Propane/Butane)
6. Select From Manufacturer Catalog

Figure 9


OUTLET PRESSURE
INCHES OF WATER COLUMN
13
12
11
10
9
10 PSIG
CU FT/HR
BTU/HR
100
250,000
200
500,000
300
750,000
400
1,000,000
500
1,250,000
600
1,500,000
PROPANE FLOW RATE

REGULATOR SELECTION

Table 11		
TYPE OF REGULATOR OR SERVICE	**CAPACITY, BTU/HR**	**RECOMMENDED FISHER REGULATOR**
First Stage[1] (Reduces tank pressure to 10 psig or less)	900,000 1,100,00-2,600,000	R312H R522H
Second Stage[2] (Reduces first stage outlet pressure to 14"W.C. or less)	270,000 875,000-1,375,000 1,600,000-2,400,000 2,025,000 5,512,000 8,000,000-12,500,000	R312 R522 S102CL R422 S302G S202G
Integral Two-Stage[1] (Combines a high pressure and a second stage regulator)	275,000 685,000-1,100,000 1,700,000	R332 R532 R432
High Pressure[3] (Reduces tank pressure to a lower pressure in excess of 1 psig)	600,000-1,150,000 2,625,000-5,250,000 9,800,000-20,400,000 6,080,00010,773,000 14,000,000 29,295,000-36,225,000	67 or 67G 64 or 64SR Type 299 627 630-104/78 99
2 PSIG[2] **Service** (Reduces first stage pressure to 2 PSIG)	400,000	R312E

1 Based on 30 psig inlet pressure and 20% droop
2 Based on 10 psig inlet pressure and 20% droop
3 Based on inlet pressure 20 psig greater than outlet pressure with 20% droop.

NOTE: The capacity BTU/HR column should be used for reference purposes only. The capacity will vary depending on the pipe size, orifice size and outlet pressure setting.

TWO-STAGE REGULATION

Advantages of Two-Stage Regulation

Uniform Appliance Pressure - Two-staging lets the first-stage regulator supply a nearly constant inlet pressure to the second-stage regulator at the house. This means the second-stage regulator has an easier time of maintaining appliance pressure at 11” w.c., thus improving the system efficiency.

Lower Installation Costs - Smaller pipe or tubing can be used between the first and second-stage regulators due to the higher pressure, thus reducing installation and piping material costs.

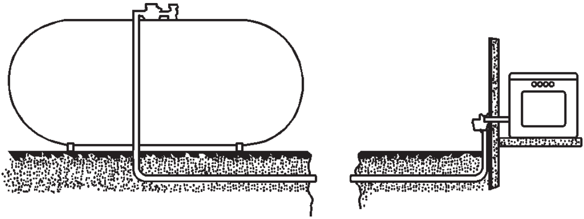
Freezeups - Two-stage systems reduce problems due to regulator freezeups caused by excessive water in gas. Larger orifices make it more difficult for ice to form and block the passage area. The expansion of gas at two different orifices in a two-stage system greatly reduces the “refrigeration effect” that causes freezeups. See **Fisher Bulletins LP-18 and LP-24** for more detailed information on freezing regulators.

Flexibility of Installation - A high pressure regulator can feed a number of low pressure regulators, thus enabling the addition of appliances in the future to the same pressure line without affecting their individual performance.

Fewer Trouble Calls - With two-stage regulation, you can expect fewer trouble calls due to pilot outage or burner adjustment. This means higher appliance efficiency, lower service costs and better customer relations.

REGULATOR INSTALLATION

Figure 10



TWO-STAGE REGULATION

Two Regulators, one at tank and one at building, reduce pressure down to burner pressure (11" w.c.)

A two-stage regulator system or an integral two-stage regulator shall be required on all fixed piping systems that serve appliance systems at 11" w.c. This includes R.V., manufactured housing and food service installations. (Exceptions: Small portable appliances and outdoor cooking appliances with input ratings of 100,000 BTU/HR or less, certain gas distribution systems utilizing multiple second-stage regulators and systems that provide an equivalent level of overpressure protection).

This standard along with changes in UL 144 requiring increased regulator relief valve capacity or an overprotection shutoff device, results in the maximum pressure downstream of the second-stage regulator being limited to 2 psig even with a regulator seat failure.

