Cylinder capacity, lb of LP gas	Winter, 0°F		Summer, 70°F	
	Low humidity, 30%	High humidity, 70%	Low humidity, 30%	High humidity, 70%
5, portable	7,000	4,280	13,370	8,182
20, portable	12,000	7,650	23,870	14,600
40, portable	16,600	10,160	31,710	19,080
60, port/exchange	20,700	12,660	39,540	24,200
100, exchange	25,000	15,300	47,750	29,220
200, stationary	31,000	20,200	59,210	36,240
300, stationary	39,000	25,090	74,490	45,590
420, stationary	45,000	29,980	86,000	52,630

Note 1: Ratings based on cylinders being 1.4 full.

Note 2: The values for exchange (60 lb and 100 lb) cylinders are for the supply cylinders only. When the supply cylinders are connected to an automatic changeover regulator or manifold, one reserve cylinder should be added for each supply cylinder that is used (i.e., 2 supply cylinders require 2 reserve cylinders or a total of 4 cylinders for the installation).

Source: *Distribution Systems Operations Book*, NPGA, section 4.1, page 12.

TABLE 6-1. *Common Department of Transportation (DOT) cylinders, vaporization rates measured in Btuh*

Determining required storage capacity

Withdrawal of propane vapor from a vessel lowers the contained pressure. This causes the liquid to "boil" in an effort to restore pressure by generating vapor to replace that which was withdrawn. 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.

Heat loss due to 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 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, then the greater the vaporization capacity of the system. A larger container would have a larger wetted surface area. Therefore, it would have greater vaporizing capacity. If 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.

Percentage of container filled	*K**	Propane vaporization capacity at 0°F, Btuh*
60	100	D × L × 100
50	90	D × L × 90
40	80	D × L × 80
30	70	D × L × 70
20	60	D × L × 60
10	45	D × L × 45

* These calculations allow for the temperature of the liquid to refrigerate to –20°F, below zero, producing a temperature differential of 20°F 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. Where, "D" equals the outside diameter, in.; "L" equals the overall length, in.; and "K" equals a constant for percent volume of liquid in a container.

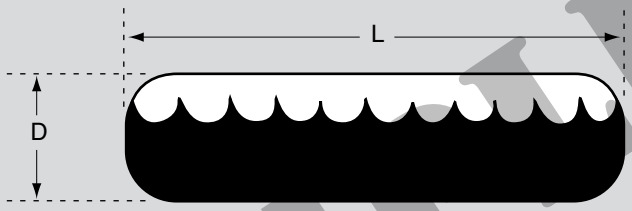


TABLE 6-2. *ASME storage containers, determining propane vaporization capacity*

How all of this affects the vaporization rate of 100-lb cylinders is shown in Table 6-1. It shows that the worst conditions for vaporization rate are when the container has a small amount of liquid in it and outside air temperature is low.

Keeping in mind the principles stated above, you can perform a simple calculation for finding the proper number of Interstate Commerce Commission (ICC) cylinders or the proper size of the American Society of Mechanical Engineering (ASME) storage containers for various loads where temperatures may reach 0°F. The data needed can be found in Tables 6-1 and 6-2.

The following is a guide for installing 100-lb propane cylinders for continuous draws where temperatures may reach 0°F and the humidity is low. Assume that the vaporization rate of a 100-lb cylinder is approximately 25,000 Btuh. The number of cylinders per side equals the total load in Btuh divided by 25,000. For example, assume that the total load equals 100,000 Btuh. The cylinders per side equals 100,000 Btuh divided by 25,000, which equals four cylinders per side.

Data provided in Table 6-1 illustrates the vaporization rate of propane in 100-lb cylinders at various temperatures and volumes of liquid. Table 6-2 covers this factor with ASME large capacity storage containers at 0°F. Table 6-3 shows the method of determining vaporization capacities from Table 6-2 at other temperatures.

