

# CHAPTER 4

## GAS PIPING INSTALLATIONS

### SECTION 401 (IFGC) GENERAL

**401.1 Scope.** This chapter and Appendix A shall govern the design, installation, modification and maintenance of piping systems. The applicability of this code to piping systems extends from the point of delivery to the connections with the equipment and includes the design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance of such piping systems.

**401.1.1 Utility piping systems located within buildings.**

Utility service piping located within buildings shall be installed in accordance with the structural safety and fire protection provisions of the *International Building Code*.

**401.2 Liquefied petroleum gas storage.** The enforcement of the location of undiluted liquefied petroleum gas containers shall be the responsibility of the North Carolina Department of Agriculture and Consumer Services in accordance with Article 5 of Chapter 119 of the General Statutes.

**401.3 Modifications to existing systems.** In modifying or adding to existing piping systems, sizes shall be maintained in accordance with this chapter.

**401.4 Additional appliances.** Where an additional appliance is to be served, the existing piping shall be checked to determine if it has adequate capacity for all appliances served. If inadequate, the existing system shall be enlarged as required or separate piping of adequate capacity shall be provided.

**401.5 Identification.** For other than black steel pipe, exposed piping shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm).

**401.6 Interconnections.** Where two or more meters are installed on the same premises but supply separate consumers, the piping systems shall not be interconnected on the outlet side of the meters.

**401.7 Piping meter identification.** Piping from multiple meter installations shall be marked with an approved permanent identification by the installer so that the piping system supplied by each meter is readily identifiable.

**401.8 Minimum sizes.** All pipe utilized for the installation, extension and alteration of any piping system shall be sized to supply the full number of outlets for the intended purpose and shall be sized in accordance with Section 402.

**401.9 Meter location.** When required, a meter shall be provided for the building or residence to be served. The location shall be such that the meter can be read, serviced or changed. The location, space requirements, dimensions and proper clearances shall be acceptable to the local gas company.

### SECTION 402 (IFGS) PIPE SIZING

**402.1 General considerations.** Piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of delivery and the gas utilization equipment.

**402.2 Maximum gas demand.** The volume of gas to be provided shall be determined directly from the manufacturer's input ratings of the gas utilization equipment served. Where an input rating is not indicated, the gas supplier, equipment manufacturer or a qualified agency shall be contacted, or the rating from Table 402.2 shall be used for estimating the volume of gas to be supplied.

The total connected hourly load shall be used as the basis for pipe sizing, assuming that all equipment could be operating at full capacity simultaneously. Where a diversity of load can be established, pipe sizing shall be permitted to be based on such loads.

**402.3 Sizing.** Gas piping shall be sized in accordance with one of the following:

1. Pipe sizing tables or sizing equations in accordance with Section 402.4.
2. The sizing tables included in a listed piping system's manufacturer's installation instructions.
3. Other approved engineering methods.

**402.4 Sizing tables and equations.** Where Tables 402.4(1) through 402.4(35) are used to size piping or tubing, the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3.

Where Equations 4-1 and 4-2 are used to size piping or tubing, the pipe or tubing shall have smooth inside walls and the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3.

1. Low-pressure gas equation [Less than 1.5 pounds per square inch (psi) (10.3 kPa)]:

$$D = \frac{Q^{0.381}}{19.17 \left( \frac{\Delta H}{C_r \times L} \right)^{0.206}} \quad \text{(Equation 4-1)}$$

2. High-pressure gas equation [1.5 psi (10.3 kPa) and above]:

$$D = \frac{Q^{0.381}}{18.93 \left[ \frac{(P_1^2 - P_2^2) \times Y}{C_r \times L} \right]^{0.206}} \quad \text{(Equation 4-2)}$$

where:

- $D$  = Inside diameter of pipe, inches (mm).
- $Q$  = Input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30-inch mercury column
- $P_1$  = Upstream pressure, psia ( $P_1 + 14.7$ )
- $P_2$  = Downstream pressure, psia ( $P_2 + 14.7$ )
- $L$  = Equivalent length of pipe, feet
- $\Delta H$  = Pressure drop, inch water column (27.7 inch water column = 1 psi)

**402.4.1 Longest length method.** The pipe size of each section of gas piping shall be determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section.

**402.4.2 Branch length method.** Pipe shall be sized as follows:

1. Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.
2. The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section.

**402.4.3 Hybrid pressure.** The pipe size for each section of higher pressure gas piping shall be determined using the longest length of piping from the point of delivery to the most remote line pressure regulator. The pipe size from the line pressure regulator to each outlet shall be determined using the length of piping from the regulator to the most remote outlet served by the regulator.

**TABLE 402.2  
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES**

APPLIANCE	INPUT BTU/H (Approx.)
<b>Space Heating Units</b>	
Hydronic boiler	
Single family	100,000
Multifamily, per unit	60,000
Warm-air furnace	
Single family	100,000
Multifamily, per unit	60,000
<b>Space and Water Heating Units</b>	
Hydronic boiler	
Single family	120,000
Multifamily, per unit	75,000
<b>Water Heating Appliances</b>	
Water heater, automatic instantaneous	
Capacity at 2 gal./minute	142,800
Capacity at 4 gal./minute	285,000
Capacity at 6 gal./minute	428,400
Water heater, automatic storage, 30- to 40-gal. tank	35,000
Water heater, automatic storage, 50-gal. tank	50,000
Water heater, domestic, circulating or side-arm	35,000
<b>Cooking Appliances</b>	
Built-in oven or broiler unit, domestic	25,000
Built-in top unit, domestic	40,000
Range, free-standing, domestic	65,000
<b>Other Appliances</b>	
Barbecue	40,000
Clothes dryer, Type 1 (domestic)	35,000
Gas fireplace, direct-vent	40,000
Gas light	2,500
Gas log	80,000
Refrigerator	3,000

For SI: 1 British thermal unit per hour = 0.293 W, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m.

**402.5 Allowable pressure drop.** The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

**402.6 Maximum design operating pressure.** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 pounds per square inch gauge (psig) (34 kPa gauge) except where one or more of the following conditions are met:

1. The piping system is welded.
2. The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
3. The piping is located inside buildings or separate areas of buildings used exclusively for:
  - 3.1. Industrial processing or heating;
  - 3.2. Research;
  - 3.3. Warehousing; or
  - 3.4. Boiler or mechanical equipment rooms.
4. The piping is a temporary installation for buildings under construction.

**TABLE 402.4  
C<sub>i</sub> AND Y VALUES FOR NATURAL GAS AND  
UNDILUTED PROPANE AT STANDARD CONDITIONS**

GAS	EQUATION FACTORS	
	C <sub>i</sub>	Y
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.9910

For SI: 1 cubic foot = 0.028 m<sup>3</sup>, 1 foot = 305 mm, 1-inch water column = 0.249 kPa, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.293 W.

**402.6.1 Liquefied petroleum gas systems.** The operating pressure for undiluted LP-gas systems shall not exceed 20 psig (140 kPa gauge). Buildings having systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate

liquid LP-gas or prevent LP-gas vapor from condensing into a liquid.

**Exception:** Buildings or separate areas of buildings constructed in accordance with Chapter 7 of NFPA 58, and used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

**402.6.2 Specific gravity.** Application of the gravity factor converts the figures given in the tables provided in this code to capacities for another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in the tables by the multipliers shown in Table 402.6.2 (also shown as Appendix A, Table A.2.4). In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

**TABLE 402.6.2**  
**MULTIPLIERS TO BE USED WITH TABLES 402.4(1)**  
**THROUGH 402.4(21) WHERE THE SPECIFIC GRAVITY**  
**OF THE GAS IS OTHER THAN 0.60**

SPECIFIC GRAVITY	MULTIPLIER	SPECIFIC GRAVITY	MULTIPLIER
0.35	1.31	1.00	0.78
0.40	1.23	1.10	0.74
0.45	1.16	1.20	0.71
0.50	1.10	1.30	0.68
0.55	1.04	1.40	0.66
0.60	1.00	1.50	0.63
0.65	0.96	1.60	0.61
0.70	0.93	1.70	0.59
0.75	0.90	1.80	0.58
0.80	0.87	1.90	0.56
0.85	0.84	2.00	0.55
0.90	0.82	2.10	0.54

**SECTION 403 (IFGS)**  
**PIPING MATERIALS**

**403.1 General.** Materials used for piping systems shall comply with the requirements of this chapter or shall be approved.

**403.2 Used materials.** Pipe, fittings, valves and other materials shall not be used again except where they are free of foreign materials and have been ascertained to be adequate for the service intended.

**403.3 Other materials.** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service, and, in addition, shall be recommended for that service by the manufacturer.

**403.4 Metallic pipe.** Metallic pipe shall comply with Sections 403.4.1 through 403.4.4.

**403.4.1 Cast iron.** Cast-iron pipe shall not be used.

**403.4.2 Steel.** Steel and wrought-iron pipe shall be at least of standard weight (Schedule 40) and shall comply with one of the following standards:

1. ASME B 36.10, 10M
2. ASTM A 53; or
3. ASTM A 106.

**403.4.3 Copper and brass.** Copper and brass pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas (0.7 milligrams per 100 liters). Threaded copper, brass and aluminum-alloy pipe shall not be used with gases corrosive to such materials.

**403.4.4 Aluminum.** Aluminum-alloy pipe shall comply with ASTM B 241 (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum-alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation, or is subject to repeated wettings by such liquids as water, detergents, or sewage. Aluminum-alloy pipe shall not be used in exterior locations or underground.

**403.5 Metallic tubing.** Seamless copper, aluminum alloy and steel tubing shall not be used with gases corrosive to such materials.

**403.5.1 Steel tubing.** Steel tubing shall comply with ASTM A 254 or ASTM A 539.

**403.5.2 Copper and brass tubing.** Copper tubing shall comply with Standard Type K or L of ASTM B 88 or ASTM B 280.

Copper and brass tubing shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas (0.7 milligrams per 100 liters).

**403.5.3 Aluminum tubing.** Aluminum-alloy tubing shall comply with ASTM B 210 or ASTM B 241. Aluminum-alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster or insulation, or is subject to repeated wettings by such liquids as water, detergent or sewage.

Aluminum-alloy tubing shall not be used in exterior locations or underground.

**403.5.4 Corrugated stainless steel tubing.** Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation and performance requirements of ANSI LC 1/CSA 6.26.

