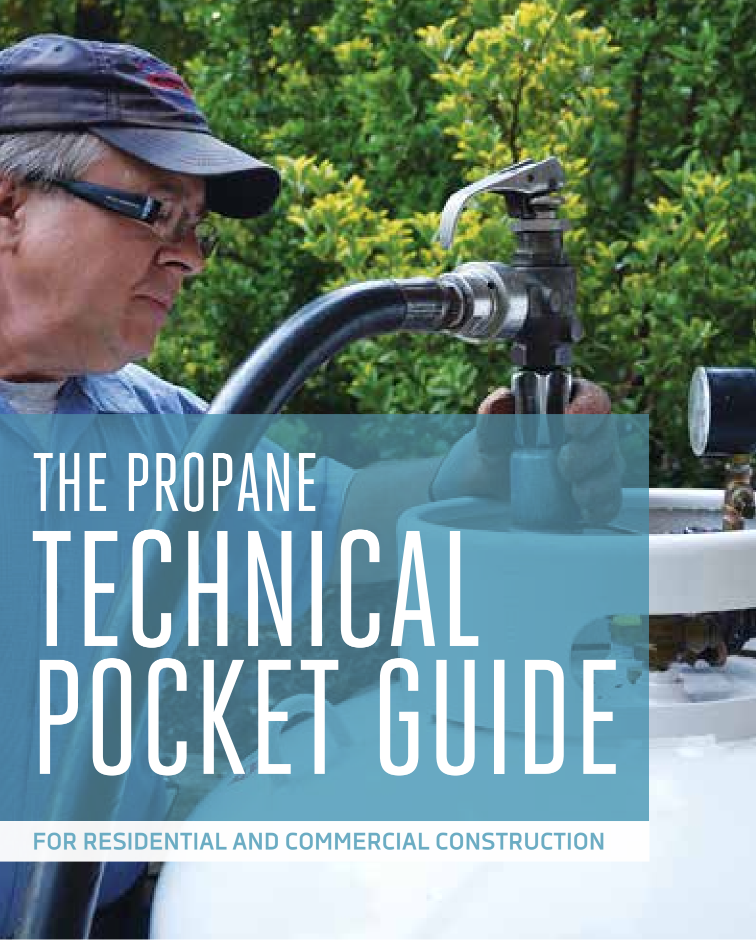

THE PROPANE TECHNICAL POCKET GUIDE

FOR RESIDENTIAL AND COMMERCIAL CONSTRUCTION




DATA AND GUIDANCE FOR CONSTRUCTION PROJECTS

PROPANE EDUCATION & RESEARCH COUNCIL

PROPANE
EXCEPTIONAL ENERGY®

The Propane Technical Pocket Guide

The Propane Technical Pocket Guide provides general information on how to prepare for the installation of propane systems for residential and commercial consumers. It includes key data and answers important questions 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 your local propane professional or **propanesafety.com.**

PROPANE education & research COUNCIL

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Propane Resources

Buildwithpropane.com
Construction pros should visit **buildwithpropane.com** to check out the latest news and insights on building products and trends, learn how to install and operate propane equipment, and find information on construction-related events, conferences, and conventions.

Propane Training Academy
The Propane Education & Research Council (PERC) provides free continuing education courses on propane and its many residential and commercial applications, installation specifics, and products, approved by the American Institute of Architects (AIA), National Association of Home Builders (NAHB), U.S. Green Building Council (USGBC), and National Association of the Remodeling Industry (NARI). Fulfill your CEU requirements today at **buildwithpropane .com/training.**

Propanesafety.com
Training and informing industry professionals and consumers on the safe handling, storage, and use of propane is a top priority at PERC. PERC's safety website provides training, resources, and compliance materials.

Find a Propane Retailer — usepropane.com/fpr.aspx
A trained professional can give you answers to your questions about propane applications. Use this handy online tool to find a propane retailer in your area, and you'll be on your way to a successful, professional propane project.

