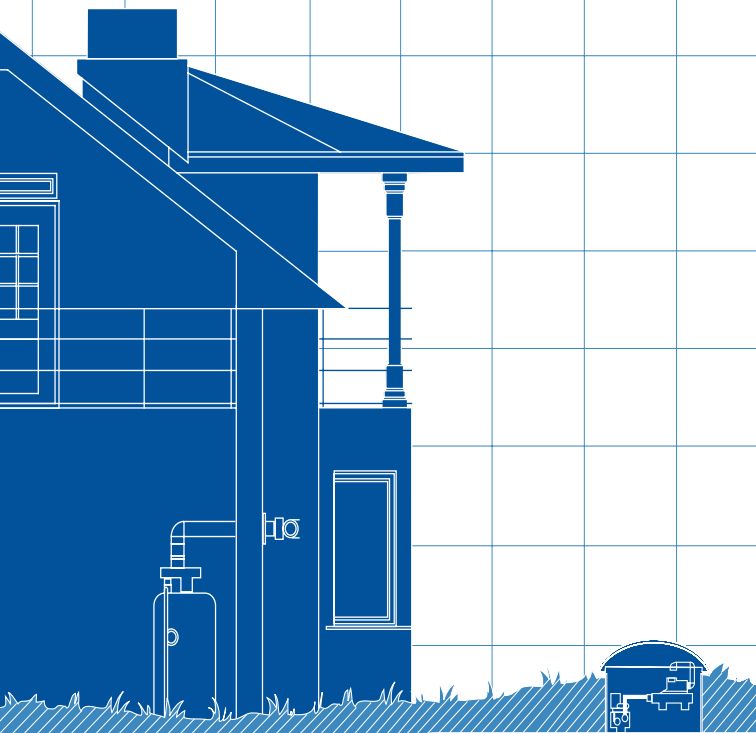


# THE PROPANE TECHNICAL POCKET GUIDE



**PROPANE**  
EXCEPTIONAL ENERGY®

## The Propane Technical Pocket Guide

The Propane Technical Pocket Guide is intended to be a general reference of information on preparing for the installation of propane systems. It provides key data and answers important questions that are relevant to construction professionals planning to incorporate propane in their construction projects.

This guide is not intended to conflict with federal, state, or local ordinances or pertinent industry regulations, including National Fire Protection Association (NFPA) 54 and 58. These should be observed at all times.

The Propane Technical Pocket Guide must not be considered a replacement for proper training on the installation and start-up of propane systems. Propane system installations should always be performed by trained propane professionals. For more information go to [propanesafety.com](http://propanesafety.com).



## Table of Contents

- 2 PROFESSIONALLY ACCREDITED TRAINING
- 3 PROPERTIES OF GAS
- 6 VAPOR PRESSURE OF GAS
- 7 DETERMINING TOTAL LOAD
- 9 VAPORIZATION RATES
- 11 CONTAINER LOCATION AND INSTALLATION
- 14 PIPE AND TUBING SIZING
- 16 GAS PIPING INLET POSITIONING
- 17 CONVERSION FACTORS

# Professionally Accredited Training

The Propane Education & Research Council (PERC) provides free AIA-, NAHB-, USGBC-, and NARI-approved continuing education courses. Fulfill your CEU requirements today at [buildwithpropane.com/training](http://buildwithpropane.com/training).

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- Propane-Enhanced Renewable Energy Systems
- Residential Energy Performance Upgrades: An Energy, Economic, and Environmental Analysis
- Understanding the 2009 IECC Energy Code, Advanced Efficiency Programs, and Their Implications for Propane
- Energy and Environmental Analysis of Propane Energy Pod Homes

## Generators

- Specifying Propane Standby Generators: Installation and Value Considerations
- Living Off-Grid: Power Generation and Storage Basics

## Heating

- A Comparative Analysis of Residential Heating Systems
- Hydronic Heating in Rural Residential Applications
- Propane Enhanced Solar Water Heating
- Retrofitting Homes from Heating Oil to Propane: Efficiency, Economic, and Environmental Benefits
- Heating Oil Conversion: Exploring Propane as a Viable Alternative Energy Source

## Outdoor Living

- Expanding Outdoor Living: Using Propane for Efficient and Sustainable Outdoor Living
- Innovations With Propane Gas for Outdoor Residential Use