**TABLE 402.4(1)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	Maximum Capacity in Cubic Feet of Gas per Hour										
10	32	72	132	278	520	1,050	1,600	3,050	4,800	8,500	17,500
20	22	49	92	190	350	730	1,100	2,100	3,300	5,900	12,000
30	18	40	73	152	285	590	890	1,650	2,700	4,700	9,700
40	15	34	63	130	245	500	760	1,450	2,300	4,100	8,300
50	14	30	56	115	215	440	670	1,270	2,000	3,600	7,400
60	12	27	50	105	195	400	610	1,150	1,850	3,250	6,800
70	11	25	46	96	180	370	560	1,050	1,700	3,000	6,200
80	11	23	43	90	170	350	530	990	1,600	2,800	5,800
90	10	22	40	84	160	320	490	930	1,500	2,600	5,400
100	9	21	38	79	150	305	460	870	1,400	2,500	5,100
125	8	18	34	72	130	275	410	780	1,250	2,200	4,500
150	8	17	31	64	120	250	380	710	1,130	2,000	4,100
175	7	15	28	59	110	225	350	650	1,050	1,850	3,800
200	6	14	26	55	100	210	320	610	980	1,700	3,500

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(2)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	Maximum Capacity in Cubic Feet of Gas per Hour										
10	43	95	175	360	680	1,400	2,100	3,950	6,300	11,000	23,000
20	29	65	120	250	465	950	1,460	2,750	4,350	7,700	15,800
30	24	52	97	200	375	770	1,180	2,200	3,520	6,250	12,800
40	20	45	82	170	320	660	990	1,900	3,000	5,300	10,900
50	18	40	73	151	285	580	900	1,680	2,650	4,750	9,700
60	16	36	66	138	260	530	810	1,520	2,400	4,300	8,800
70	15	33	61	125	240	490	750	1,400	2,250	3,900	8,100
80	14	31	57	118	220	460	690	1,300	2,050	3,700	7,500
90	13	29	53	110	205	430	650	1,220	1,950	3,450	7,200
100	12	27	50	103	195	400	620	1,150	1,850	3,250	6,700
125	11	24	44	93	175	360	550	1,020	1,650	2,950	6,000
150	10	22	40	84	160	325	500	950	1,500	2,650	5,500
175	9	20	37	77	145	300	460	850	1,370	2,450	5,000
200	8	19	35	72	135	280	430	800	1,280	2,280	4,600

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(3)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	Maximum Capacity in Cubic Feet of Gas per Hour								
10	1,506	3,041	5,561	11,415	17,106	32,944	52,505	92,819	189,326
20	1,065	2,150	3,932	8,072	12,096	23,295	37,127	65,633	133,873
30	869	1,756	3,211	6,591	9,876	19,020	30,314	53,589	109,307
40	753	1,521	2,781	5,708	8,553	16,472	26,253	46,410	94,663
50	673	1,360	2,487	5,105	7,650	14,733	23,481	41,510	84,669
60	615	1,241	2,270	4,660	6,983	13,449	21,435	37,893	77,292
70	569	1,150	2,102	4,315	6,465	12,452	19,845	35,082	71,558
80	532	1,075	1,966	4,036	6,048	11,647	18,563	32,817	66,937
90	502	1,014	1,854	3,805	5,702	10,981	17,502	30,940	63,109
100	462	934	1,708	3,508	5,257	10,125	16,138	28,530	58,194
125	414	836	1,528	3,138	4,702	9,056	14,434	25,518	52,050
150	372	751	1,373	2,817	4,222	8,130	12,960	22,911	46,732
175	344	695	1,271	2,608	3,909	7,527	11,999	21,211	43,265
200	318	642	1,174	2,413	3,613	6,959	11,093	19,608	39,997

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(4)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	Maximum Capacity in Cubic Feet of Gas per Hour								
10	3,185	6,434	11,766	24,161	36,206	69,727	111,133	196,468	400,732
20	2,252	4,550	8,320	17,084	25,602	49,305	78,583	138,924	283,361
30	1,839	3,715	6,793	13,949	20,904	40,257	64,162	113,431	231,363
40	1,593	3,217	5,883	12,080	18,103	34,864	55,566	98,234	200,366
50	1,425	2,878	5,262	10,805	16,192	31,183	49,700	87,863	179,213
60	1,301	2,627	4,804	9,864	14,781	28,466	45,370	80,208	163,598
70	1,204	2,432	4,447	9,132	13,685	26,354	42,004	74,258	151,463
80	1,153	2,330	4,260	8,542	12,801	24,652	39,291	69,462	141,680
90	1,062	2,145	3,922	8,054	12,069	23,242	37,044	65,489	133,577
100	979	1,978	3,617	7,427	11,128	21,433	34,159	60,387	123,173
125	876	1,769	3,235	6,643	9,953	19,170	30,553	54,012	110,169
150	786	1,589	2,905	5,964	8,937	17,211	27,431	48,494	98,911
175	728	1,471	2,690	5,522	8,274	15,934	25,396	44,897	91,574
200	673	1,360	2,487	5,104	7,649	14,729	23,478	41,504	84,656

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(5)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	215	442	662	1,275	2,033	3,594	5,262	7,330	13,261	21,472	44,118	80,130	126,855
100	148	304	455	877	1,397	2,470	3,616	5,038	9,114	14,758	30,322	55,073	87,187
150	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
200	102	209	313	602	960	1,698	2,485	3,462	6,264	10,143	20,840	37,851	59,923
250	90	185	277	534	851	1,505	2,203	3,069	5,552	8,990	18,470	33,547	53,109
300	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
400	70	143	215	414	660	1,167	1,708	2,380	4,305	6,971	14,323	26,015	41,185
500	62	127	191	367	585	1,034	1,514	2,109	3,816	6,178	12,694	23,056	36,501
1,000	43	87	131	252	402	711	1,041	1,450	2,623	4,246	8,725	15,847	25,087
1,500	34	70	105	203	323	571	836	1,164	2,106	3,410	7,006	12,725	20,146
2,000	29	60	90	173	276	488	715	996	1,802	2,919	5,997	10,891	17,242

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(6)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	284	583	873	1,681	2,680	4,738	6,937	9,663	17,482	28,308	58,161	105,636	167,236
100	195	400	600	1,156	1,842	3,256	4,767	6,641	12,015	19,456	39,974	72,603	114,940
150	157	322	482	928	1,479	2,615	3,828	5,333	9,649	15,624	32,100	58,303	92,301
200	134	275	412	794	1,266	2,238	3,277	4,565	8,258	13,372	27,474	49,900	78,998
250	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
300	108	221	331	638	1,017	1,797	2,631	3,666	6,632	10,738	22,062	40,071	63,438
400	92	189	283	546	870	1,538	2,252	3,137	5,676	9,190	18,883	34,296	54,295
500	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
1,000	56	115	173	333	530	937	1,372	1,911	3,457	5,598	11,502	20,891	33,073
1,500	45	93	139	267	426	752	1,102	1,535	2,776	4,496	9,237	16,776	26,559
2,000	39	79	119	229	364	644	943	1,313	2,376	3,848	7,905	14,358	22,731

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(7)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	20	42	85	148	210	448	806	1,271	2,646	4,682	
20	14	29	58	102	144	308	554	873	1,819	3,218	
30	11	23	47	82	116	247	445	701	1,461	2,584	
40	10	20	40	70	99	211	381	600	1,250	2,212	
50	8.4	17	35	62	88	187	337	532	1,108	1,960	
60	7.6	16	32	56	79	170	306	482	1,004	1,776	
70	7.0	14	29	52	73	156	281	443	924	1,634	
80	6.5	13	27	48	68	145	262	413	859	1,520	
90	6.1	13	26	45	64	136	245	387	806	1,426	
100	5.8	12	24	43	60	129	232	366	761	1,347	
125	5.1	11	22	38	53	114	206	324	675	1,194	
150	4.7	10	20	34	48	103	186	294	612	1,082	
175	4.3	8.8	18	31	45	95	171	270	563	995	
200	4.0	8.2	17	29	41	89	159	251	523	926	
250	3.5	7.3	15	26	37	78	141	223	464	821	
300	3.2	6.6	13	23	33	71	128	202	420	744	

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(8)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		Maximum Capacity in Cubic Feet of Gas per Hour									
10		27	55	111	195	276	590	1,062	1,675	3,489	6,173
20		18	38	77	134	190	406	730	1,151	2,398	4,242
30		15	30	61	107	152	326	586	925	1,926	3,407
40		13	26	53	92	131	279	502	791	1,648	2,916
50		11	23	47	82	116	247	445	701	1,461	2,584
60		10	21	42	74	105	224	403	635	1,323	2,341
70		9.3	19	39	68	96	206	371	585	1,218	2,154
80		8.6	18	36	63	90	192	345	544	1,133	2,004
90		8.1	17	34	59	84	180	324	510	1,063	1,880
100		7.6	16	32	56	79	170	306	482	1,004	1,776
125		6.8	14	28	50	70	151	271	427	890	1,574
150		6.1	13	26	45	64	136	245	387	806	1,426
175		5.6	12	24	41	59	125	226	356	742	1,312
200		5.2	11	22	39	55	117	210	331	690	1,221
250		4.7	10	20	34	48	103	186	294	612	1,082
300		4.2	8.7	18	31	44	94	169	266	554	980

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(9)**  
**SEMI-RIGID COPPER TUBING**  
 Use this Table to Size Tubing from House Line Regulator to the Appliance.