National Fire Protection Association (NFPA) — nfpa.org
National Fire Protection Association (NFPA) standards govern the use of propane and gas in buildings. Visit nfpa.org for the latest information.

Properties of Propane and Natural Gas (Methane)

Table 1A. Approximate Properties of Gases (U.S.)		
PROPERTY	Propane	Natural Gas
	C_3H_8	CH_4
Initial Boiling Point	-44	-259
Specific Gravity of Liquid (Water at 1.0) at 60°F	0.504	n/a
Weight per Gallon of Liquid at 60°F, LB	4.2	n/a
Specific Heat of Liquid, Btu/LB at 60°F	0.63	n/a
Cubic Feet of Vapor per Gallon at 60°F	36.38	n/a
Cubic Feet of Vapor per Pound at 60°F	8.66	23.55
Specific Gravity of Vapor (Air = 1.0) at 60°F	1.5	0.6
Ignition Temperature in Air, °F	920–1,120	1,301
Maximum Flame Temperature in Air, °F	3,595	2,834
Cubic Feet of Air Required to Burn One Cubic Foot of Gas	23.68	9.57
Limits of Flammability in Air, % of Vapor in Air-Gas Mix: (a) Lower (b) Upper	 2.15 9.6	 5 15
Latent Heat of Vaporization at Boiling Point: (a) Btu per Pound (b) Btu per Gallon	 184 773	 219 n/a
Total Heating Values After Vaporization: (a) Btu per Cubic Foot (b) Btu per Pound (c) Btu per Gallon	 2,488 21,548 91,502	 1,012 28,875 n/a

Table 1B. Approximate Properties of Gases (Metric)		
PROPERTY	Propane	Natural Gas
	C_3H_8	CH_4
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: (a) Lower (b) Upper	 2.15 9.6	 5.0 15.0
Latent Heat of Vaporization at Boiling Point: (a) Kilojoule per Kilogram (b) Kilojoule per Liter	 428 216	 509 n/a
Total Heating Values After Vaporization: (a) Kilojoule per Cubic Meter (b) Kilojoule per Kilogram (c) Kilojoule per Liter	 92,430 49,920 25,140	 37,706 55,533 n/a

Table 1C. Energy Content and Environmental Impact of Various Energy Sources					
	Propane (per ft^3)	Methane	Propane (per gallon)	Fuel Oil	Electricity
Energy Value	2,524 Btu/ft^3	1,012 Btu/ft^3	91,500 Btu/gal	139,400 Btu/gal	3,413 Btu/kWh
CO_2 Emissions (lbs/MMBtu)	139.2	115.3	139.2	161.4	389.5
Source Energy 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. The high source energy multiplier for electricity is due in part to transmission and distribution losses that do not occur with propane.

Vapor Pressure of Gas

Vapor pressure can be defined as the force exerted by a gas or liquid attempting to escape from a container. It is what forces propane gas from the container through the piping and regulator system to the appliance.

Outside temperature affects the propane vapor pressure in the container. A lower temperature creates lower propane vapor pressure in the container. If container pressure is too low, not enough gas will reach the appliance. Placement of the container below grade can help alleviate wide swings in vapor pressures during the year due to the consistent temperature of the earth.