## Propane Systems

- Community Propane Tanks: Economical, Environmentally Responsible Energy Without Geographic Limits
- Propane Gas Underground Systems: Residential Infrastructure Requirements and Energy Benefits

## Water Heating

- A Comparative Analysis of Residential Water Heating Systems
- Water Heaters: Retrofitting from Standard Electric to Gas Tankless
- Condensing Tankless Water Heaters: Using Propane for the Most Efficient Water Heaters on the Market



# Properties of Propane and Natural Gas

(Methane)

| Table 1A. Approximate Properties of Gases (English)          |                               |                 |
|--|-------------------------------|-----------------|
| PROPERTY   | Propane                       | Natural Gas     |
|  | C <sub>3</sub> H <sub>8</sub> | CH <sub>4</sub> |
| Initial Boiling Point  | -44                           | -259            |
| Specific Gravity of Liquid<br>(Water at 1.0) at 60°F         | 0.504                         | n/a             |
| Weight per Gallon of Liquid<br>at 60°F, LB                   | 4.2                           | n/a             |
| Specific Heat of Liquid,<br>Btu/LB at 60°F                   | 0.63                          | n/a             |
| Cubic Feet of Vapor per Gallon<br>at 60°F                    | 36.38                         | n/a             |
| Cubic Feet of Vapor per Pound<br>at 60°F                     | 8.66                          | 23.55           |
| Specific Gravity of Vapor<br>(Air = 1.0) at 60°F             | 1.5                           | 0.6             |
| Ignition Temperature in Air, °F                              | 920–1120                      | 1301            |
| Maximum Flame Temperature<br>in Air, °F                      | 3595                          | 2834            |
| Cubic Feet of Air Required to<br>Burn One Cubic Foot of Gas  | 23.68                         | 9.57            |
| Limits of Flammability in Air,<br>% of Vapor in Air-Gas Mix: |                               |                 |
| (a) Lower  | 2.15                          | 5               |
| (b) Upper  | 9.6                           | 15              |
| Latent Heat of Vaporization<br>at Boiling Point:             |                               |                 |
| (a) Btu per Pound  | 184                           | 219             |
| (b) Btu per Gallon   | 773                           | n/a             |
| Total Heating Values After<br>Vaporization:                  |                               |                 |
| (a) Btu per Cubic Foot                                       | 2,488                         | 1,012           |
| (b) Btu per Pound  | 21,548                        | 28,875          |
| (c) Btu per Gallon   | 91,502                        | n/a             |

# Properties of Gas *(Continued)*

**Table 1B. Approximate Properties of Gases (Metric)**

| PROPERTY   | Propane                       | Natural Gas             |
|--|-------------------------------|-------------------------|
|  | C <sub>3</sub> H <sub>8</sub> | CH <sub>4</sub>         |
| Initial Boiling Point, °C  | -42                           | -162                    |
| Specific Gravity of Liquid (Water at 1.0) at 15.56°C   | 0.504                         | n/a                     |
| Weight per Cubic Meter of Liquid at 15.56°C, kg  | 504                           | n/a                     |
| Specific Heat of Liquid, Kilojoule/Kilogram at 15.56°C   | 1.464                         | n/a                     |
| Cubic Meter of Vapor per Liter at 15.56°C  | 0.271                         | n/a                     |
| Cubic Meter of Vapor per Kilogram at 15.56°C   | 0.539                         | 1.470                   |
| Specific Gravity of Vapor (Air = 1.0) at 15.56°C   | 1.50                          | 0.56                    |
| Ignition Temperature in Air, °C  | 493–604                       | 705                     |
| Maximum Flame Temperature in Air, °C   | 1,980                         | 1,557                   |
| Cubic Meters of Air Required to Burn One Cubic Meter of Gas  | 23.86                         | 9.57                    |
| Limits of Flammability in Air, % of Vapor in Air-Gas Mix:<br>(a) Lower<br>(b) Upper  | 2.15<br>9.6                   | 5.0<br>15.0             |
| Latent Heat of Vaporization at Boiling Point:<br>(a) Kilojoule per Kilogram<br>(b) Kilojoule per Liter                             | 428<br>216                    | 509<br>n/a              |
| Total Heating Values After Vaporization:<br>(a) Kilojoule per Cubic Meter<br>(b) Kilojoule per Kilogram<br>(c) Kilojoule per Liter | 92,430<br>49,920<br>25,140    | 37,706<br>55,533<br>n/a |