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	1.0 inch WC
<b>Specific Gravity</b>	0.60

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	39	80	162	283	402	859	1,546	2,437	5,076	8,981	
20	27	55	111	195	276	590	1,062	1,675	3,489	6,173	
30	21	44	89	156	222	474	853	1,345	2,802	4,957	
40	18	38	77	134	190	406	730	1,151	2,398	4,242	
50	16	33	68	119	168	359	647	1,020	2,125	3,760	
60	15	30	61	107	152	326	586	925	1,926	3,407	
70	13	28	57	99	140	300	539	851	1,772	3,134	
80	13	26	53	92	131	279	502	791	1,648	2,916	
90	12	24	49	86	122	262	471	742	1,546	2,736	
100	11	23	47	82	116	247	445	701	1,461	2,584	
125	9.8	20	41	72	103	219	394	622	1,295	2,290	
150	8.9	18	37	65	93	198	357	563	1,173	2,075	
175	8.2	17	34	60	85	183	329	518	1,079	1,909	
200	7.6	16	32	56	79	170	306	482	1,004	1,776	
250	6.8	14	28	50	70	151	271	427	890	1,574	
300	6.1	13	26	45	64	136	245	387	806	1,426	

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
 For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(10)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi or less
<b>Pressure Drop</b>	17.0 inch WC
<b>Specific Gravity</b>	0.60

		TUBE SIZE (in.)									
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		190	391	796	1,391	1,974	4,216	7,591	11,968	24,926	44,100
20		130	269	547	956	1,357	2,898	5,217	8,226	17,132	30,310
30		105	216	439	768	1,089	2,327	4,189	6,605	13,757	24,340
40		90	185	376	657	932	1,992	3,586	5,653	11,775	20,832
50		79	164	333	582	826	1,765	3,178	5,010	10,436	18,463
60		72	148	302	528	749	1,599	2,879	4,540	9,455	16,729
70		66	137	278	486	689	1,471	2,649	4,177	8,699	15,390
80		62	127	258	452	641	1,369	2,464	3,886	8,093	14,318
90		58	119	243	424	601	1,284	2,312	3,646	7,593	13,434
100		55	113	229	400	568	1,213	2,184	3,444	7,172	12,689
125		48	100	203	355	503	1,075	1,936	3,052	6,357	11,246
150		44	90	184	321	456	974	1,754	2,765	5,760	10,190
175		40	83	169	296	420	896	1,614	2,544	5,299	9,375
200		38	77	157	275	390	834	1,501	2,367	4,930	8,721
250		33	69	140	244	346	739	1,330	2,098	4,369	7,730
300		30	62	126	221	313	670	1,205	1,901	3,959	7,004

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
 For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(11)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi or less
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	245	506	1,030	1,800	2,554	5,455	9,820	15,483	32,247	57,051	
20	169	348	708	1,237	1,755	3,749	6,749	10,641	22,163	39,211	
30	135	279	568	993	1,409	3,011	5,420	8,545	17,798	31,488	
40	116	239	486	850	1,206	2,577	4,639	7,314	15,232	26,949	
50	103	212	431	754	1,069	2,284	4,111	6,482	13,500	23,885	
60	93	192	391	683	969	2,069	3,725	5,873	12,232	21,641	
70	86	177	359	628	891	1,904	3,427	5,403	11,253	19,910	
80	80	164	334	584	829	1,771	3,188	5,027	10,469	18,522	
90	75	154	314	548	778	1,662	2,991	4,716	9,823	17,379	
100	71	146	296	518	735	1,570	2,826	4,455	9,279	16,416	
125	63	129	263	459	651	1,391	2,504	3,948	8,223	14,549	
150	57	117	238	416	590	1,260	2,269	3,577	7,451	13,183	
175	52	108	219	383	543	1,160	2,087	3,291	6,855	12,128	
200	49	100	204	356	505	1,079	1,942	3,062	6,377	11,283	
250	43	89	181	315	448	956	1,721	2,714	5,652	10,000	
300	39	80	164	286	406	866	1,559	2,459	5,121	9,060	

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

Gas	Natural
Inlet Pressure	2.0 psi
Pressure Drop	1.5 psi
Specific Gravity	0.60

**TABLE 402.4(12)**  
**SEMI-RIGID COPPER TUBING**  
**Pipe Sizing Between Point of Delivery and the House Line Regulator. Total Load Supplied by a Single House Line Regulator Not Exceeding 150 Cubic Feet per Hour.<sup>2</sup>**

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
Outside		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
Inside <sup>1</sup>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	303	625	1,272	2,224	3,155	6,739	12,131	19,127	39,837	70,481	
20	208	430	874	1,528	2,168	4,631	8,338	13,146	27,380	48,441	
30	167	345	702	1,227	1,741	3,719	6,696	10,557	21,987	38,900	
40	143	295	601	1,050	1,490	3,183	5,731	9,035	18,818	33,293	
50	127	262	533	931	1,321	2,821	5,079	8,008	16,678	29,507	
60	115	237	483	843	1,197	2,556	4,602	7,256	15,112	26,736	
70	106	218	444	776	1,101	2,352	4,234	6,675	13,903	24,597	
80	98	203	413	722	1,024	2,188	3,939	6,210	12,934	22,882	
90	92	191	388	677	961	2,053	3,695	5,826	12,135	21,470	
100	87	180	366	640	908	1,939	3,491	5,504	11,463	20,280	
125	77	159	324	567	804	1,718	3,094	4,878	10,159	17,974	
150	70	145	294	514	729	1,557	2,803	4,420	9,205	16,286	
175	64	133	270	473	671	1,432	2,579	4,066	8,469	14,983	
200	60	124	252	440	624	1,333	2,399	3,783	7,878	13,938	
250	53	110	223	390	553	1,181	2,126	3,352	6,982	12,353	
300	48	99	202	353	501	1,070	1,927	3,038	6,327	11,193	

Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. When this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 inch w.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(13)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi or less
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		511	1,054	2,144	3,747	5,315	11,354	20,441	32,229	67,125	118,758
20		351	724	1,473	2,575	3,653	7,804	14,049	22,151	46,135	81,622
30		282	582	1,183	2,068	2,934	6,267	11,282	17,788	37,048	65,545
40		241	498	1,013	1,770	2,511	5,364	9,656	15,224	31,708	56,098
50		214	441	898	1,569	2,225	4,754	8,558	13,493	28,102	49,719
60		194	400	813	1,421	2,016	4,307	7,754	12,225	25,463	45,049
70		178	368	748	1,308	1,855	3,962	7,134	11,247	23,425	41,444
80		166	342	696	1,216	1,726	3,686	6,636	10,463	21,793	38,556
90		156	321	653	1,141	1,619	3,459	6,227	9,817	20,447	36,176
100		147	303	617	1,078	1,529	3,267	5,882	9,273	19,315	34,172
125		130	269	547	955	1,356	2,896	5,213	8,219	17,118	30,286
150		118	243	495	866	1,228	2,624	4,723	7,447	15,510	27,441
175		109	224	456	796	1,130	2,414	4,345	6,851	14,269	25,245
200		101	208	424	741	1,051	2,245	4,042	6,374	13,275	23,486
250		90	185	376	657	932	1,990	3,583	5,649	11,765	20,815
300		81	167	340	595	844	1,803	3,246	5,118	10,660	18,860

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(14)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
5	46	63	115	134	225	270	471	546	895	1,790	4,142
10	32	44	82	95	161	192	330	383	639	1,261	2,934
15	25	35	66	77	132	157	267	310	524	1,027	2,398
20	22	31	58	67	116	137	231	269	456	888	2,078
25	19	27	52	60	104	122	206	240	409	793	1,860
30	18	25	47	55	96	112	188	218	374	723	1,698
40	15	21	41	47	83	97	162	188	325	625	1,472
50	13	19	37	42	75	87	144	168	292	559	1,317
60	12	17	34	38	68	80	131	153	267	509	1,203
70	11	16	31	36	63	74	121	141	248	471	1,114
80	10	15	29	33	60	69	113	132	232	440	1,042
90	10	14	28	32	57	65	107	125	219	415	983
100	9	13	26	30	54	62	101	118	208	393	933
150	7	10	20	23	42	48	78	91	171	320	762
200	6	9	18	21	38	44	71	82	148	277	661
250	5	8	16	19	34	39	63	74	133	247	591
300	5	7	15	17	32	36	57	67	95	226	540

Note: 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD— Equivalent Hydraulic Diameter, which 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.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(15)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	3.0 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
5	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
10	83	112	197	231	380	462	828	958	1,528	3,199	7,156
15	67	90	161	189	313	379	673	778	1,254	2,541	5,848
20	57	78	140	164	273	329	580	672	1,090	2,197	5,069
25	51	69	125	147	245	295	518	599	978	1,963	4,536
30	46	63	115	134	225	270	471	546	895	1,790	4,142
40	39	54	100	116	196	234	407	471	778	1,548	3,590
50	35	48	89	104	176	210	363	421	698	1,383	3,213
60	32	44	82	95	161	192	330	383	639	1,261	2,934
70	29	41	76	88	150	178	306	355	593	1,166	2,717
80	27	38	71	82	141	167	285	331	555	1,090	2,543
90	26	36	67	77	133	157	268	311	524	1,027	2,398
100	24	34	63	73	126	149	254	295	498	974	2,276
150	19	27	52	60	104	122	206	240	409	793	1,860
200	17	23	45	52	91	106	178	207	355	686	1,612
250	15	21	40	46	82	95	159	184	319	613	1,442
300	13	19	37	42	75	87	144	168	234	559	1,317

Note: 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD— Equivalent Hydraulic Diameter, which 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.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(16)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	6.0 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
5	173	229	389	461	737	911	1,687	1,946	3,000	6,282	14,263
10	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
15	96	130	227	267	436	532	960	1,110	1,758	3,607	8,257
20	83	112	197	231	380	462	828	958	1,528	3,119	7,156
25	74	99	176	207	342	414	739	855	1,371	2,786	6,404
30	67	90	161	189	313	379	673	778	1,254	2,541	5,848
40	57	78	140	164	273	329	580	672	1,090	2,197	5,069
50	51	69	125	147	245	295	518	599	978	1,963	4,536
60	46	63	115	134	225	270	471	546	895	1,790	4,142
70	42	58	106	124	209	250	435	505	830	1,656	3,837
80	39	54	100	116	196	234	407	471	778	1,548	3,590
90	37	51	94	109	185	221	383	444	735	1,458	3,386
100	35	48	89	104	176	210	363	421	698	1,383	3,213
150	28	39	73	85	145	172	294	342	573	1,126	2,626
200	24	34	63	73	126	149	254	295	498	974	2,276
250	21	30	57	66	114	134	226	263	447	870	2,036
300	19	27	52	60	104	122	206	240	409	793	1,860

Note: 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(17)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	270	353	587	700	1,098	1,372	2,592	2,986	4,509	9,599	21,637
25	166	220	374	444	709	876	1,620	1,869	2,887	6,041	13,715
30	151	200	342	405	650	801	1,475	1,703	2,642	5,509	12,526
40	129	172	297	351	567	696	1,273	1,470	2,297	4,763	10,855
50	115	154	266	314	510	624	1,135	1,311	2,061	4,255	9,715
75	93	124	218	257	420	512	922	1,066	1,692	3,467	7,940
80	89	120	211	249	407	496	892	1,031	1,639	3,355	7,689
100	79	107	189	222	366	445	795	920	1,471	2,997	6,881
150	64	87	155	182	302	364	646	748	1,207	2,442	5,624
200	55	75	135	157	263	317	557	645	1,049	2,111	4,874
250	49	67	121	141	236	284	497	576	941	1,886	4,362
300	44	61	110	129	217	260	453	525	862	1,720	3,983
400	38	52	96	111	189	225	390	453	749	1,487	3,452
500	34	46	86	100	170	202	348	404	552	1,329	3,089

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 3/4 psi, 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.
  2. CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
  3. 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- \*EHD— Equivalent Hydraulic Diameter, which 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.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1 degree = 0.01745 rad.