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 (0.25)	-	-	-	-	-	-
-30	-34.4	8 (0.55)	4.5 (0.31)	-	-	-	-	-
-20	-28.9	13.5 (0.93)	9.2 (0.63)	4.9 (0.34)	1.9 (0.13)	-	-	-
-10	-23.3	20 (1.4)	16 (1.1)	9 (0.62)	6 (0.41)	3.5 (0.24)	-	-
0	-17.8	28 (1.9)	22 (1.5)	15 (1.0)	11 (0.76)	7.3 (0.50)	-	-
10	-12.2	37 (2.6)	29 (2.0)	20 (1.4)	17 (1.2)	13 (0.90)	3.4 (0.23)	-
20	-6.7	47 (3.2)	36 (2.5)	28 (1.9)	23 (1.6)	18 (1.2)	7.4 (0.51)	-
30	-1.1	58 (4.0)	45 (3.1)	35 (2.4)	29 (2.0)	24 (1.7)	13 (0.9)	-
40	4.4	72 (5.0)	58 (4.0)	44 (3.0)	37 (2.6)	32 (2.2)	18 (1.2)	3 (0.21)
50	10	86 (5.9)	69 (4.8)	53 (3.7)	46 (3.2)	40 (2.8)	24 (1.7)	6.9 (0.58)
60	15.6	102 (7.0)	80 (5.5)	65 (4.5)	56 (3.9)	49 (3.4)	30 (2.1)	12 (0.83)
70	21.1	127 (8.8)	95 (6.6)	78 (5.4)	68 (4.7)	59 (4.1)	38 (2.6)	17 (1.2)
80	26.7	140 (9.7)	125 (8.6)	90 (6.2)	80 (5.5)	70 (4.8)	46 (3.2)	23 (1.6)
90	32.2	165 (11.4)	140 (9.7)	112 (7.7)	95 (6.6)	82 (5.7)	56 (3.9)	29 (2.0)
100	37.8	196 (13.5)	168 (11.6)	137 (9.4)	123 (8.5)	100 (6.9)	69 (4.8)	36 (2.5)
110	43.3	220 (15.2)	185 (12.8)	165 (11.4)	148 (10.2)	130 (9.0)	80 (5.5)	45 (3.1)

Table adapted from LP-Gas Serviceman's Handbook 2012

Determining Total Load

The best way to determine British thermal unit (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, refer to Table 3A below. Remember to allow for appliances that may be installed at a later date, especially if a manifold with unused ports is installed. Some examples may include gas outlets for fireplaces and grills and a switch from electric to gas dryer.

If the propane load needs to be in standard cubic feet per hour (SCFH), divide the Btu/hour load by 2,488 to get SCFH. Conversely, the Btu/hour capacity can be obtained from SCFH by multiplying the SCFH figure by 2,488.

Your propane provider will need to know the total Btu load of the system to be served to properly design the propane system, including determining the proper sizing and distance placement of the propane tank, the location of regulators, and the specifications of the underground high-pressure piping system.

Table 3A. Approximate Gas Input for Typical Appliances

APPLIANCE	Approximate Input Btu/Hour
Warm Air Furnace	
Single Family	100,000
Multifamily, per Unit	60,000
Hydronic Boiler, Space Heating	
Single Family	100,000
Multifamily, per Unit	60,000
Hydronic Boiler, Space and Water Heating	
Single Family	120,000
Multifamily, per Unit	75,000
Water Heater, Storage, 30- to 40-Gallon Tank	35,000
Water Heater, Storage, 50-Gallon Tank	50,000
Water Heater, Tankless	
2 GPM	142,800
4 GPM	285,000
6 GPM	428,400
Water Heater, Domestic, Circulating, or Side-Arm	35,000
Range, Freestanding, Domestic	65,000
Built-In Oven or Broiler Unit, Domestic	25,000
Built-In Top Unit, Domestic	40,000
Refrigerator	3,000
Clothes Dryer, Type 1 (Domestic)	35,000
Gas Fireplace, Direct Vent	40,000
Gas Log	80,000
Barbecue	40,000
Gas Light	2,500

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 Btu depending on the equipment type, efficiency, and energy price. The "$/MMBtu" figure can be compared across different options to evaluate them.