**Table 1C. Energy Content and Environmental Impact of Various Energy Sources**

|   | Propane<br>(per ft <sup>3</sup> ) | Methane                      | Propane<br>(per gallon) | Fuel Oil           | Electricity          |
|---|-----------------------------------|------------------------------|-------------------------|--------------------|----------------------|
| Energy Value                              | 2,524<br>Btu/ft <sup>3</sup>      | 1,012<br>Btu/ft <sup>3</sup> | 91,500<br>Btu/gal       | 139,400<br>Btu/gal | 3,413<br>Btu/<br>kWh |
| CO <sub>2</sub> emissions (lbs/<br>MMBtu) | 139.2                             | 115.3                        | 139.2                   | 161.4              | 389.5                |
| Source<br>Energy<br>Multipliers*          | 1.151                             | 1.092                        | 1.151                   | 1.158              | 3.365                |

\*Source Energy Multiplier is the total units of energy that go into generation, processing, and delivery for a particular energy source to produce one unit of energy at the site.

# Vapor Pressure of Gas

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.

| Table 2. Vapor Pressures |       |  |               |               |               |               |               |               |
|--------------------------|-------|--|---------------|---------------|---------------|---------------|---------------|---------------|
| TEMPERATURE              |       | Approximate Vapor Pressure, PSIG (bar) |               |               |               |               |               |               |
|                          |       | Propane                                |               |               | to            |               |               | Butane        |
| °F                       | °C    | 100%                                   | 80/20         | 60/40         | 50/50         | 40/60         | 20/80         | 100%          |
| -40                      | -40   | 3.6<br>(0,25)                          | -             | -             | -             | -             | -             | -             |
| -30                      | -34,4 | 8<br>(0,55)                            | 4.5<br>(0,31) | -             | -             | -             | -             | -             |
| -20                      | -28,9 | 13.5<br>(0,93)                         | 9.2<br>(0,63) | 4.9<br>(0,34) | 1.9<br>(0,13) | -             | -             | -             |
| -10                      | -23,3 | 20<br>(1,4)                            | 16<br>(1,1)   | 9<br>(0,62)   | 6<br>(0,41)   | 3.5<br>(0,24) | -             | -             |
| 0                        | -17,8 | 28<br>(1,9)                            | 22<br>(1,5)   | 15<br>(1,0)   | 11<br>(0,76)  | 7.3<br>(0,50) | -             | -             |
| 10                       | -12,2 | 37<br>(2,6)                            | 29<br>(2,0)   | 20<br>(1,4)   | 17<br>(1,2)   | 13<br>(0,90)  | 3.4<br>(0,23) | -             |
| 20                       | -6,7  | 47<br>(3,2)                            | 36<br>(2,5)   | 28<br>(1,9)   | 23<br>(1,6)   | 18<br>(1,2)   | 7.4<br>(0,51) | -             |
| 30                       | -1,1  | 58<br>(4,0)                            | 45<br>(3,1)   | 35<br>(2,4)   | 29<br>(2,0)   | 24<br>(1,7)   | 13<br>(0,9)   | -             |
| 40                       | 4,4   | 72<br>(5,0)                            | 58<br>(4,0)   | 44<br>(3,0)   | 37<br>(2,6)   | 32<br>(2,2)   | 18<br>(1,2)   | 3<br>(0,21)   |
| 50                       | 10    | 86<br>(5,9)                            | 69<br>(4,8)   | 53<br>(3,7)   | 46<br>(3,2)   | 40<br>(2,8)   | 24<br>(1,7)   | 6.9<br>(0,58) |
| 60                       | 15,6  | 102<br>(7,0)                           | 80<br>(5,5)   | 65<br>(4,5)   | 56<br>(3,9)   | 49<br>(3,4)   | 30<br>(2,1)   | 12<br>(0,83)  |
| 70                       | 21,1  | 127<br>(8,8)                           | 95<br>(6,6)   | 78<br>(5,4)   | 68<br>(4,7)   | 59<br>(4,1)   | 38<br>(2,6)   | 17<br>(1,2)   |
| 80                       | 26,7  | 140<br>(9,7)                           | 125<br>(8,6)  | 90<br>(6,2)   | 80<br>(5,5)   | 70<br>(4,8)   | 46<br>(3,2)   | 23<br>(1,6)   |
| 90                       | 32,2  | 165<br>(11,4)                          | 140<br>(9,7)  | 112<br>(7,7)  | 95<br>(6,6)   | 82<br>(5,7)   | 56<br>(3,9)   | 29<br>(2,0)   |
| 100                      | 37,8  | 196<br>(13,5)                          | 168<br>(11,6) | 137<br>(9,4)  | 123<br>(8,5)  | 100<br>(6,9)  | 69<br>(4,8)   | 36<br>(2,5)   |
| 110                      | 43,3  | 220<br>(15,2)                          | 185<br>(12,8) | 165<br>(11,4) | 148<br>(10,2) | 130<br>(9,0)  | 80<br>(5,5)   | 45<br>(3,1)   |