See **Fisher Bulletin LP-15** for more detailed information on regulator operation, installation and maintenance.

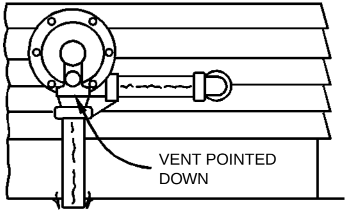
REGULATOR INSTALLATION

Regulator Vents

Regulators should be installed in accordance with NFPA 58 and any other applicable regulations, as well as the manufacturer's instructions. The following guidelines shall be followed:

Outdoor Installations - A regulator installed outdoors without a protective hood must have its vent pointed vertically down, as shown in the drawing.

Figure 11



The regulator should be at least 18 inches above ground. Do not install the regulator where there can be excessive water accumulation or ice formation, such as directly beneath a downspout, gutter or roofline. All vent openings must be at least three horizontal feet from any building opening and no less than five feet in any direction from any source of ignition, openings into direct vent appliances or mechanical ventilation intakes.

Horizontally mounted regulators, such as on single cylinder installations, must be installed underneath a protective cover. On ASME tank installations with the regulator installed under the tank dome, the regulator vent should slope slightly down enough to allow any condensation to drain from the spring case. The regulator vent should be positioned far enough back from the tank dome slot so that it is protected from the weather. The hood should be kept closed.

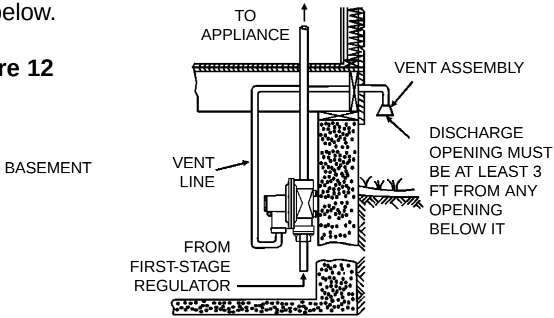
Regulators without "drip lip" vents must be installed under a protective cover.

REGULATOR INSTALLATION

Regulator Vents (cont.)

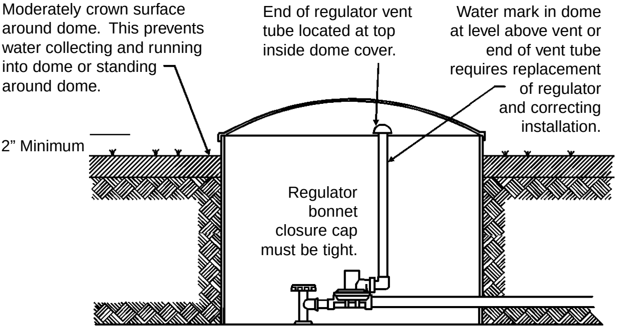
Indoor Installations - In a fixed pipe system, regulators installed indoors require a vent line to the outside air. A screened vent assembly (Fisher Type Y602 series or equivalent) must be used at the end of the vent line. The vent assembly position and location precautions are the same as for regulator vents. The vent line must be the same size as the regulator vent and adequately supported. See Figure below.

Figure 12



Underground Tanks - A vent tube is required on these installations to prevent water from entering the regulator's spring case. The vent tube connects to the regulator vent and terminates above any possible water level, see Figure below. Be sure that the ground slopes away from the tank dome as illustrated. See Figure below.

Figure 13



LEAK TESTING METHODS

There are two primary methods for testing leaks in installations:

Low Pressure Method

1) Inspect all connections and appliance valves to be sure they are tight or closed. This includes pilot valves.
2) Connect a low pressure gauge (Fisher Type 50P-2 or equivalent) to the burner orifice and open the valve.
3) Open the service valve at the tank to pressure the system. Close the service valve tightly.
4) The low pressure gauge should read at least 11” w.c. Slowly bleed off pressure by opening burner valve on the appliance to vent enough gas to reduce the pressure to exactly 9” w.c.
5) If the pressure remains at 9” w.c. for 3 minutes, you can assume the system is leak tight. If the pressure drops, refer to the leak detection procedures on the next page.
6) After the leak is repaired, repeat steps 3, 4, and 5.