Table 3B. Operating Costs and Equipment Efficiencies of Residential Space and Water Heating Systems

SPACE HEATING	Pricing Estimation Formula ($/MMBtu)	Typical Equipment Efficiency Ranges for Newer Systems	
Propane (furnace or boiler)	(10.9 x $/gal) / (AFUE/100)	AFUE: 78–98	
Natural Gas (furnace or boiler)	(10 x $/therm) / (AFUE/100)	AFUE: 78–98	
Fuel Oil (furnace or boiler)	(7.2 x $/gal) / (AFUE/100)	AFUE: 78–95	
Electric Resistance	293 x $/kWh	COP: 1.0	
Electric Air Source Heat Pump	(1,000 x $/kWh) / HSPF	HSPF: 7.7–13.0	
Electric Ground Source Heat Pump	(293 x $/kWh) / COP	COP: 3.0–4.7[1]	
WATER HEATING	Pricing Estimation Formula ($/MMBtu)	Typical Storage Water Heater Energy Factors (EF)	Typical Instantaneous Water Heater Energy Factor (EF)
Propane	(10.9 x $/gal)/EF	0.59–0.67[2]	0.82–0.98
Methane	(10 x $/therm)/EF	0.59–0.70[2]	0.82–0.98
Fuel Oil	(7.2 x $/gal)/EF	0.51–0.68	—
Electric Resistance	(293 x $/kWh)/EF	0.90–0.95	0.93–1.0
Electric Air Source Heat Pump	(293 x $/kWh)/EF	2.0–2.51	—

[1]Note that COP does not account for pump energy used to move refrigerant through the extensive ground loop.

[2]Residential and commercial units are available with thermal efficiencies up to 97%.

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. Underground tanks will experience a more-constant temperature year-round, stabilizing vaporization rates due to the stability of soil temperatures.

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.

Table 4. Propane Storage Tank Capacities and Measurements*

WATER CAPACITY (GALLONS)	Outside Diameter	Length
120	24"	5'6"
250	30"	7'8"
320	32"	9'
500	38"	10'
1,000	40"	16'8"
2,000	49"	21'4"
12,000	84"	44'10"
18,000	110"	41'
30,000	110"	66'

*These dimensions are only for guidance, as tank sizes and dimensions vary by manufacturer.

Vaporization Rates for ASME Storage Tanks

A number of assumptions were made in calculating the Btu figures listed in Table 5, noted below:

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

Although none of these conditions may apply, Table 5 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 degrees Fahrenheit. Continuous loading is not a very common occurrence on domestic installations, but under continuous loading the withdrawal rates in Table 5 should be multiplied by 0.25.

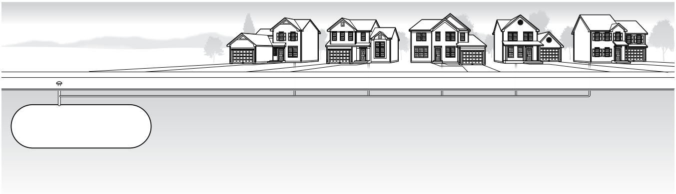
Table 5. Maximum Intermittent Withdrawal Rate (Btu/Hour) Without Tank Frosting* If Lowest Outdoor Temperature (Average for 24 Hours) Reaches ...

TEMPERATURE		Tank Size, Gallons (Liters)			
		150 (568)	250 (946)	500 (1,893)	1,000 (3,785)
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.

Propane Jurisdictional Systems

Propane jurisdictional systems, sometimes referred to as community propane systems or master meter systems, typically serve multiple dwellings, buildings, or businesses.



In general, an operator needs to comply with two primary codes when installing, maintaining, and servicing a jurisdictional system:

- The Code of Federal Regulations (CFR), Title 49, Parts 191 and 192. See www.gpoaccess.gov/cfr.
- National Fire Protection Association's Liquefied Petroleum Gas Code (NFPA 58). See www.nfpa.org.

For more guidance in recognizing jurisdictional systems and the responsibilities required of companies that install and service them, visit propanesafety.com and download "Propane Jurisdictional Systems: A Guide to Understanding Basic Fundamentals and Requirements."