Table adapted from LP-Gas Serviceman's Handbook 2012



# 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, Table 3A below will be useful. Remember to allow for appliances that 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 2,488 to get SCFH. Conversely, the Btu/hr capacity can be obtained from SCFH by multiplying the SCFH figure by 2,488.

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

**Table 3A. Gas Required for Common Appliances**

| APPLIANCE  | Approximate Input Btu/hr   |
|--|--|
| Warm Air Furnace<br>Single Family<br>Multifamily, per Unit   | 60,000–120,000<br>40,000–60,000  |
| Hydronic Boiler, Space Heating<br>Single Family<br>Multifamily, per Unit   | 80,000–140,000<br>50,000–80,000  |
| Hydronic Boiler, Space and Water Heating<br>Single Family<br>Multifamily, per Unit   | 100,000–200,000<br>50,000–100,000  |
| Range, Freestanding, Domestic<br>Built-In Oven or Broiler Unit, Domestic<br>Built-In Top Unit, Domestic  | 50,000–90,000<br>14,000–16,000<br>40,000–85,000  |
| Water Heater, Storage, 30 to 40 gal. Tank<br>Water Heater, Storage, 50 gal. Tank<br>Water Heater, Tankless<br>2.5 GPM<br>3 GPM<br>4 GPM<br>Water Heater, Domestic, Circulating or Side-Arm | 25,000–50,000<br>30,000–55,000<br>30,000–55,000<br><br>115,000–125,000<br>125,000–150,000<br>155,000–200,000 |
| Refrigerator<br>Clothes Dryer, Type 1 (Domestic)<br>Gas Fireplace Direct Vent<br>Gas Log<br>Barbecue<br>Gas Light  | 1,500–2,000<br>18,000–22,000<br>20,000–90,000<br>35,000–90,000<br>40,000–80,000<br>1,400–2,800               |

Table adapted from Newport Partners, 2011.

## Determining Total Load *(Continued)*

A variety of mechanical systems are available for space heating and water heating in homes. These systems have varying energy sources and varying efficiency levels. Table 3B below provides simple calculations that allow contractors and homeowners to estimate the dollars per million Btus depending on the equipment type, efficiency, and energy price. The “\$/MMBtu” figure can be compared across different options to evaluate them.

| <b>Table 3B. Operating Costs and Equipment Efficiencies of Residential Space and Water Heating Systems</b> |   |   |   |
|--|---|---|---|
| SPACE HEATING  | Pricing Estimation Formula (\$/MMBtu)                   | Typical Equipment Efficiency Ranges for Newer Systems |   |
| Propane (furnace or boiler)  | $\frac{(10.9 \times \$/\text{gal})}{(\text{AFUE}/100)}$ | AFUE: 78–98   |   |
| Natural Gas (furnace or boiler)  | $\frac{(10 \times \$/\text{therm})}{(\text{AFUE}/100)}$ | AFUE: 78–98   |   |
| Fuel Oil (furnace or boiler)   | $\frac{(7.2 \times \$/\text{gal})}{(\text{AFUE}/100)}$  | AFUE: 78–95   |   |
| Electric Resistance  | 293 x \$/kWh  | COP: 1.0  |   |
| Electric Air Source Heat Pump  | $\frac{(1000 \times \$/\text{kWh})}{\text{HSPF}}$       | HSPF: 7.7–13.0  |   |
| Electric Ground Source Heat Pump   | $\frac{(293 \times \$/\text{kWh})}{\text{COP}}$         | COP: 3.0–4.7  |   |
| WATER HEATING  | Pricing Estimation Formula (\$/MMBtu)                   | Typical Storage Water Heater Energy Factors (EF)      | Typical Instantaneous Water Heater Energy Factor (EF) |
| Propane  | $(10.9 \times \$/\text{gal})/\text{EF}$                 | 0.59–0.67*  | 0.82–0.98   |
| Methane  | $(10 \times \$/\text{therm})/\text{EF}$                 | 0.59–0.70*  | 0.82–0.98   |
| Fuel Oil   | $(7.2 \times \$/\text{gal})/\text{EF}$                  | 0.51–0.68   | —   |
| Electric Resistance  | $(293 \times \$/\text{kWh})/\text{EF}$                  | 0.90–0.95   | 0.93–1.0  |
| Electric Air Source Heat Pump  | $(293 \times \$/\text{kWh})/\text{EF}$                  | 2.0–2.51  | —   |