Gas	Natural
Inlet Pressure	5.0 psi
Pressure Drop	3.5 psi
Specific Gravity	0.60

**TABLE 402.4(18)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	523	674	1,084	1,304	1,995	2,530	4,923	5,659	8,295	18,080	40,353
25	322	420	691	827	1,289	1,616	3,077	3,543	5,311	11,378	25,580
30	292	382	632	755	1,181	1,478	2,803	3,228	4,860	10,377	23,361
40	251	329	549	654	1,031	1,284	2,418	2,786	4,225	8,972	20,246
50	223	293	492	586	926	1,151	2,157	2,486	3,791	8,015	18,119
75	180	238	403	479	763	944	1,752	2,021	3,112	6,530	14,809
80	174	230	391	463	740	915	1,694	1,955	3,016	6,320	14,341
100	154	205	350	415	665	820	1,511	1,744	2,705	5,646	12,834
150	124	166	287	339	548	672	1,228	1,418	2,221	4,600	10,489
200	107	143	249	294	478	584	1,060	1,224	1,931	3,977	9,090
250	95	128	223	263	430	524	945	1,092	1,732	3,553	8,135
300	86	116	204	240	394	479	860	995	1,585	3,240	7,430
400	74	100	177	208	343	416	742	858	1,378	2,802	6,439
500	66	89	159	186	309	373	662	766	1,035	2,503	5,762

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds  $\frac{3}{4}$  psi, 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.
2. CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
3. 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(19)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	153	305	551	955	1,442	2,590
20	105	210	379	656	991	1,780
30	84	169	304	527	796	1,430
40	72	144	260	451	681	1,224
50	64	128	231	400	604	1,084
60	58	116	209	362	547	983
70	53	107	192	333	503	904
80	50	99	179	310	468	841
90	46	93	168	291	439	789
100	44	88	159	275	415	745
125	39	78	141	243	368	661
150	35	71	127	221	333	598
175	32	65	117	203	306	551
200	30	60	109	189	285	512

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(20)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	201	403	726	1,258	1,900	3,415
20	138	277	499	865	1,306	2,347
30	111	222	401	695	1,049	1,885
40	95	190	343	594	898	1,613
50	84	169	304	527	796	1,430
60	76	153	276	477	721	1,295
70	70	140	254	439	663	1,192
80	65	131	236	409	617	1,109
90	61	123	221	383	579	1,040
100	58	116	209	362	547	983
125	51	103	185	321	485	871
150	46	93	168	291	439	789
175	43	86	154	268	404	726
200	40	80	144	249	376	675

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(21)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	1,858	3,721	6,714	11,631	17,565	31,560
20	1,277	2,557	4,614	7,994	12,072	21,691
30	1,026	2,054	3,706	6,420	9,695	17,419
40	878	1,758	3,172	5,494	8,297	14,908
50	778	1,558	2,811	4,869	7,354	13,213
60	705	1,412	2,547	4,412	6,663	11,972
70	649	1,299	2,343	4,059	6,130	11,014
80	603	1,208	2,180	3,776	5,703	10,246
90	566	1,134	2,045	3,543	5,351	9,614
100	535	1,071	1,932	3,347	5,054	9,081
125	474	949	1,712	2,966	4,479	8,048
150	429	860	1,551	2,688	4,059	7,292
175	395	791	1,427	2,473	3,734	6,709
200	368	736	1,328	2,300	3,474	6,241

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(22)**  
**SCHEDULE 40 METALLIC PIPE**  
**Pipe Sizing Between First Stage (High Pressure Regulator)**  
**and Second Stage (Low Pressure Regulator)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	10.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal Inside	PIPE SIZE (in.)								
	1/2	3/4	1	1 1/4	1 1/2	2	3	3 1/2	4
<b>Actual</b>	0.622	0.824	1.049	1.38	1.61	2.067	3.068	3.548	4.026
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>								
30	1,834	3,835	7,225	14,834	22,225	42,804	120,604	176,583	245,995
40	1,570	3,283	6,184	12,696	19,022	36,634	103,222	151,132	210,539
50	1,391	2,909	5,480	11,252	16,859	32,468	91,484	133,946	186,597
60	1,261	2,636	4,966	10,195	15,275	29,419	82,891	121,364	169,071
70	1,160	2,425	4,568	9,379	14,053	27,065	76,258	111,654	155,543
80	1,079	2,256	4,250	8,726	13,074	25,179	70,944	103,872	144,703
90	1,012	2,117	3,988	8,187	12,267	23,624	66,564	97,460	135,770
100	956	2,000	3,767	7,733	11,587	22,315	62,876	92,060	128,247
150	768	1,606	3,025	6,210	9,305	17,920	50,492	73,927	102,987
200	657	1,374	2,589	5,315	7,964	15,337	43,214	63,272	88,144
250	582	1,218	2,294	4,711	7,058	13,593	38,300	56,077	78,120
300	528	1,104	2,079	4,268	6,395	12,316	34,703	50,810	70,782
350	486	1,015	1,913	3,927	5,883	11,331	31,926	46,744	65,119
400	452	945	1,779	3,653	5,473	10,541	29,701	43,487	60,581
450	424	886	1,669	3,428	5,135	9,890	27,867	40,802	56,841
500	400	837	1,577	3,238	4,851	9,342	26,323	38,541	53,691
600	363	759	1,429	2,934	4,395	8,465	23,851	34,921	48,648
700	334	698	1,314	2,699	4,044	7,788	21,943	32,127	44,756
800	310	649	1,223	2,511	3,762	7,245	20,413	29,888	41,637
900	291	609	1,147	2,356	3,530	6,798	19,153	28,043	39,066
1,000	275	575	1,084	2,225	3,334	6,421	18,092	26,489	36,902
1,500	221	462	870	1,787	2,677	5,156	14,528	21,272	29,633
2,000	189	395	745	1,529	2,291	4,413	12,435	18,206	25,362

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(23)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal	PIPE SIZE (in.)								
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>								
10	2,676	5,595	10,539	21,638	32,420	62,438	99,516	175,927	358,835
20	1,839	3,845	7,243	14,872	22,282	42,913	68,397	120,914	246,625
30	1,477	3,088	5,817	11,942	17,893	34,461	54,925	97,098	198,049
40	1,264	2,643	4,978	10,221	15,314	29,494	47,009	83,103	169,504
50	1,120	2,342	4,412	9,059	13,573	26,140	41,663	73,653	150,229
60	1,015	2,122	3,998	8,208	12,298	23,685	37,750	66,735	136,118
70	934	1,952	3,678	7,551	11,314	21,790	34,729	61,395	125,227
80	869	1,816	3,422	7,025	10,526	20,271	32,309	57,116	116,499
90	815	1,704	3,210	6,591	9,876	19,020	30,314	53,590	109,307
100	770	1,610	3,033	6,226	9,329	17,966	28,635	50,621	103,251
125	682	1,427	2,688	5,518	8,268	15,923	25,378	44,865	91,510
150	618	1,293	2,435	5,000	7,491	14,427	22,995	40,651	82,914
175	569	1,189	2,240	4,600	6,892	13,273	21,155	37,398	76,280
200	529	1,106	2,084	4,279	6,411	12,348	19,681	34,792	70,964

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(24)**  
**SCHEDULE 40 METALLIC PIPE**  
**Pipe Sizing Between Single or Second Stage**  
**(Low Pressure Regulator) and Appliance**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

	PIPE SIZE (in.)								
Nominal Inside	1/2	3/4	1	1 1/4	1 1/2	2	3	3 1/2	4
Actual	0.622	0.824	1.049	1.38	1.61	2.067	3.068	3.548	4.026
Length (ft)	Maximum Capacity in Thousands of Btu/h								
10	291	608	1,145	2,352	3,523	6,786	19,119	27,993	38,997
20	200	418	787	1,616	2,422	4,664	13,141	19,240	26,802
30	160	336	632	1,298	1,945	3,745	10,552	15,450	21,523
40	137	287	541	1,111	1,664	3,205	9,031	13,223	18,421
50	122	255	480	984	1,475	2,841	8,004	11,720	16,326
60	110	231	434	892	1,337	2,574	7,253	10,619	14,793
80	94	197	372	763	1,144	2,203	6,207	9,088	12,661
100	84	175	330	677	1,014	1,952	5,501	8,055	11,221
125	74	155	292	600	899	1,730	4,876	7,139	9,945
150	67	140	265	543	814	1,568	4,418	6,468	9,011
200	58	120	227	465	697	1,342	3,781	5,536	7,712
250	51	107	201	412	618	1,189	3,351	4,906	6,835
300	46	97	182	373	560	1,078	3,036	4,446	6,193
350	42	89	167	344	515	991	2,793	4,090	5,698
400	40	83	156	320	479	922	2,599	3,805	5,301

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(25)**  
**SEMI-RIGID COPPER TUBING**  
**Sizing Between First Stage (High Pressure Regulator)**  
**and Second Stage (Low Pressure Regulator)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	10.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	513	1,058	2,152	3,760	5,335	11,396	20,516	32,347	67,371	119,193	
20	352	727	1,479	2,585	3,667	7,832	14,101	22,232	46,303	81,921	
30	283	584	1,188	2,075	2,944	6,290	11,323	17,853	37,183	65,785	
40	242	500	1,016	1,776	2,520	5,383	9,691	15,280	31,824	56,304	
50	215	443	901	1,574	2,234	4,771	8,589	13,542	28,205	49,901	
60	194	401	816	1,426	2,024	4,323	7,782	12,270	25,556	45,214	
70	179	369	751	1,312	1,862	3,977	7,160	11,288	23,511	41,596	
80	166	343	699	1,221	1,732	3,700	6,661	10,502	21,873	38,697	
90	156	322	655	1,145	1,625	3,471	6,250	9,853	20,522	36,308	
100	147	304	619	1,082	1,535	3,279	5,903	9,307	19,385	34,297	
125	131	270	549	959	1,361	2,906	5,232	8,249	17,181	30,396	
150	118	244	497	869	1,233	2,633	4,741	7,474	15,567	27,541	
175	109	225	457	799	1,134	2,423	4,361	6,876	14,321	25,338	
200	101	209	426	744	1,055	2,254	4,057	6,397	13,323	23,572	
225	95	196	399	698	990	2,115	3,807	6,002	12,501	22,117	
250	90	185	377	659	935	1,997	3,596	5,669	11,808	20,891	
275	85	176	358	626	888	1,897	3,415	5,385	11,215	19,841	
300	81	168	342	597	847	1,810	3,258	5,137	10,699	18,929	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 402.4(26)**  
**SEMI-RIGID COPPER TUBING**  
**Sizing Between Single or Second Stage**  
**(Low Pressure Regulator) and Appliance**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	45	93	188	329	467	997	1,795	2,830	5,895	10,429	
20	31	64	129	226	321	685	1,234	1,945	4,051	7,168	
30	25	51	104	182	258	550	991	1,562	3,253	5,756	
40	21	44	89	155	220	471	848	1,337	2,784	4,926	
50	19	39	79	138	195	417	752	1,185	2,468	4,366	
60	17	35	71	125	177	378	681	1,074	2,236	3,956	
70	16	32	66	115	163	348	626	988	2,057	3,639	
80	15	30	61	107	152	324	583	919	1,914	3,386	
90	14	28	57	100	142	304	547	862	1,796	3,177	
100	13	27	54	95	134	287	517	814	1,696	3,001	
125	11	24	48	84	119	254	458	722	1,503	2,660	
150	10	21	44	76	108	230	415	654	1,362	2,410	
175	10	20	40	70	99	212	382	602	1,253	2,217	
200	8.9	18	37	65	92	197	355	560	1,166	2,062	
225	8.3	17	35	61	87	185	333	525	1,094	1,935	
250	7.9	16	33	58	82	175	315	496	1,033	1,828	
275	7.5	15	31	55	78	166	299	471	981	1,736	
300	7.1	15	30	52	74	158	285	449	936	1,656	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W.