Container Location and Installation

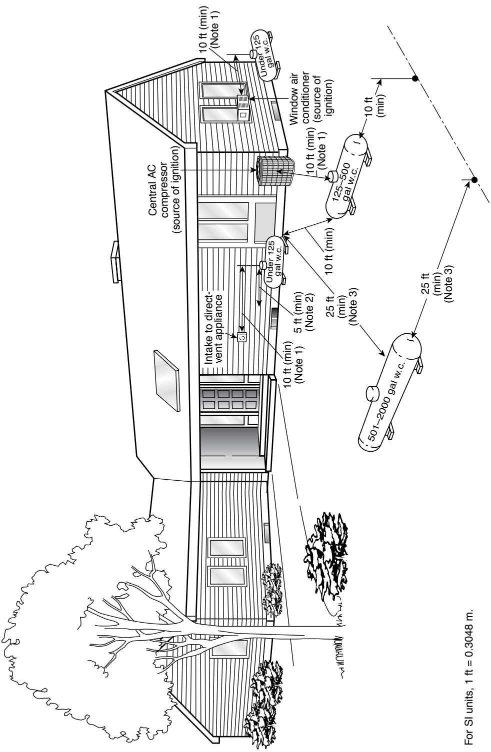
Once the proper size of the ASME storage tank has been determined, careful attention must be given to the most convenient yet safe place for its location on the customer's property.

The container should be placed in a location that pleases the customer but does not conflict 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 a concrete pad or concrete blocks of appropriate size and reinforcement. For underground propane tanks, properly determining the depth and size of the burial location is critical for placement of the tank. To avoid damage, underground propane tanks should be installed in a location where the delivery truck will not need to drive over septic tanks or other underground amenities. 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 1 and 2 on pages 12 and 13, respectively.

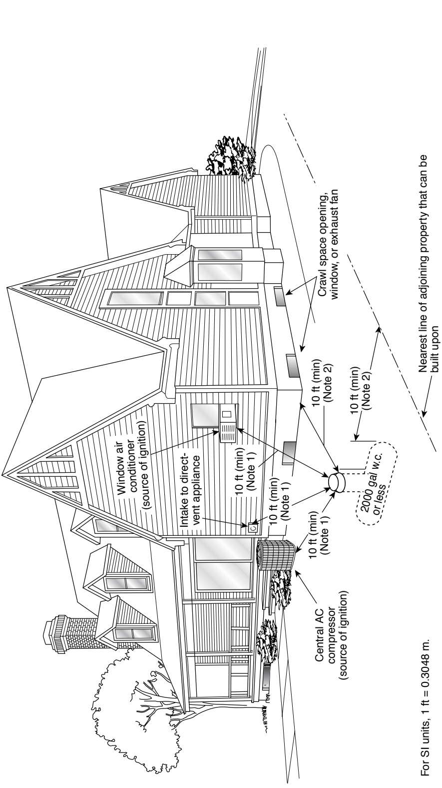
Refer to NFPA 58 for the minimum distances that these containers must be placed from a building or other objects.



1. Regardless of its size, any ASME container filled on site must be located so that the filling connection and fixed maximum liquid level gauge are at least 10 feet 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 can be reduced to no less than 10 feet for a single container of 1,200 gal (4.5 m^3) water capacity or less, provided such container is at least 25 feet from any other LP-gas container of more than 125 gal (0.5 m^3) water capacity.

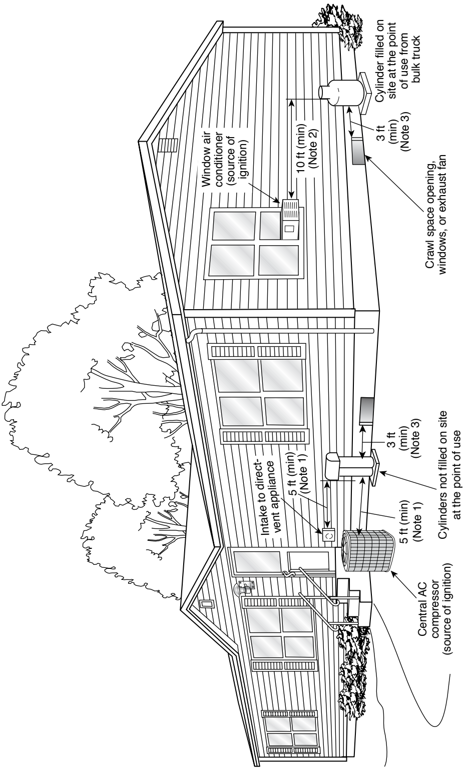
Figure 1. *Aboveground ASME Containers. Reproduced with permission from NFPA 58-2014,* Liquefied Petroleum Gas Code, *copyright © 2013, National Fire Protection Association. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only 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 feet 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 feet from an important building or line of adjoining property that can be built upon.