\*Residential and commercial units are available with thermal efficiencies up to 96%.

# Vaporization Rates

The factors affecting vaporization include wetted surface area of the container, liquid level in the container, temperature and humidity surrounding the container, and whether the container is aboveground or underground.

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, it is important to consider the lowest winter temperature at the location.

See page 10 for more information.

# Vaporization Rates for ASME Storage Tanks

A number of assumptions were made in calculating the Btu figures listed in Table 4, below:

- 1 The tank is one-half full.
- 2 Relative humidity is 70 percent.
- 3 The tank is under intermittent loading.

Although none of these conditions may apply, Table 4 can still serve as a good rule of thumb in estimating what a particular tank size will provide under various temperatures. This method uses ASME tank dimensions, liquid level, and a constant value for each 10 percent of liquid to estimate the vaporization capacity of a given tank size at 0°F. Continuous loading is not a very common occurrence on domestic installations, but under continuous loading the withdrawal rates in Table 4 should be multiplied by 0.25.

| Table 4. Maximum Intermittent Withdrawal Rate (Btu/hr) Without Tank Frosting* If Lowest Outdoor Temperature (Average for 24 Hours) Reaches ... |       |                        |           |            |             |
|--|-------|------------------------|-----------|------------|-------------|
| TEMPERATURE  |       | Tank Size, Gallons (l) |           |            |             |
|  |       | 150 (568)              | 250 (946) | 500 (1893) | 1000 (3785) |
| 40°F   | 4°C   | 214,900                | 288,100   | 478,800    | 852,800     |
| 30°F   | -1°C  | 187,000                | 251,800   | 418,600    | 745,600     |
| 20°F   | -7°C  | 161,800                | 216,800   | 360,400    | 641,900     |
| 10°F   | -12°C | 148,000                | 198,400   | 329,700    | 587,200     |
| 0°F  | -18°C | 134,700                | 180,600   | 300,100    | 534,500     |
| -10°F  | -23°C | 132,400                | 177,400   | 294,800    | 525,400     |
| -20°F  | -29°C | 108,800                | 145,800   | 242,300    | 431,600     |
| -30°F  | -34°C | 107,100                | 143,500   | 238,600    | 425,000     |

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

## Container Location and Installation

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

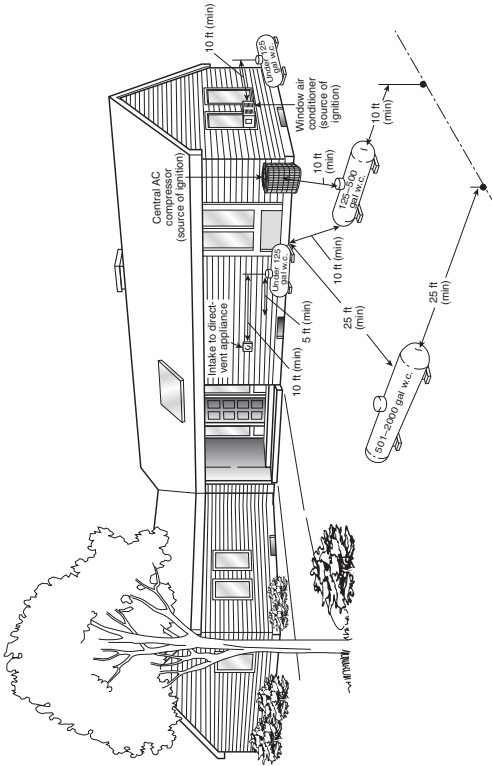
The container should be placed in a location pleasing to the customer but not conflicting with state and local regulations or NFPA 58, Storage and Handling of Liquefied Petroleum Gases. Refer to this standard and consult with your propane professional to determine the appropriate placement of propane containers.