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 402.4(27)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0. psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

		TUBE SIZE (in.)									
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
Length (ft)		Maximum Capacity in Thousands of Btu/h									
10		413	852	1,732	3,027	4,295	9,175	16,517	26,042	54,240	95,962
20		284	585	1,191	2,081	2,952	6,306	11,352	17,899	37,279	65,954
30		228	470	956	1,671	2,371	5,064	9,116	14,373	29,936	52,963
40		195	402	818	1,430	2,029	4,334	7,802	12,302	25,621	45,330
50		173	356	725	1,267	1,798	3,841	6,915	10,903	22,708	40,175
60		157	323	657	1,148	1,629	3,480	6,266	9,879	20,575	36,401
70		144	297	605	1,057	1,499	3,202	5,764	9,088	18,929	33,489
80		134	276	562	983	1,394	2,979	5,363	8,455	17,609	31,155
90		126	259	528	922	1,308	2,795	5,031	7,933	16,522	29,232
100		119	245	498	871	1,236	2,640	4,753	7,493	15,607	27,612
125		105	217	442	772	1,095	2,340	4,212	6,641	13,832	24,472
150		95	197	400	700	992	2,120	3,817	6,017	12,533	22,173
175		88	181	368	644	913	1,950	3,511	5,536	11,530	20,399
200		82	168	343	599	849	1,814	3,267	5,150	10,727	18,978
225		77	158	321	562	797	1,702	3,065	4,832	10,064	17,806
250		72	149	304	531	753	1,608	2,895	4,564	9,507	16,819
275		69	142	288	504	715	1,527	2,750	4,335	9,029	15,974
300		66	135	275	481	682	1,457	2,623	4,136	8,614	15,240

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 402.4(28)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Thousands of Btu/h										
5	72	99	181	211	355	426	744	863	1,415	2,830	6,547
10	50	69	129	150	254	303	521	605	971	1,993	4,638
15	39	55	104	121	208	248	422	490	775	1,623	3,791
20	34	49	91	106	183	216	365	425	661	1,404	3,285
25	30	42	82	94	164	192	325	379	583	1,254	2,940
30	28	39	74	87	151	177	297	344	528	1,143	2,684
40	23	33	64	74	131	153	256	297	449	988	2,327
50	20	30	58	66	118	137	227	265	397	884	2,082
60	19	26	53	60	107	126	207	241	359	805	1,902
70	17	25	49	57	99	117	191	222	330	745	1,761
80	15	23	45	52	94	109	178	208	307	696	1,647
90	15	22	44	50	90	102	169	197	286	656	1,554
100	14	20	41	47	85	98	159	186	270	621	1,475
150	11	15	31	36	66	75	123	143	217	506	1,205
200	9	14	28	33	60	69	112	129	183	438	1,045
250	8	12	25	30	53	61	99	117	163	390	934
300	8	11	23	26	50	57	90	107	147	357	854

For SI: 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Note: 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

**TABLE 402.4(29)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Thousands of Btu/h										
10	426	558	927	1,106	1,735	2,168	4,097	4,720	7,128	15,174	34,203
25	262	347	591	701	1,120	1,384	2,560	2,954	4,564	9,549	21,680
30	238	316	540	640	1,027	1,266	2,331	2,692	4,176	8,708	19,801
40	203	271	469	554	896	1,100	2,012	2,323	3,631	7,529	17,159
50	181	243	420	496	806	986	1,794	2,072	3,258	6,726	15,357
75	147	196	344	406	663	809	1,457	1,685	2,675	5,480	12,551
80	140	189	333	393	643	768	1,410	1,629	2,591	5,303	12,154
100	124	169	298	350	578	703	1,256	1,454	2,325	4,738	10,877
150	101	137	245	287	477	575	1,021	1,182	1,908	3,860	8,890
200	86	118	213	248	415	501	880	1,019	1,658	3,337	7,705
250	77	105	191	222	373	448	785	910	1,487	2,981	6,895
300	69	96	173	203	343	411	716	829	1,363	2,719	6,296
400	60	82	151	175	298	355	616	716	1,163	2,351	5,457
500	53	72	135	158	268	319	550	638	1,027	2,101	4,883

For SI: 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where 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.
2. CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
3. 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

**TABLE 402.4(30)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	826	1,065	1,713	2,061	3,153	3,999	7,829	8,945	13,112	28,580	63,788
25	509	664	1,092	1,307	2,037	2,554	4,864	5,600	8,395	17,986	40,436
30	461	603	999	1,193	1,866	2,336	4,430	5,102	7,682	16,403	36,928
40	396	520	867	1,033	1,629	2,029	3,822	4,404	6,679	14,183	32,004
50	352	463	777	926	1,463	1,819	3,409	3,929	5,993	12,670	28,642
75	284	376	637	757	1,206	1,492	2,769	3,194	4,919	10,322	23,409
80	275	363	618	731	1,169	1,446	2,677	3,090	4,768	9,990	22,670
100	243	324	553	656	1,051	1,296	2,388	2,756	4,276	8,925	20,287
150	196	262	453	535	866	1,062	1,941	2,241	3,511	7,271	16,581
200	169	226	393	464	755	923	1,675	1,934	3,052	6,287	14,369
250	150	202	352	415	679	828	1,493	1,726	2,738	5,616	12,859
300	136	183	322	379	622	757	1,359	1,572	2,505	5,122	11,745
400	117	158	279	328	542	657	1,173	1,356	2,178	4,429	10,178
500	104	140	251	294	488	589	1,046	1,210	1,954	3,957	9,108

For SI: 1 foot = 305 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

1. Table does not include effect of pressure drop across line regulator. Where regulator loss exceeds 1 psi, 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.
2. CAUTION: Capacities shown in table may exceed maximum capacity of selected regulator. Consult with tubing manufacturer for guidance.
3. 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 additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

**TABLE 402.4(31)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>					
10	340	680	1,227	2,126	3,211	5,769
20	233	467	844	1,461	2,207	3,965
30	187	375	677	1,173	1,772	3,184
40	160	321	580	1,004	1,517	2,725
50	142	285	514	890	1,344	2,415
60	129	258	466	807	1,218	2,188
70	119	237	428	742	1,121	2,013
80	110	221	398	690	1,042	1,873
90	103	207	374	648	978	1,757
100	98	196	353	612	924	1,660
125	87	173	313	542	819	1,471
150	78	157	284	491	742	1,333
175	72	145	261	452	683	1,226
200	67	135	243	420	635	1,141

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

1. Table does not include effect of pressure drop across line regulator. If regulator loss exceeds 1 psi, **DO NOT USE THIS TABLE**. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drop across regulator may vary with the flow rate.
2. CAUTION: Capacities shown in table may exceed maximum capacity of selected regulator. Consult with tubing manufacturer for guidance.
3. 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 additional length (feet) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD—Equivalent Hydraulic Diameter, which 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.

**TABLE 402.4(32)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>					
10	3,126	6,259	11,293	19,564	29,545	53,085
20	2,148	4,302	7,762	13,446	20,306	36,485
30	1,725	3,454	6,233	10,798	16,307	29,299
40	1,477	2,957	5,335	9,242	13,956	25,076
50	1,309	2,620	4,728	8,191	12,369	22,225
60	1,186	2,374	4,284	7,421	11,207	20,137
70	1,091	2,184	3,941	6,828	10,311	18,526
80	1,015	2,032	3,666	6,352	9,592	17,235
90	952	1,907	3,440	5,960	9,000	16,171
100	899	1,801	3,249	5,629	8,501	15,275
125	797	1,596	2,880	4,989	7,535	13,538
150	722	1,446	2,609	4,521	6,827	12,266
175	664	1,331	2,401	4,159	6,281	11,285
200	618	1,238	2,233	3,869	5,843	10,498

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(33)  
POLYETHYLENE PLASTIC TUBING**

<b>Gas</b>	Undiluted propane
<b>Inlet pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal OD	PLASTIC TUBING SIZE (CTS) (in.)	
	$\frac{1}{2}$	$\frac{3}{4}$
<b>Designation</b>	SDR 7.00	SDR 11.00
<b>Actual ID</b>	0.445	0.927
<b>Length (ft)</b>	Maximum Capacity in Thousands of Btu/h	
10	121	828
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(34)**  
**POLYETHYLENE PLASTIC PIPE SIZING**  
**BETWEEN FIRST STAGE AND SECOND STAGE REGULATOR**  
 Maximum undiluted propane capacities listed are based on 10 psi  
 first stage and 1 psi pressure drop. Capacities in 1000 Btu/hr