Figure 2. *Underground ASME Containers. Reproduced with permission from NFPA 58-2014,* Liquefied Petroleum Gas Code, *copyright © 2013, 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. Five feet minimum from relief valve in any direction away from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes.

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

Figure 3. *Cylinders. Reproduced with permission from NFPA 58-2014,* Liquefied Petroleum Gas Code, *copyright © 2013, 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 6. Pipe Sizing Between Second-Stage Regulator and Appliance

MAXIMUM UNDILUTED PROPANE CAPACITIES BASED ON AN INLET PRESSURE OF 11 INCHES W.C. AND A PRESSURE DROP OF 0.5 INCH W.C. (BASED ON A 1.52 SPECIFIC GRAVITY GAS)									
	Nominal Pipe Size, Schedule 40								
Piping Length, Feet	1/2 in. (0.622)	3/4 in. (0.824)	1 in. (1.049)	1-1/4 in. (1.38)	1-1/2 in. (1.61)	2 in. (2.067)	3 in. (3.068)	3-1/2 in. (3.548)	4 in. (4.026)
10	291	608	1,146	2,353	3,525	6,789	19,130	28,008	39,018
20	200	418	788	1,617	2,423	4,666	13,148	19,250	26,817
30	161	336	632	1,299	1,946	3,747	10,558	15,458	21,535
40	137	287	541	1,111	1,665	3,207	9,036	13,230	18,431
50	122	255	480	985	1,476	2,842	8,009	11,726	16,335
60	110	231	435	892	1,337	2,575	7,256	10,625	14,801
80	94	198	372	764	1,144	2,204	6,211	9,093	12,668
100	84	175	330	677	1,014	1,954	5,504	8,059	11,227
125	74	155	292	600	899	1,731	4,878	7,143	9,950
150	67	141	265	544	815	1,569	4,420	6,472	9,016
200	58	120	227	465	697	1,343	3,783	5,539	7,716
250	51	107	201	412	618	1,190	3,353	4,909	6,839
300	46	97	182	374	560	1,078	3,038	4,448	6,196
350	43	89	167	344	515	992	2,795	4,092	5,701
400	40	83	156	320	479	923	2,600	3,807	5,303

Note: Capacities are in 1,000 Btu/Hour.

Table 7. Maximum Capacity of CSST[1]

EHD[2] FLOW DESIGNATION	IN THOUSANDS OF BTU/HOUR OF UNDILUTED PROPANE AT A PRESSURE OF 11 INCHES W.C. AND A PRESSURE DROP OF 0.5 INCH W.C. (BASED ON A 1.52 SPECIFIC GRAVITY GAS)																
	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