High Pressure Method

1) Inspect all connections and appliance valves to be sure they are tight or closed. This includes pilot valves.
2) Connect a test block . (Fisher Type J600 or equivalent in the service valve outlet at the tank, between the valve’s outlet and the first regulator in the system.)

LEAK TESTING METHODS

High Pressure Method (cont.)

3) Open the service valve at the tank to pressure the system. Close the service valve tightly.
4) Open an appliance valve until the test block's pressure gauge drops to 10 psig.
5) The system should stand for 3 minutes without an increase or decrease in the 10-psig reading. If pressure drops, refer to the leak detection procedure section. If pressure increases, then the service valve is leaking.
6) After any leaks are repaired, repeat steps 2, 3 and 4.

Leak Detection and Correction Procedures

1) Use a bubble leak detection solution, or mechanical leak detector, (never a match or an open flame) when checking for leaks.
2) Apply the solution over every pipe or tubing joint and observe carefully to see if the bubbles expand, indicating a leak is present. A large leak can blow the solution away before bubbles have a chance to form.
3) To correct a leak on flaring tubing, first try to tighten the connection. If this doesn't work, reflare.
4) On threaded piping, try tightening or redoping first. If the leak continues, take the connection apart and inspect the threads. Cut new threads if necessary.
5) If steps 3 and 4 fail to correct the problem, look for sandholes in the pipe or fittings and check for splits in the tubing. Replace whatever material is defective.

   Note: Leaks caused by equipment such as gas cocks, appliances, valves, etc., will require repair of the faulty part or replacement of the entire device.

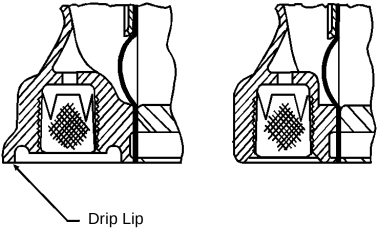
REGULATOR INSPECTION

The following items should be checked at each gas delivery and at regularly scheduled testing and maintenance program intervals.

The customer should be instructed to turn off the tank service valve if gas can be smelled, pilot lights fail to stay on, or any other abnormal situation takes place.

Improper Installation

Figure 14



The regulator vent must be pointed down or under a protective cover. Regulators without "drip lip" vents must be under a protective cover. Proper installation also minimizes weather related vent blockage and internal corrosion.

Vent Blockage

Make sure the regulator vent, vent assembly, or vent tube is not blocked with mud, insect nests, ice, snow, paint, etc. The screen should be clean and properly installed.

Internal & External Corrosion

Replace any regulator that has had water in the spring case or shows evidence of external or internal corrosion. Regulators that have been flooded or that have been installed horizontally which minimizes moisture drainage, or on underground tanks, or in coastal areas are more susceptible to internal corrosion.

To inspect for internal corrosion:

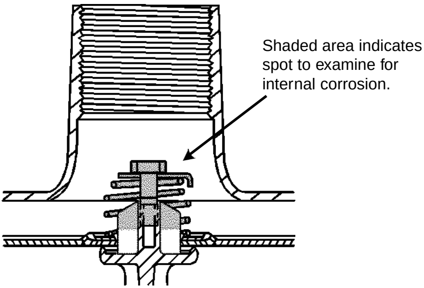
1) Remove the regulator's closing cap and look down into the spring case (a flashlight may be needed).
2) On some regulators it may be necessary to shut down the system and remove the adjusting screw and main spring to adequately see any internal corrosion.

REGULATOR INSPECTION (cont.)

Internal & External Corrosion (cont.)

3) Look for visible corrosion or water marks on the relief valve area and chimney (shaded area in the picture below).
4) Replace the regulator if corrosion is present.

Figure 15



Regulator Age

Locate and replace old regulators. Replace regulators that are over 15 years of age or that have experienced conditions (corrosion, underground systems, flooding, etc.) that would shorten their service life. Older regulators are more likely to fail because of worn or corroded parts. Replace with a two stage regulator system.

Abnormal Pressure

Regulator disc wear (especially on older regulators) or foreign material (dirt, pipe scale, etc.) lodged between the regulator disc and orifice can cause higher than normal outlet pressure to the appliances at lock up or extremely low flows. <u>A pressure test of the system will be required to verify the outlet pressure under these conditions.</u> Replace the regulator if pressure is high. Check the system for foreign material and clean out or replace pigtails as needed.