PLASTIC PIPE LENGTH (feet)	PLASTIC PIPE NOMINAL OUTSIDE DIAMETER (IPS) (dimensions in parenthesis are inside diameter)					
	1/2 in. SDR 9.33 (0.660)	3/4 in. SDR 11.0 (0.860)	1 in. SDR 11.00 (1.077)	1 1/4 in. SDR 10.00 (1.328)	1 1/2 in. SDR 11.00 (1.554)	2 in. SDR 11.00 (1.943)
30	2143	4292	7744	13416	20260	36402
40	1835	3673	6628	11482	17340	31155
50	1626	3256	5874	10176	15368	27612
60	1473	2950	5322	9220	13924	25019
70	1355	2714	4896	8483	12810	23017
80	1261	2525	4555	7891	11918	21413
90	1183	2369	4274	7404	11182	20091
100	1117	2238	4037	6994	10562	18978
125	990	1983	3578	6199	9361	16820
150	897	1797	3242	5616	8482	15240
175	826	1653	2983	5167	7803	14020
200	678	1539	2775	4807	7259	13043
225	721	1443	2603	4510	6811	12238
250	681	1363	2459	4260	6434	11560
275	646	1294	2336	4046	6111	10979
300	617	1235	2228	3860	5830	10474
350	567	1136	2050	3551	5363	9636
400	528	1057	1907	3304	4989	8965
450	495	992	1789	3100	4681	8411
500	468	937	1690	2928	4422	7945
600	424	849	1531	2653	4007	7199
700	390	781	1409	2441	3686	6623
800	363	726	1311	2271	3429	6161
900	340	682	1230	2131	3217	5781
1000	322	644	1162	2012	3039	5461
1500	258	517	933	1616	2441	4385
2000	221	443	798	1383	2089	3753

For SI: 1 inch = 25.4 mm, 304.8 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(35)**  
**POLYETHYLENE PLASTIC TUBE SIZING**

Sizing between single or second stage regulator and building maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop 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 (0.445)	1 in. CTS SDR 11.00 (0.927)
30	762	5225
40	653	4472
50	578	3964
60	524	3591
70	482	3304
80	448	3074
90	421	2884
100	397	2724
125	352	2414
150	319	2188
175	294	2013
200	273	1872
225	256	1757
250	242	1659
275	230	1576
300	219	1503
350	202	1383
400	188	1287
450	176	1207
500	166	1140
600	151	1033
700	139	951
800	129	884
900	121	830
1000	114	784
1500	92	629
2000	79	539

For SI: 1 inch = 25.4 mm, 304.8 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895kPa, 1 British thermal unit per hour = 0.2931 W.

**403.6 Plastic pipe, tubing and fittings.** Plastic pipe, tubing and fittings shall be used outside, underground, only, and shall conform to ASTM D 2513. Pipe shall be marked “gas” and “ASTM D 2513.”

**403.6.1 Anodeless risers.** Plastic pipe, tubing and anodeless risers shall comply with the following:

1. Factory-assembled anodeless risers shall be recommended by the manufacturer for the gas used and shall be leak tested by the manufacturer in accordance with written procedures.
2. Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used, and shall be designed and certified to meet the requirements of Category I of ASTM D 2513, and U.S. Department of Transportation, Code of Federal Regulations, Title 49, Part 192.281(e). The manufacturer shall provide the user with qualified installation instructions as prescribed by the U.S. Department of Transportation, Code of Federal Regulations, Title 49, Part 192.283(b).

**403.6.2 LP-gas systems.** The use of plastic pipe, tubing and fittings in undiluted liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

**403.7 Workmanship and defects.** Pipe, tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed, and chip and scale blown.

Defects in pipe, tubing and fittings shall not be repaired. Defective pipe, tubing and fittings shall be replaced (see Section 406.1.2).

**403.8 Protective coating.** Where in contact with material or atmosphere exerting a corrosive action, metallic piping and fittings coated with a corrosion-resistant material shall be used. External or internal coatings or linings used on piping or components shall not be considered as adding strength.

**403.9 Metallic pipe threads.** Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1.

**403.9.1 Damaged threads.** Pipe with threads that are stripped, chipped, corroded or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

**403.9.2 Number of threads.** Field threading of metallic pipe shall be in accordance with Table 403.9.2.

**403.9.3 Thread compounds.** Thread (joint) compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gases to be conducted through the piping.

**403.10 Metallic piping joints and fittings.** The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force caused by the internal pressure and any additional forces caused by temperature expansion or contraction, vibration, fatigue or the weight of the pipe and its contents.

**TABLE 403.9.2  
SPECIFICATIONS FOR THREADING METALLIC PIPE**

IRON PIPE SIZE (inches)	APPROXIMATE LENGTH OF THREADED PORTION (inches)	APPROXIMATE NUMBER OF THREADS TO BE CUT
1/2	3/4	10
3/4	3/4	10
1	7/8	10
1 1/4	1	11
1 1/2	1	11
2	1	11
2 1/2	1 1/2	12
3	1 1/2	12
4	1 5/8	13

For SI: 1 inch = 25.4 mm.

**403.10.1 Pipe joints.** Pipe joints shall be threaded, flanged, brazed or welded. Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05-percent phosphorus.

**403.10.2 Tubing joints.** Tubing joints shall be either made with approved gas tubing fittings or brazed with a material having a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05-percent phosphorus.

**403.10.3 Flared joints.** Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints.

**403.10.4 Metallic fittings.** Metallic fittings, including valves, strainers and filters, shall comply with the following:

1. Threaded fittings in sizes larger than 4 inches (102 mm) shall not be used.
2. Fittings used with steel or wrought-iron pipe shall be steel, brass, bronze, malleable iron or cast iron.
3. Fittings used with copper or brass pipe shall be copper, brass or bronze.
4. Fittings used with aluminum-alloy pipe shall be of aluminum alloy.
5. Cast-iron fittings:
  - 5.1. Flanges shall be permitted.
  - 5.2. Bushings shall not be used.
  - 5.3. Fittings shall not be used in systems containing flammable gas-air mixtures.
  - 5.4. Fittings in sizes 4 inches (102 mm) and larger shall not be used indoors.
  - 5.5. Fittings in sizes 6 inches (152 mm) and larger shall not be used.

6. Aluminum-alloy fittings. Threads shall not form the joint seal.
7. Zinc aluminum-alloy fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.
8. Special fittings. Fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless or compression-type tubing fittings shall be: used within the fitting manufacturer's pressure-temperature recommendations; used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion or contraction; and installed or braced to prevent separation of the joint by gas pressure or external physical damage.

**403.11 Plastic pipe, joints and fittings.** Plastic pipe, tubing and fittings shall be joined in accordance with the manufacturer's instructions. Such joint shall comply with the following:

1. The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material.
2. Heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gas-tight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat fusion fittings shall be marked "ASTM D 2513."
3. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the pipe or tubing and at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used.
4. Plastic piping joints and fittings for use in liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

**403.12 Flanges.** All flanges shall comply with ASME B16.1, ASME B16.20, AWWA C111/A21.11 or MSS SP-6. The pressure-temperature ratings shall equal or exceed that required by the application.

**403.12.1 Flange facings.** Standard facings shall be permitted for use under this code. Where 150-pound (1034 kPa) pressure-rated steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed.

**403.12.2 Lapped flanges.** Lapped flanges shall be used only above ground or in exposed locations accessible for inspection.

**403.13 Flange gaskets.** Material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system, and the chemical constituents of the gas being con-

ducted, without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing material. Acceptable materials include metal or metal-jacketed asbestos (plain or corrugated), asbestos, and aluminum "O" rings and spiral wound metal gaskets. When a flanged joint is opened, the gasket shall be replaced. Full-face gaskets shall be used with all bronze and cast-iron flanges.

## SECTION 404 (IFGC) PIPING SYSTEM INSTALLATION

**404.1 Prohibited locations.** Piping shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft.

**404.2 Piping in solid partitions and walls.** Concealed piping shall not be located in solid partitions and solid walls, unless installed in a chase or casing.

**404.3 Piping in concealed locations.** Portions of a piping system installed in concealed locations shall not have unions, tubing fittings, right and left couplings, bushings, compression couplings and swing joints made by combinations of fittings.

### Exceptions:

1. Tubing joined by brazing.
2. Fittings listed for use in concealed locations.

**404.4 Piping through foundation wall.** Underground piping, where installed below grade through the outer foundation or basement wall of a building, shall be encased in a protective pipe sleeve. The annular space between the gas piping and the sleeve shall be sealed.

**404.5 Protection against physical damage.** In concealed locations, where piping other than black or galvanized steel is installed through holes or notches in wood studs, joists, rafters or similar members less than 1 inch (25 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Shield plates shall be a minimum of 1/16-inch-thick (1.6 mm) steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 4 inches (102 mm) above sole plates, below top plates and to each side of a stud, joist or rafter.

**404.6 Piping in solid floors.** Piping in solid floors shall be laid in channels in the floor and covered in a manner that will allow access to the piping with a minimum amount of damage to the building. Where such piping is subject to exposure to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. As an alternative to installation in channels, the piping shall be installed in a casing of Schedule 40 steel, wrought iron, PVC or ABS pipe with tightly sealed ends and joints. Both ends of such casing shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor.

**404.7 Above-ground outdoor piping.** All piping installed outdoors shall be elevated not less than 3 1/2 inches (152 mm) above ground and where installed across roof surfaces, shall be elevated not less than 3 1/2 inches (152 mm) above the roof surface. Piping installed above ground, outdoors, and installed across the surface of roofs shall be securely supported and located where it will be protected from physical damage.

Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. Where piping is encased in a protective pipe sleeve, the annular space between the piping and the sleeve shall be sealed. Ferrous metal exposed in exterior locations shall be protected from corrosion.

**404.8 Protection against corrosion underground.** Metallic pipe or tubing exposed to corrosive action, such as soil condition or moisture, shall be protected in an approved manner. Zinc coatings (galvanizing) shall not be deemed adequate protection for gas piping underground. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

**404.8.1 Prohibited use.** Uncoated threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion is known to occur.

**404.8.2 Protective coatings and wrapping.** Pipe protective coatings and wrappings shall be approved for the application.

**Exception:** Where installed in accordance with the manufacturer's installation instructions, field application of coatings and wrappings shall be permitted for pipe nipples, fittings and locations where the factory coating or wrapping has been damaged or necessarily removed at joints.

**404.9 Minimum burial depth.** Underground piping systems shall be installed a minimum depth of 12 inches (305 mm) below grade, except as provided for in Section 404.9.1.

**404.9.1 Individual outside appliances.** Individual lines to outside lights, grills or other appliances shall be installed a minimum of 8 inches (203 mm) below finished grade, provided that such installation is approved and is installed in locations not susceptible to physical damage.