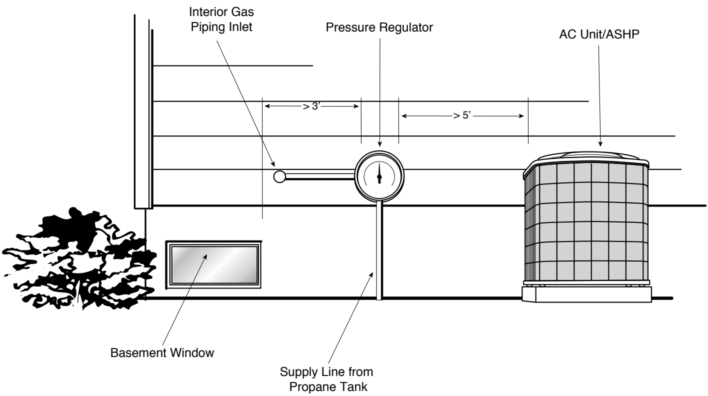
[1]Table includes losses for four 90° bends and two end fittings. Tubing runs with larger numbers of bend and/or fittings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n where L is the additional length (feet) of tubing and n is the number of additional fittings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

[2]EHD (Equivalent Hydraulic Diameter) is 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.

Gas Piping Inlet Positioning

Just like tanks, propane pressure regulators come with requirements regarding pipe size and installation distance. Regulators installed on the gas piping system at the side of buildings cannot be placed closer than three 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 five feet from any source of ignition, such as an AC compressor or the intake to a direct-vent appliance. 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.

Figure 4.
Interior Gas Piping Inlet Positioning Guidelines



Gas Piping Hangers, Supports, and Anchors

These guidelines cover the placement of gas piping hangers, supports, and anchors, and have been adapted with permission from NFPA 54-2012, the National Fuel Gas Code. NFPA 54, local codes and standards, and manufacturer recommendations should be observed at all times.

Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of the piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of ANSI/MSS SP-58, *Pipe Hangers and Supports — Materials, Design and Manufacture.*

Spacings of supports in gas piping installations shall not be greater than shown in Table 8.

Table 8. Support of Piping

Steel Pipe, Nominal Size of Pipe (Inches)	Spacing of Supports (Feet)	Nominal Size of Tubing Smooth Wall (Inches O.D.)	Spacing of Supports (Feet)
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1-1/4 or larger (horizontal)	10	7/8 or 1 (horizontal)	8
1-1/4 or larger (vertical)	Every floor level	1 or larger (vertical)	Every floor level

Spacing of supports of CSST shall be in accordance with the CSST manufacturer's instructions.

Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting system shall be designed and installed so they are not disengaged by movement of the supported piping.

The Propane-Ready Home

A home can be made propane-ready with simple steps like installing gas piping (CSST or alternative) to future use points, installing a manifold with available ports, and roughing in for future applications, such as by using a generator-ready electric panel. These steps add value to the home and pave the way for more propane applications. The house cutaway below shows use points for propane to consider both inside and outside the home.