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

For ASME 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 5 and 6 on pages 12 and 13, respectively.

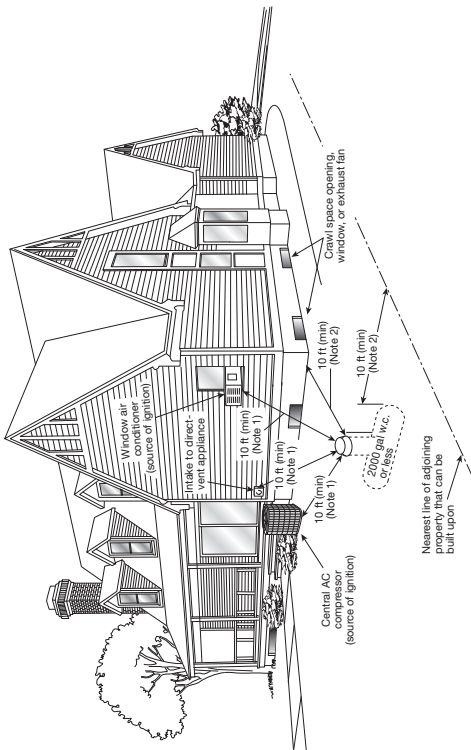
Refer to NFPA 58 for the minimum distances that these containers must be placed from a building or other objects.

# Container Location (Continued)



1. Regardless of its size, any ASME tank filled on site must be located so that the filling connection and fixed maximum liquid level gauge are at least 10 ft from any external source of ignition (e.g., open flame, window AC, compressor), intake to direct-vented gas appliances or intake to a mechanical ventilation system.
2. The distance may be reduced to no less than 10 ft for a single container of 1200 gal (4.5 m<sup>3</sup>) water capacity or less, provided such container is at least 25 ft from any other LP-Gas container of more than 125 gal (0.5 m<sup>3</sup>) water capacity.

**Figure 5.** Aboveground ASME containers. Reproduced with permission from NFPA 58-2011, Liquefied Petroleum Gas Code, Copyright © 2010, National Fire Protection Association. 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.



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

**Figure 6.** Underground ASME containers. Reproduced with permission from NFPA 58-2011, Liquefied Petroleum Gas Code, Copyright © 2010, National Fire Protection Association. 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.

**Table 7. Pipe Sizing Between Second-Stage Regulator and Appliance**

| MAXIMUM UNDILUTED PROPANE CAPACITIES BASED ON 10.0 PSI INLET PRESSURE AND 1.0 PSI PRESSURE DROP. (BASED ON A 1.52 SPECIFIC-GRAVITY GAS.) |                    |                    |                  |                     |                     |                  |                  |                      |                  |
|--|--------------------|--------------------|------------------|---------------------|---------------------|------------------|------------------|----------------------|------------------|
| Nominal Pipe Size, Schedule 40   |                    |                    |                  |                     |                     |                  |                  |                      |                  |
| Piping Length, Feet  | 1/2 in.<br>(0.622) | 3/4 in.<br>(0.824) | 1 in.<br>(1.049) | 1-1/4 in.<br>(1.38) | 1-1/2 in.<br>(1.61) | 2 in.<br>(2.067) | 3 in.<br>(3.068) | 3-1/2 in.<br>(3.548) | 4 in.<br>(4.026) |
| 10   | 291                | 608                | 1146             | 2353                | 3525                | 6789             | 19130            | 28008                | 39018            |
| 20   | 200                | 418                | 788              | 1617                | 2423                | 4666             | 13148            | 19250                | 26817            |
| 30   | 161                | 336                | 632              | 1299                | 1946                | 3747             | 10558            | 15458                | 21535            |
| 40   | 137                | 287                | 541              | 1111                | 1665                | 3207             | 9036             | 13230                | 18431            |
| 50   | 122                | 255                | 480              | 985                 | 1476                | 2842             | 8009             | 11726                | 16335            |
| 60   | 110                | 231                | 435              | 892                 | 1337                | 2575             | 7256             | 10625                | 14801            |
| 80   | 94                 | 198                | 372              | 764                 | 1144                | 2204             | 6211             | 9093                 | 12668            |
| 100  | 84                 | 175                | 330              | 677                 | 1014                | 1954             | 5504             | 8059                 | 11227            |
| 125  | 74                 | 155                | 292              | 600                 | 899                 | 1731             | 4878             | 7143                 | 9950             |
| 150  | 67                 | 141                | 265              | 544                 | 815                 | 1569             | 4420             | 6472                 | 9016             |
| 200  | 58                 | 120                | 227              | 465                 | 697                 | 1343             | 3783             | 5539                 | 7716             |
| 250  | 51                 | 107                | 201              | 412                 | 618                 | 1190             | 3353             | 4909                 | 6839             |
| 300  | 46                 | 97                 | 182              | 374                 | 560                 | 1078             | 3038             | 4448                 | 6196             |
| 350  | 43                 | 89                 | 167              | 344                 | 515                 | 992              | 2795             | 4092                 | 5701             |
| 400  | 40                 | 83                 | 156              | 320                 | 479                 | 923              | 2600             | 3807                 | 5303             |