Sizing storage tanks

In order to properly size the storage container, regulator, and piping, the total Btu load must be determined. *Total load* is the gas usage in the heating installation if separately supplied, or by adding up the Btu input of all burners being supplied with fuel. The Btu input may be obtained from the name plate on the furnace, boiler, or appliance or from the literature by manufacturers.

Future appliances that 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 cubic feet per hour (ft^3/h), divide the total Btu load by 2,516 for the ft^3/h of propane. Table 6-4 lists the approximate Btuh gas input for various heaters and appliances as data for computing total Btu input requirement.

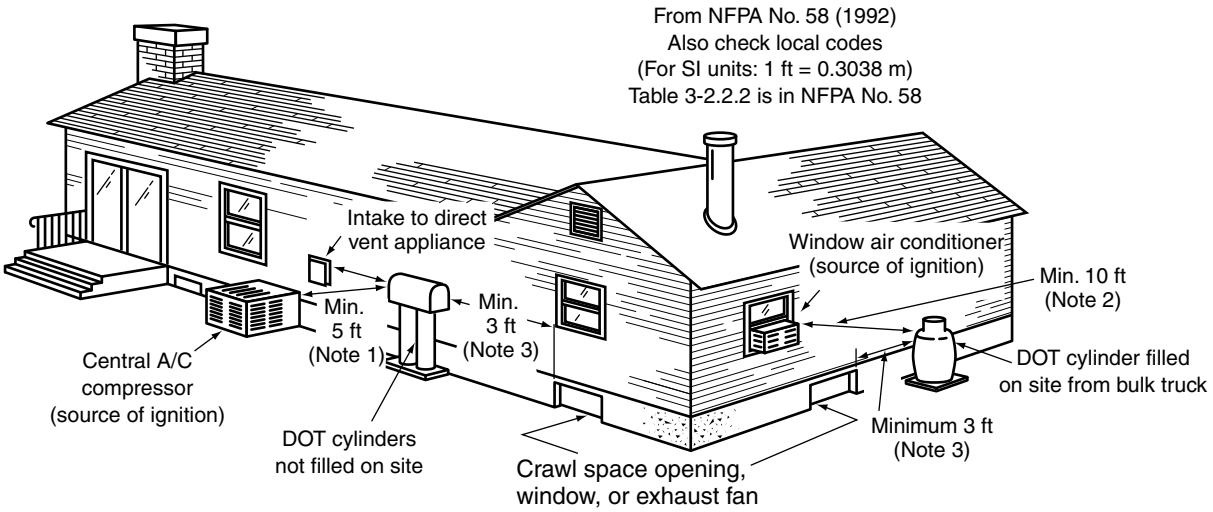
Prevailing air temperature, °F	Multiplier*
–15	0.25
–10	0.50
– 5	0.75
0	1.00
5	1.25
10	1.50
15	1.75
20	2.00

* Multiply the results obtained with the calculation in Table 6-2, by one of these factors for the prevailing air temperature.

TABLE 6-3. *Vaporizing capacities for other air temperatures*

Appliance	Approximate input, Btuh
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-gal tank	30,000
40-gal tank	38,000
50-gal tank	50,000
Water heater, automatic	
instantaneous	
Capacity, 2 gal/minute	142,800
Capacity, 4 gal/minute	285,000
Capacity, 6 gal/minute	428,000
Refrigerator	3,000
Clothes dryer, domestic	35,000
Incinerator, domestic	32,000
Furnace or boiler	unit data

TABLE 6-4. *Approximate Btuh input for some common appliances*



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. Refer to Note (b)(1) under Table 3-2.2.2.
Note 2: If the DOT cylinder is filled on site from bulk truck, the filling connection and vent valve must be a least 10 ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to Note (b)(3) under Table 3-2.2.2.
Note 3: Refer to Note (b)(1) under Table 3-2.2.2.
Source: NFPA No. 58, appendix I, 1992.