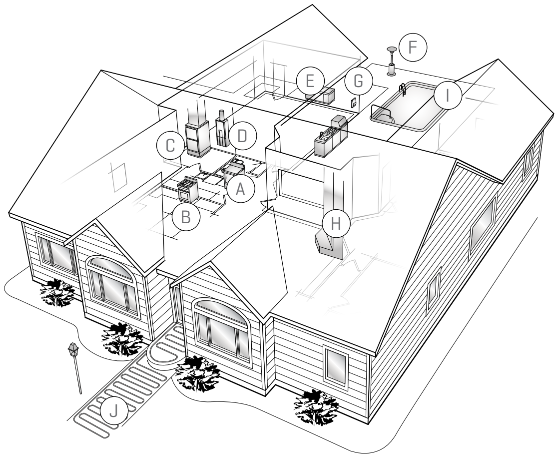


Figure 5. *The Propane-Ready Home*

A. Clothes drying

B. Cooking

C. Space heating

D. Water heating

E. Backup power

F. Outdoor kitchen and amenities

G. Future flexibility

H. Fireplace

I. Pool heating

J. Snowmelt

Propane Generator Installation

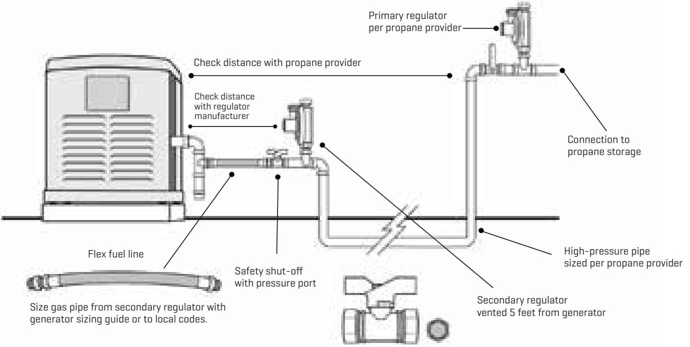


Figure 6. *Propane Generator Installation Diagram*

Table 9. Propane Generator Fuel Consumption [1,2,3]

Generator kW Rating	Fuel Consumption at 100% Btu/Hour	Fuel Consumption at 50% Btu/Hour
8	129,000	79,000
11	175,000	107,000
13	268,000	149,000
14	279,000	168,000
15	260,000	166,000
17	325,000	181,000
20	350,000	189,000
22	313,000	188,000
25	430,000	298,000
27	356,000	195,000
30	493,000	320,000
36	500,000	280,000
45	725,000	378,000
48	755,000	393,000
60	818,000	458,000
70	1,028,000	503,000
80	1,163,000	603,000
100	1,268,000	718,000
130	1,798,000	933,000
150	2,075,000	1,078,000

1. Propane generators are available up to 400kW and some models can be tied together for increased capacity. Refer to manufacturer specifications for guidance on larger generator sizes.

2. Generator manufacturers and models may have varying Btu requirements. Check manufacturer specifications for guidance.

3. Generator Btu load may require separate second-stage propane regulation. The propane system installer will make that determination based on total Btu load of the project.

Diagram and chart based on information provided courtesy of Generac.

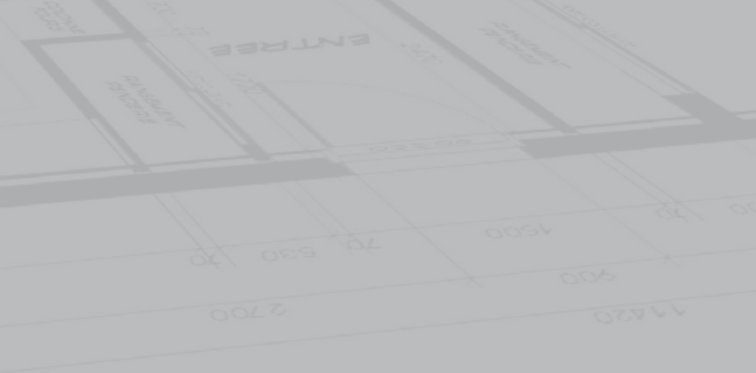
Conversion Factors

Multiply	By	To Obtain
LENGTH AND AREA		
Millimeters	0.0394	Inches
Meters	3.2808	Feet
Sq. centimeters	0.1550	Sq. inches
Sq. meters	10.764	Sq. feet
VOLUME AND 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 (U.S.)
Liters	0.2642	Gallons (U.S.)
Kilograms	2.2046	Pounds
Tonnes	1.1024	Tons (U.S.)
PRESSURE AND 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

Multiply	By	To Obtain
LENGTH AND AREA		
Inches	25.4	Millimeters
Feet	0.3048	Meters
Sq. inches	6.4516	Sq. centimeters
Sq. feet	0.0929	Sq. meters
VOLUME AND MASS		
Cubic feet	0.0283	Cubic meters
Cubic feet	28.316	Liters
Cubic feet	7.481	Gallons
Cubic inches	16.387	Cubic cm.
Pints (U.S.)	0.473	Liters
Gallons (U.S.)	3.785	Liters
Pounds	0.4535	Kilograms
Tons (U.S.)	0.9071	Tonnes
PRESSURE AND 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.	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.
MISCELLANEOUS		
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 10. 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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BUILDWITHPROPANE.COM
202.452.8975
INFO@PROPANE.COM