Always retest the system after replacing a regulator.

See **Fisher Bulletin LP-32** and the instruction manual for more detailed information on inspecting LP-Gas regulators.

TROUBLESHOOTING DOMESTIC TANK FITTINGS

A periodic inspection and maintenance program is recommended for domestic tank fittings. The following briefly discusses ways to avoid and correct potential safety problems with the most common domestic fittings.

A more complete examination of this subject can be found in **Fisher's Bulletin LP-26**, applicable Fisher instruction manuals and NPGA Safety Bulletin 306.

Filler Valves

Always use a filling hose adapter on the end of the hose end valve during the filling process. After filling the tank, do not disconnect the Acme coupling from the filler valve until the Fill valve is closed and all pressure between the hose end valve and the Fill valve has been bled off. If pressure discharge continues, the filler valve may have malfunctioned. DO NOT REMOVE THE FILL HOSE AS THE INTERNAL PARTS MAY BE BLOWN OUT. If light tapping does not close the Fill valve, disconnect the Filling Hose Adapter from the Hose End Valve, leaving the Filling Hose Adapter on the Fill valve. The tank will probably have to be emptied to replace the Fill valve.

Some Fill valve designs allow the seat disc to be replaced while the tank is pressurized. On these designs, make sure the lower back check is still functioning by forcing open the upper back check with an adapter. Take care to dislodge only the upper back check and not both back checks. If there is little leakage with the upper back check open, then the lower back check is in place and the disc can be replaced by following the manufacturer's instructions.

Relief Valves

DO NOT STAND OVER A RELIEF VALVE WHEN TANK PRESSURE IS HIGH. A relief valve's purpose is to relieve excessive tank pressure which can be caused by overfilling, improper purging of air from the container, overheating of the tank, improper paint color, or high vapor pressure, to list just a few reasons. Check the tank pressure gauge if the relief valve is leaking. On a 250 psi design

TROUBLESHOOTING DOMESTIC TANK FITTINGS (cont.)

Relief Valves (cont.)

pressure tank for example, if the relief valve is discharging between the 240 to 260 psig range, the relief valve is working properly as long as it reseats.

A relief valve that discharges substantially below 240 psig or that does not reseat when the tank pressure is lowered, will have to be replaced. Do not attempt to force the valve closed. Lower the tank pressure by withdrawing gas or cooling the outside of the tank.

Always keep a rain cap on the relief valve to help keep out dirt, debris and moisture.

Relief valves, like other pieces of equipment, will not last forever. Fisher recommends that a relief valve not be used for over 15 years. Earlier replacement may be required because of severe service conditions or applicable federal, state, or local codes.

Liquid Withdrawal Valves

A damaged seat or missing internal parts may allow an excessive amount of liquid discharge when the closing cap is loosened. These valves have a bleed hole in the closing cap to vent liquid before the cap is completely unscrewed. If a significant amount of the liquid continues to vent from beneath the cap after 30 seconds, do not remove the cap. Should only vapor be leaking from under the cap, the connection to the withdrawal valve can usually be made.

There is the possibility of liquid spray while opening the withdrawal valve with an angle valve-special adapter. For this reason, protective clothing should be worn and extreme care taken throughout the entire process.

Service Valves

Show the customer this valve and tell him to shut it off if gas is escaping into the house or any other abnormal situation takes place. Check the stem seal and shut off seats periodically for leakage and replace it is necessary (empty the tank first).

Table 12 LP-Gas Orifice Capacities LP-Gases (BTU/HR at Sea Level)

ORIFICE OR DRILL SIZE	PROPANE	BUTANE	ORIFICE OR DRILL SIZE	PROPANE	BUTANE
0.008	519	589	51	36,531	41,414
0.009	656	744	50	39,842	45,168
0.01	812	921	49	43,361	49,157
0.011	981	1,112	48	46,983	53,263
0.012	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	191,114
60	13,008	14,747	26	175,617	199,092
59	13,660	15,846	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	223,945	253,880
52	32,805	37,190	18	233,466	264,673

BTU Per Cubic Foot =	**Propane—2,516**	**Butane—3,280**
Specific Gravity =	**Propane—1.52**	**Butane—2.01**
Pressure at Orifice, Inches Water column =	**Propane—11**	**Butane—11**
Orifice Coefficent =	**Propane—0.9**	**Butane—0.9**

Table 13 Line Sizing Chart For Liquid Propane Flow in GPM

Based on 1 psig pressure drop. Propane at 60°F. Based on Schedule 40/80 steel/iron pipe.