**404.10 Trenches.** The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench.

**404.11 Piping underground beneath buildings.** Piping installed underground beneath buildings is prohibited except where the piping is encased in a conduit of wrought iron, plastic pipe, or steel pipe designed to withstand the superimposed loads. Such conduit shall extend into an occupiable portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is capable of withstanding the full pressure of the gas pipe, the conduit shall be designed for the same pressure as the pipe. Such conduit shall extend not less than 4 inches (102 mm) outside the building, shall be vented above grade to the outdoors, and shall be installed so as to prevent the entrance of water and insects. The conduit shall be protected from corrosion in accordance with Section 404.8.

**404.12 Outlet closures.** Gas outlets that do not connect to appliances shall be capped gas tight.

**Exception:** Listed and labeled flush-mounted-type quick-disconnect devices and listed and labeled gas convenience

outlets shall be installed in accordance with the manufacturer's installation instructions.

**404.13 Location of outlets.** The unthreaded portion of piping outlets shall extend not less than 1 inch (25 mm) through finished ceilings and walls and where extending through floors or outdoor patios and slabs, shall not be less than 2 inches (51 mm) above them. The outlet fitting or piping shall be securely supported. Outlets shall not be placed behind doors. Outlets shall be located in the room or space where the appliance is installed.

**Exception:** Listed and labeled flush-mounted-type quick-disconnect devices and listed and labeled gas convenience outlets shall be installed in accordance with the manufacturer's installation instructions.

**404.14 Plastic pipe.** The installation of plastic pipe shall comply with Sections 404.14.1 through 404.14.3.

**404.14.1 Limitations.** Plastic pipe shall be installed outside underground only. Plastic pipe shall not be used within or under any building or slab or be operated at pressures greater than 100 psig (689 kPa) for natural gas or 30 psig (207 kPa) for LP-gas.

**Exceptions:**

1. Plastic pipe shall be permitted to terminate above ground outside of buildings where installed in premanufactured anodeless risers or service head adapter risers that are installed in accordance with the manufacturer's installation instructions.
2. Plastic pipe shall be permitted to terminate with a wall head adapter within buildings where the plastic pipe is inserted in a piping material for fuel gas use in buildings.

**404.14.2 Connections.** Connections made outside and underground between metallic and plastic piping shall be made only with transition fittings categorized as Category I in accordance with ASTM D 2513.

**404.14.3 Tracer.** An insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.

**404.15 Prohibited devices.** A device shall not be placed inside the piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas.

**Exception:** Approved gas filters.

**404.16 Testing of piping.** Before any system of piping is put in service or concealed, it shall be tested to ensure that it is gas tight. Testing, inspection and purging of piping systems shall comply with Section 406.

## SECTION 405 (IFGS) PIPING BENDS AND CHANGES IN DIRECTION

**405.1 General.** Changes in direction of pipe shall be permitted to be made by the use of fittings, factory bends, or field bends.

**405.2 Metallic pipe.** Metallic pipe bends shall comply with the following:

1. Bends shall be made only with bending equipment and procedures intended for that purpose.
2. All bends shall be smooth and free from buckling, cracks, or other evidence of mechanical damage.
3. The longitudinal weld of the pipe shall be near the neutral axis of the bend.
4. Pipe shall not be bent through an arc of more than 90 degrees (1.6 rad).
5. The inside radius of a bend shall be not less than six times the outside diameter of the pipe.

**405.3 Plastic pipe.** Plastic pipe bends shall comply with the following:

1. The pipe shall not be damaged and the internal diameter of the pipe shall not be effectively reduced.
2. Joints shall not be located in pipe bends.
3. The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.
4. Where the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

**405.4 Mitered bends.** Mitered bends are permitted subject to the following limitations:

1. Miters shall not be used in systems having a design pressure greater than 50 psig (340 kPa gauge). Deflections caused by misalignments up to 3 degrees (0.05 rad) shall not be considered as miters.
2. The total deflection angle at each miter shall not exceed 90 degrees (1.6 rad).

**405.5 Elbows.** Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch at least 1 inch (25 mm) in pipe sizes 2 inches (51 mm) and larger.

## SECTION 406 (IFGS) INSPECTION, TESTING AND PURGING

**406.1 General.** Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code.

**406.1.1 Inspections.** Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly, or pressure tests as appropriate. Supplementary types of nondestructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc., shall not be required unless specifically listed herein or in the engineering design.

**406.1.2 Repairs and additions.** In the event repairs or additions are made after the pressure test, the affected piping shall be tested.

Minor repairs and additions are not required to be pressure tested provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other approved leak-detecting methods.

**406.1.2.1 Additions to existing piping systems.** In cases where the work authorized by the permit consists of additional piping to an existing system, a shutoff valve shall be installed and the additional piping shall be tested in accordance with Section 406.4.

**406.1.3 New branches.** Deleted.

**406.1.4 Section testing.** Deleted.

**406.1.5 Regulators and valve assemblies.** Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication.

**406.2 Test medium.** The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

**406.3 Test preparation.** Pipe joints, including welds, shall be left exposed for examination during the test.

**Exception:** Covered or concealed pipe end joints that have been previously tested in accordance with this code.

**406.3.1 Expansion joints.** Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test.

**406.3.2 Equipment isolation.** Equipment that is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.

**406.3.3 Equipment disconnection.** Where the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

**406.3.4 Valve isolation.** Where the piping system is connected to equipment or components designed for operating pressures equal to or greater than the test pressure, such equipment shall be isolated from the piping system by closing the individual equipment shutoff valve(s).

**406.3.5 Testing precautions.** All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage, and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleared of all foreign material.

**406.4 Test pressure measurement.** Test pressure shall be measured with a manometer or with a pressure-measuring device designed and calibrated to read, record, or indicate a pressure loss caused by leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pres-

tures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

**406.4.1 Method of testing.** Low pressure gas piping shall withstand a pressure of at least 10 psi (958 kPa) for a period of not less than 10 minutes without showing any drop in pressure. High pressure piping, 5 psi (479 kPa) and greater must withstand a pressure of at least 50 psi (4788 kPa) for a period of not less than 10 minutes without showing any drop in pressure.

**406.4.2 Test instruments.** For these tests, pressure shall be measured with a manometer or slope gauge or other accurate and sensitive pressure-indicating device, the scale of which is so graduated that variations in pressure may be accurately read. All necessary apparatus for conducting the pressure test shall be furnished by the installer.

**406.5 Detection of leaks and defects.** The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects.

Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

**406.5.1 Detection methods.** The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. Matches, candles, open flames, or other methods that could provide a source of ignition shall not be used.

**406.5.2 Corrections.** Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested.

**406.6 System and equipment leakage test.** Leakage testing of systems and equipment shall be in accordance with Sections 406.6.1 through 406.6.4.

**406.6.1 Test gases.** Leak checks using fuel gas shall be permitted in piping systems that have been pressure tested in accordance with Section 406.

**406.6.2 Before turning gas on.** Before gas is introduced into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that all valves at unused outlets are closed and plugged or capped.

**406.6.3 Test for leakage.** Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be tested for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

**406.6.4 Placing equipment in operation.** Gas utilization equipment shall be permitted to be placed in operation after the piping system has been tested and determined to be free of leakage and purged in accordance with Section 406.7.2.

**406.7 Purging.** Purging of piping shall comply with Sections 406.7.1 through 406.7.4.

**406.7.1 Removal from service.** Where gas piping is to be opened for servicing, addition, or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the

outdoors, or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures.

The remaining gas in this section of pipe shall be displaced with an inert gas as required by Table 406.7.1.

**TABLE 406.7.1**  
**LENGTH OF PIPING REQUIRING PURGING WITH INERT GAS FOR SERVICING OR MODIFICATION**

NOMINAL PIPE SIZE (inches)	LENGTH OF PIPING REQUIRING PURGING
2 <sup>1</sup> / <sub>2</sub>	> 50 feet
3	> 30 feet
4	> 15 feet
6	> 10 feet
8 or larger	Any length

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**406.7.2 Placing in operation.** Where piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, except where such piping is required by Table 406.7.2 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed. Where required by Table 406.7.2, the air in the piping shall first be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas.

**TABLE 406.7.2**  
**LENGTH OF PIPING REQUIRING PURGING WITH INERT GAS BEFORE PLACING IN OPERATION**

NOMINAL PIPE SIZE (inches)	LENGTH OF PIPING REQUIRING PURGING
3	> 30 feet
4	> 15 feet
6	> 10 feet
8 or larger	Any length

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**406.7.3 Discharge of purged gases.** The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions.

**406.7.4 Placing equipment in operation.** After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary.

**SECTION 407 (IFGC)**  
**PIPING SUPPORT**

**407.1 General.** Piping shall be provided with support in accordance with Section 407.2.

**407.2 Design and installation.** Piping shall be supported with pipe hooks, metal pipe straps, bands, brackets, or hangers suitable for the size of 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 equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58 and shall be spaced in accordance with Section 415. 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 equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.

### SECTION 408 (IFGC) DRIPS AND SLOPED PIPING

**408.1 Slopes.** Deleted.

**408.2 Drips.** Deleted.

**408.3 Location of drips.** Deleted.

**408.4 Sediment trap.** Where a sediment trap is not incorporated as part of the gas utilization equipment, a sediment trap, if required by the manufacturer's installation instructions, shall be installed as close to the inlet of the equipment as practical. The sediment trap shall be either a tee fitting with a capped nipple in the bottom opening of the run of the tee or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, gas logs, log lighters and outdoor grills need not be so equipped.

### SECTION 409 (IFGC) SHUTOFF VALVES

**409.1 General.** Piping systems shall be provided with shutoff valves in accordance with this section.

**409.1.1 Valve approval.** Shutoff valves shall be of an approved type. Shutoff valves shall be constructed of materials compatible with the piping. Shutoff valves installed in a portion of a piping system operating above 0.5 psig shall comply with ASME B 16.33. Shutoff valves installed in a portion of a piping system operating at 0.5 psig or less shall comply with ANSI Z 21.15 or ASME B 16.33.

**409.1.2 Prohibited locations.** Shutoff valves shall be prohibited in concealed locations and furnace plenums.

**409.1.3 Access to shutoff valves.** Shutoff valves shall be located in places so as to provide access for operation and shall be installed so as to be protected from damage.

**409.2 Meter valve.** Deleted.

**409.3 Shutoff valves for multiple-building line systems.** Where a single meter is used to supply gas to more than one building or tenant, a separate shutoff valve shall be provided for each building or tenant.

**409.3.1 Multiple tenant buildings.** In multiple tenant buildings, where a common piping system is installed to supply other than one- and two-family dwellings, shutoff

valves shall be provided for each tenant. Each tenant shall have access to the shutoff valve serving that tenant's space.