FIGURE 6-1. *Location of 100-lb cylinder systems*

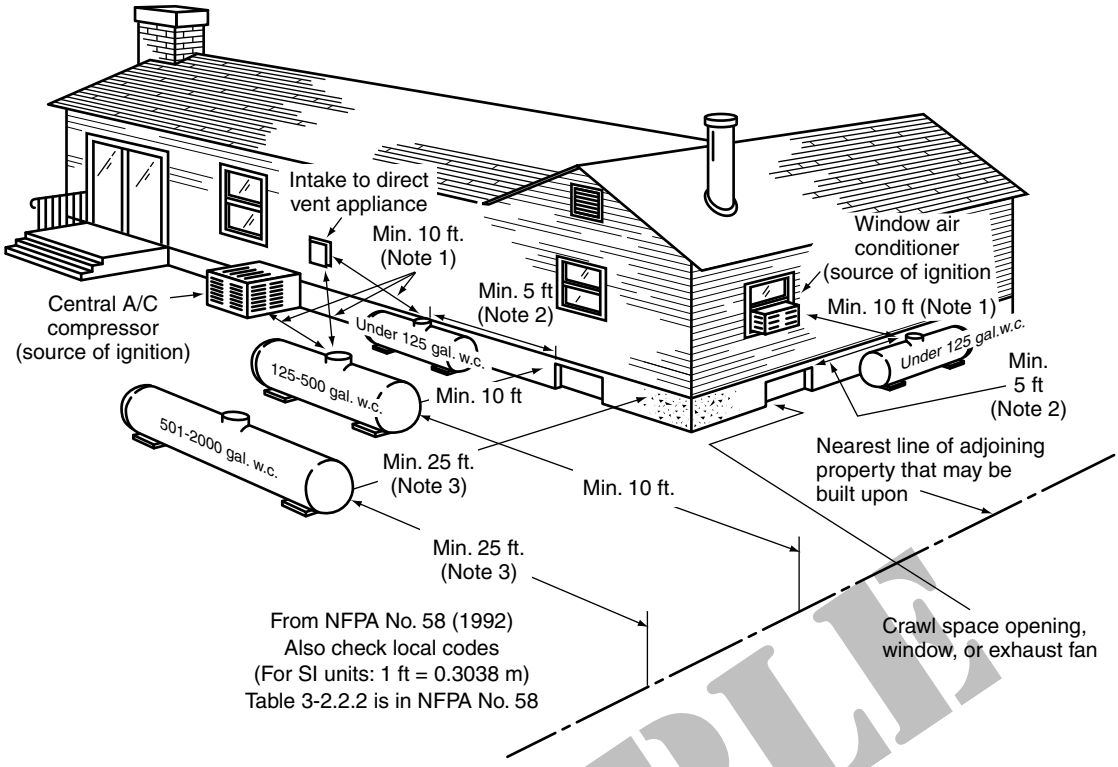
Placement of storage containers

After the proper number of ICC cylinders or the proper size of the ASME storage container 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 requests of the customer as to the location of LP-gas containers and the ease of exchanging cylinders or refilling storage tank from delivery truck. However, precedence must be given to state and local regulations and the No. 58, Standard for the Storage and Handling of Liquefied Petroleum Gases of the National Fire Protection Association (NFPA). For locating 100-lb cylinder systems, see Figure 6-1. For the location of ASME storage containers, refer to Figures 6-2 and 6-3, which are on the next few pages, and the NFPA No. 58, Section 3-2, 1992.

Storage tank purging

When LP gas-storage capacity requirements have been determined and the needed size is obtained, the tanks selected must be completely purged of air and moisture before being installed. Attention to this important procedure will



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 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. Refer to Note (b) (3) under Table 3-2.2.2.
Note 2: Refer to Note (b)(2) under Table 3-2.2.2.
Note 3: This distance may be reduced to not less than 10 ft (3 m) for a single container of 1,200 gal (4.5m3) 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. (.05 m3) water capacity. Refer to Note (c) under Table 3-2.2.2.
Source: NFPA No. 58, Appendix I, 1992.