Pipe (Ft.)	1/2"		3/4"		1"		1-1/4"		1-1/2"		2"		2-1/2"		3"		4"	
	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80
10	7.1	5.0	15.0	11.3	28.3	22.2	58	47.6	87	73	169	143	269	229	475	410	967	846
15	5.8	4.1	12.2	9.2	23.0	18.1	47.5	38.8	71	59	137	116	219	187	387	334	789	690
20	5.0	3.5	10.5	8.0	19.9	15.6	41.0	33.5	62	51	119	100	189	161	335	289	682	597
30	4.1	2.9	8.5	6.5	16.2	12.7	33.4	27.3	50.1	41.6	97	82	154	131	283	235	556	486
40	3.5	2.5	7.4	5.6	14.0	11.0	28.8	23.5	43.3	35.9	84	71	133	114	236	203	481	421
50	3.1	2.2	6.6	5.0	12.5	9.8	25.7	21.0	36.6	32.1	75	63	119	101	211	182	429	376
60	2.8	2.0	6.0	4.5	11.3	8.9	23.4	19.1	35.2	29.2	68	57	109	92	192	166	391	343
70	2.6	1.8	5.5	4.2	10.5	8.2	21.6	17.7	32.5	27.0	63	53	100	85	177	153	362	317
80	2.4	1.7	5.2	3.9	9.8	7.7	20.2	16.5	30.4	25.2	59	49.6	94	80	166	143	338	296
90	2.3	1.6	4.8	3.7	9.2	7.2	19.0	15.5	28.6	23.7	55	46.7	88	75	156	135	319	279
100	2.2	1.5	4.6	3.5	8.7	6.8	18.0	14.7	27.1	22.5	52	44.2	84	71	148	128	302	264
150	1.8	1.2	3.7	2.8	7.1	5.5	14.6	11.9	22.0	18.2	42.5	35.9	68	58	120	104	246	215
200	1.5	1.1	3.2	2.4	6.1	4.8	12.6	10.3	18.9	15.7	36.7	31.0	59	49.9	104	89	212	185
300	1.2	0.9	2.6	1.9	4.9	3.8	10.2	8.3	15.3	12.7	29.7	25.1	47.5	40.4	84	73	172	151
400	1.0	0.7	2.2	1.7	4.2	3.3	8.8	7.1	13.2	10.9	25.6	21.6	40.9	34.8	73	66	149	130

CONVERSION FACTORS

Multiply	By	To Obtain
LENGTH & AREA		
Millimeters	0.0394	Inches
Meters	3.2808	Feet
Sq. Centimeters	0.155	Sq. Inches
Sq. Meters	10.764	Sq. Feet
VOLUME & MASS		
Cubic Meters	35.315	Cubic Feet
Liters	0.0353	Cubic Feet
Gallons	0.1337	Cubic Feet
Cubic cm.	0.061	Cubic Inches
Liters	2.114	Pints (US)
Liters	0.2642	Gallons (US)
Kilograms	2.2046	Pounds
Tonnes	1.1024	Tons (US)
PRESSURE & FLOW RATE		
Millibars	0.4018	Inches w.c.
Ounces/sq. in.	1.733	Inches w.c.
Inches w.c.	0.0361	Pounds/sq. in.
Bars	14.50	Pounds/sq. in.
Kilopascals	0.1450	Pounds/sq. in.
Kilograms/sq. cm.	14.222	Pounds/sq. in.
Pounds/sq. in.	0.068	Atmospheres
Liters/hr.	0.0353	Cubic Feet/hr.
Cubic Meters/hr.	4.403	Gallons/min.
MISCELLANEOUS		
Kilojoules	0.9478	BTU
Calories, kg	3.968	BTU
Watts	3.414	BTU/HR
BTU	0.00001	Therms
Megajoules	0.00948	Therms