Note: Capacities are in 1000 Btu/hr.

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**Table 8. Maximum Capacity of CSST\***

| EHD** FLOW DESIGNATION |  | Tubing Length, Feet |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|------------------------|--|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                        |  | 5                   | 10  | 15  | 20  | 25  | 30  | 40  | 50  | 60  | 70  | 80  | 90  | 100 | 150 | 200 | 250 | 300 |
| 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  |
| 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  |
| 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  |
| 31                     |  | 863                 | 605 | 490 | 425 | 379 | 344 | 297 | 265 | 241 | 222 | 208 | 197 | 186 | 143 | 129 | 117 | 107 |

\*Table includes losses for four 90° bends and two end fittings. Tubing runs with larger numbers of bend 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.

\*\*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.

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## Gas Piping Inlet Positioning

Just like tanks, propane pressure regulators come with pipe-size and installation-distance requirements. Regulators installed on the gas piping system at the side of buildings cannot be placed closer than 3 feet horizontally from any building opening, such as a window well, that's lower than the installed regulator. Nor can they be placed closer than 5 feet from any source of ignition, such as an AC compressor. Additional regulations, as well as regulator manufacturer's instructions, may apply. Check with a propane professional first to ensure you comply with interior gas piping inlet positioning requirements.

# Conversion Factors

| <b>Multiply</b>               | <b>By</b> | <b>To Obtain</b> |
|-------------------------------|-----------|------------------|
| <b>LENGTH AND AREA</b>        |           |                  |
| Millimeters                   | 0.0394    | Inches           |
| Meters                        | 3.2808    | Feet             |
| Sq. Centimeters               | 0.1550    | Sq. Inches       |
| Sq. Meters                    | 10.764    | Sq. Feet         |
| <b>VOLUME AND MASS</b>        |           |                  |
| 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)        |
| <b>PRESSURE AND FLOW RATE</b> |           |                  |
| 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.     |
| <b>MISCELLANEOUS</b>          |           |                  |
| Kilojoules                    | 0.9478    | Btu              |
| Calories, kg                  | 3.968     | Btu              |
| Watts                         | 3.414     | Btu/hr           |
| Btu                           | 0.00001   | Therms           |
| Megajoules                    | 0.00948   | Therms           |

# Conversion Factors

| <b>Multiply</b>               | <b>By</b> | <b>To Obtain</b>  |
|-------------------------------|-----------|-------------------|
| <b>LENGTH AND AREA</b>        |           |                   |
| Inches                        | 25.4      | Millimeters       |
| Feet                          | 0.3048    | Meters            |
| Sq. Inches                    | 6.4516    | Sq. Centimeters   |
| Sq. Feet                      | 0.0929    | Sq. Meters        |
| <b>VOLUME AND MASS</b>        |           |                   |
| 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            |
| <b>PRESSURE AND FLOW RATE</b> |           |                   |
| 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.                | 6.895     | 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.  |
| <b>MISCELLANEOUS</b>          |           |                   |
| Btu                           | 1.055     | Kilojoules        |
| Btu                           | 0.252     | Calories, kg      |
| Btu/hr                        | 0.293     | Watts             |
| Therms                        | 100,000   | Btu               |
| Therms                        | 105.5     | Megajoules        |

# Temperature Conversion

| Table 9. 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 |

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