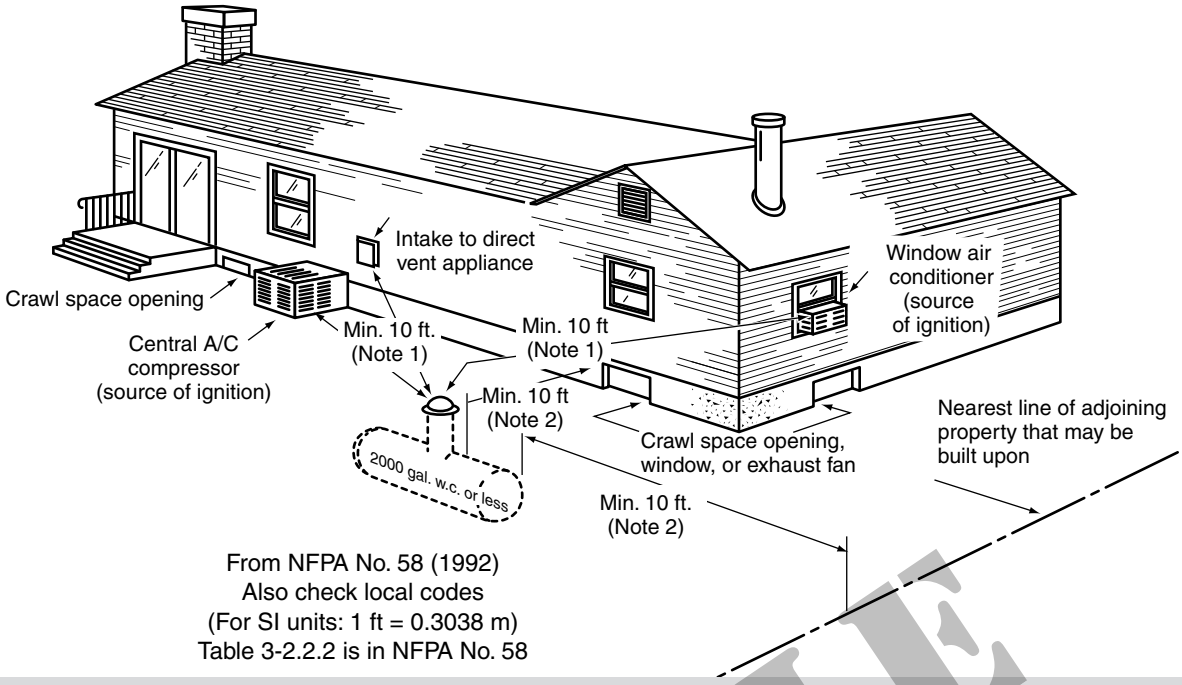
FIGURE 6-2. *Location of ASME storage containers*

promote customer satisfaction and greatly reduce service calls on new installations. Purging is required for the following reasons:

- Both ASME and ICC 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 burners. If not removed, then they will result in costly service calls and needless expense far exceeding the nominal cost of proper purging.



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 intakes. Refer to Note (d) under Table 3-2.2.2.
Note 2: No part of the underground container shall be less than 10 ft from any important building or line of adjoining property that may be built upon. Refer to Note (d) under Table 3-2.2.2.
Source: NFPA No. 58, appendix J, 1992.

FIGURE 6-3. *Location of ASME storage containers*

NEUTRALIZING MOISTURE

Even if a careful inspection (using a pen flashlight) reveals no visible moisture, the storage tank must still be neutralized, because dew may have formed on the walls. Also, the contained air may have a relative humidity of up to 100%.

A rule 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 in Table 6-5 on the next page.

If the natural volume of atmosphere in the vessel is not removed before the first fill, the following 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.