CONVERSION FACTORS

Multiply	By	To Obtain
LENGTH & AREA		
Inches	25.4	Millimeters
Feet	0.3048	Meters
Sq. Inches	6.4516	Sq. Centimeters
Sq. Feet	0.0929	Sq. Meters
VOLUME & MASS		
Cubic Feet	0.0283	Cubic Meters
Cubic Feet	28.316	Liters
Cubic Feet	7.481	Gallons
Cubic Inches	16.387	Cubic cm.
Pints (US)	0.473	Liters
Gallons (US)	3.785	Liters
Pounds	0.4535	Kilograms
Tons (US)	0.9071	Tonnes
PRESSURE & FLOW RATE		
Inches w.c.	2.488	Millibars
Inches w.c.	0.577	Ounces/sq. in.
Pounds/sq. in.	27.71	Inches w.c.
Pounds/sq. in.	0.0689	Bars
Pounds/sq. in.	6894.7	Kilopascals
Pounds/sq. in.	0.0703	Kilograms/sq. cm.
Atmospheres	14.696	Pounds/sq. in.
Cubic Feet/hr.	28.316	Liters/hr.
Gallons/min.	0.2271	Cubic Meters/hr.
MISCELLANEOUS		
BTU	1.055	Kilojoules
BTU	0.252	Calories, kg
BTU/HR	0.293	Watts
Therms	100,000	BTU
Therms	105.5	Megajoules

FLOW EQUIVALENTS AND TEMPERATURE CONVERSION

Table 14 Flow Equivalents

To convert flow capacities of one kind of gas to flow capacities of a different kind of gas

		MULTIPLY BY:
If you have a flow capacity (CFH, etc.) in NATURAL GAS and want to know equivalent flow capacity of—	Propane:	0.63
	Butane:	0.55
	Air:	0.77
If you have BUTANE and want to know equivalent flow capacity of—	Propane:	1.15
	Natural Gas:	1.83
	Air:	1.42
If you have AIR and want to know equivalent flow capacity of—	Propane:	0.81
	Butane:	0.71
	Natural Gas:	1.29
If you have PROPANE and want to know equivalent flow capacity of—	Butane:	0.87
	Natural Gas:	1.59
	Air:	1.23

Table 15 Temperature Conversion

°F	°C	°F	°C	°F	°C
-40	-40	30	-1.1	90	32.2
-30	-34.4	32	0	100	37.8
-20	-28.9	40	4.4	110	43.3
-10	-23.3	50	10.0	120	48.9
0	-17.8	60	15.6	130	54.4
10	-12.2	70	21.1	140	60.0
20	-6.7	80	26.7	150	65.6

FISHER LITERATURE

LP-12: Regulator Selection And Pipe Sizing Chart.
Handy reference guide for selecting Fisher regulators with convenient method of sizing pipe on the reverse side.

LP-15: Give A Regulator The Attention It Deserves.
Explains how domestic self-operated regulators work; gives installation and maintenance tips.

LP-18: How Drip Lips Can Prevent Regulator Freezeups.
Shows how drip lip style vents can reduce the possibility of vent blockage due to freezing rain.

LP-19: How To Keep Your Internal Valves Working.
A discussion about the operation, installation and maintenance of Fisher's C-Series Internal Valves.

LP-24: Plain Facts About Freezing Regulators.
Describes how a regulator can freeze internally and gives tips to prevent this situation.

LP-26: Safety Practices For Domestic Tank Fittings.
Offers inspection and maintenance programs to reduce tank fitting problems.

LP-29: Complying With NFPA Transfer Area Rulings.
An overview of the NFPA requirements with examples of acceptable equipment.

LP-31: LP-Gas Equipment Buyer Guide.
Serves as a general reference of available equipment.

LP-32: Inspecting LP-Gas Regulators: What To Look For.
Discusses service life, reducing vent blockage, corrosion, inspection, etc.

Tech Talk: Two-Stage Regulation.
Describes how two-staging gives more uniform regulation, reduces trouble calls.

Tech Talk: Trouble Shooting Truck Pumping Systems.
Gives procedures on how to trouble shoot a bobtail or transport pumping system when it doesn't work.

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