**409.3.2 Individual buildings.** In a common system serving more than one building, shutoff valves shall be installed outdoors at each building.

**409.3.3 Identification of shutoff valves.** Each house line shutoff valve shall be plainly marked with an identification tag attached by the installer so that the piping systems supplied by such valves are readily identified.

**409.4 MP Regulator valves.** A listed shutoff valve shall be installed immediately ahead of each MP regulator.

**409.5 Equipment shutoff valve.** Each appliance shall be provided with a shutoff valve separate from the appliance. The shutoff valve shall be located in the same room as the appliance, not further than 6 feet (1829 mm) from the appliance, and shall be installed upstream from the union, connector or quick disconnect device it serves. Such shutoff valves shall be provided with access.

**Exception:** Shutoff valves for vented decorative appliances and decorative appliances for installation in vented fireplaces shall not be prohibited from being installed in an area remote from the appliance where such valves are provided with ready access. Such valves shall be permanently identified and shall serve no other equipment. Piping from the shutoff valve to within 3 feet (914 mm) of the appliance connection shall be sized in accordance with Section 402.

**409.5.1 Shutoff valve in fireplace.** Equipment shutoff valves located in the firebox of a fireplace shall be installed in accordance with the appliance manufacturer's instructions. This section shall not prohibit the use or the installation of gas shutoff valves in the firebox of fireplaces serving listed gas appliances.

### SECTION 410 (IFGC) FLOW CONTROLS

**410.1 Pressure regulators.** A line pressure regulator shall be installed where the appliance is designed to operate at a lower pressure than the supply pressure. Line gas pressure regulators shall be listed as complying with ANSI Z21.80. Line pressure regulators exceeding 2 psi (192 kPa) nominal shall install a tested and approved overpressure protection device (OPD) for use with the regulator. Access shall be provided to pressure regulators and overpressure protection devices. Pressure regulators shall be protected from physical damage. Regulators installed on the exterior of the building shall be approved for outdoor installation.

**410.2 MP regulators.** MP pressure regulators shall comply with the following:

1. The MP regulator shall be approved and shall be suitable for the inlet and outlet gas pressures for the application.
2. The MP regulator shall maintain a reduced outlet pressure under lockup (no-flow) conditions.
3. The capacity of the MP regulator, determined by published ratings of its manufacturer, shall be adequate to supply the appliances served.

4. The MP pressure regulator shall be provided with access. Where located indoors, the regulator shall be vented to the outdoors or shall be equipped with a leak-limiting device, in either case complying with Section 410.3.
5. A tee fitting with one opening capped or plugged shall be installed between the MP regulator and its upstream shutoff valve. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument and to serve as a sediment trap.
6. A means to test pressure shall be installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such fitting shall be positioned to allow connection of a pressure-measuring instrument.

**410.3 Venting of regulators.** Pressure regulators that require a vent shall have an independent metallic vent to the outside of the building. The vent shall be designed to prevent the entry of water or foreign objects.

**Exception:** A vent to the outside of the building is not required for regulators equipped with and labeled for utilization with approved vent-limiting devices installed in accordance with the manufacturer's instructions.

### SECTION 411 (IFGC) APPLIANCE CONNECTIONS

**411.1 Connecting appliances.** Appliances shall be connected to the piping system by one of the following:

1. Rigid metallic pipe and fittings.
2. Semirigid metallic tubing and metallic fittings. Lengths shall not exceed 6 feet (1829 mm) and shall be located entirely in the same room as the appliance. Semirigid metallic tubing shall not enter a motor-operated appliance through an unprotected knockout opening.
3. Listed and labeled appliance connectors installed in accordance with the manufacturer's installation instructions and located entirely in the same room as the appliance.
4. Listed and labeled quick-disconnect devices used in conjunction with listed and labeled appliance connectors.
5. Listed and labeled convenience outlets used in conjunction with listed and labeled appliance connectors.
6. Listed and labeled appliance connectors complying with ANSI Z21.69 and listed for use with food service equipment having casters, or that is otherwise subject to movement for cleaning, and other large movable equipment.

**411.1.1 Protection from damage.** Connectors and tubing shall be installed so as to be protected against physical damage.

**411.1.2 Appliance fuel connectors.** Connectors shall have an overall length not to exceed 3 feet (914 mm), except for range and domestic clothes dryer connectors, which shall not exceed 6 feet (1829 mm) in length. Connectors shall not be concealed within, or extended through, walls, floors, partitions, ceilings or appliance housings. A shutoff valve not less than the nominal size of the connector shall be installed

ahead of the connector in accordance with Section 409.5. Connectors shall be sized to provide the total demand of the connected appliance.

**Exception:** Fireplace inserts factory equipped with grommets, sleeves, or other means of protection in accordance with the listing of the appliance.

**411.1.3 Movable appliances.** Where appliances are equipped with casters or are otherwise subject to periodic movement or relocation for purposes such as routine cleaning and maintenance, such appliances shall be connected to the supply system piping by means of an approved flexible connector designed and labeled for the application. Such flexible connectors shall be installed and protected against physical damage in accordance with the manufacturer's installation instructions.

### SECTION 412 (IFGC) LIQUEFIED PETROLEUM GAS MOTOR FUEL-DISPENSING FACILITIES

**412.1 General.** Motor fuel-dispensing facilities for LP-gas fuel shall be as regulated by the North Carolina Department of Agriculture and Consumer Services.

**412.2 Storage and dispensing.** Deleted.

**412.3 Approved equipment.** Deleted.

**412.4 Listed equipment.** Deleted.

**412.5 Attendants.** Deleted.

**412.6 Location.** Deleted.

**412.7 Installation of dispensing devices and equipment.** Deleted.

**412.7.1 Valves.** Deleted.

**412.7.2 Hoses.** Deleted.

**412.7.3 Vehicle impact protection.** Deleted.

**412.8 Private fueling of motor vehicles.** Deleted.

### SECTION 413 (IFGC) COMPRESSED NATURAL GAS MOTOR FUEL-DISPENSING FACILITIES

**413.1 General.** Motor fuel-dispensing facilities for CNG fuel shall be in accordance with this section and the *International Fire Code*. The operation of CNG motor fuel-dispensing facilities shall be regulated by the *International Fire Code*.

**413.2 General.** Storage vessels and equipment used for the storage, compression or dispensing of CNG shall be approved or listed in accordance with Sections 413.2.1 and 413.2.2.

**413.2.1 Approved equipment.** Containers; compressors; pressure-relief devices, including pressure-relief valves; and pressure regulators and piping used for CNG shall be approved.

**413.2.2 Listed equipment.** Hoses, hose connections, dispensers, gas detection systems and electrical equipment used for CNG shall be listed. Vehicle fueling connections shall be listed and labeled.

**413.3 Location of dispensing operations and equipment.** Compression, storage and dispensing equipment shall be located above ground outside.

**Exceptions:**

1. Compression, storage or dispensing equipment is allowed in buildings of noncombustible construction, as set forth in the *International Building Code*, which are unenclosed for three-quarters or more of the perimeter.
2. Compression, storage and dispensing equipment is allowed to be located indoors in accordance with the *International Fire Code*.

**413.3.1 Location on property.** In addition to the fuel-dispensing requirements of the *International Fire Code*, compression, storage and dispensing equipment shall not be installed:

1. Beneath power lines,
2. Less than 10 feet (3048 mm) from the nearest building or property line which could be built on, public street, sidewalk, or source of ignition.

**Exception:** Dispensing equipment need not be separated from canopies providing weather protection for the dispensing equipment constructed in accordance with the *International Building Code*.

3. Less than 25 feet (7620 mm) from the nearest rail of any railroad track.
4. Less than 50 feet (15 240 mm) from the nearest rail of any railroad main track or any railroad or transit line where power for train propulsion is provided by an outside electrical source such as third rail or overhead catenary.
5. Less than 50 feet (15 240 mm) from the vertical plane below the nearest overhead wire of a trolley bus line.

**413.4 Private fueling of motor vehicles.** Self-service CNG-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted fuel containers on CNG-powered vehicles.

In addition to the requirements in the *International Fire Code*, the owner of a self-service CNG-dispensing facility shall ensure the safe operation of the system and the training of users.

**413.5 Pressure regulators.** Pressure regulators shall be designed, installed or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud or debris). This protection is allowed to be integral with the regulator.

**413.6 Valves.** Piping to equipment shall be provided with a manual shutoff valve. Such valve shall be provided with ready access.

**413.7 Emergency shutdown equipment.** An emergency shutdown device shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and shall also be provided in the compressor area. Upon activation, the emergency shutdown shall automatically shut off the power supply to the compressor and close valves between the main gas supply and the compressor and between the storage containers and dispensers.

**413.8 Discharge of CNG from motor vehicle fuel storage containers.** The discharge of CNG from motor vehicle fuel cylinders for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with this section. The discharge of CNG from motor vehicle fuel cylinders shall be accomplished through a closed transfer system or an approved method of atmospheric venting in accordance with Section 413.8.1 or 413.8.2.

**413.8.1 Closed transfer system.** A documented procedure which explains the logical sequence for discharging the cylinder shall be provided to the code official for review and approval. The procedure shall include what actions the operator will take in the event of a low-pressure or high-pressure natural gas release during the discharging activity. A drawing illustrating the arrangement of piping, regulators and equipment settings shall be provided to the code official for review and approval. The drawing shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

**413.8.2 Atmospheric venting.** Atmospheric venting of motor vehicle fuel cylinders shall be in accordance with Sections 413.8.2.1 through 413.8.2.6.

**413.8.2.1 Plans and specifications.** A drawing illustrating the location of the vessel support, piping, the method of grounding and bonding, and other requirements specified herein shall be provided to the code official for review and approval.

**413.8.2.2 Cylinder stability.** A method of rigidly supporting the vessel during the venting of CNG shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel's rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials.

**413.8.2.3 Separation.** The structure or appurtenance used for stabilizing the cylinder shall be separated from the site equipment, features and exposures and shall be located in accordance with Table 413.8.2.3.

**TABLE 413.8.2.3  
SEPARATION DISTANCE FOR  
ATMOSPHERIC VENTING OF CNG**

EQUIPMENT OR FEATURE	MINIMUM SEPARATION (feet)
Buildings	25
Building openings	25
Lot lines	15
Public ways	15
Vehicles	25
CNG compressor and storage vessels	25
CNG dispensers	25

For SI: 1 foot = 304.8 mm.

**413.8.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with the ICC *Electrical Code*. The cylinder valve shall be bonded prior to the commencement of venting operations.

**413.8.2.5 Vent tube.** A vent tube that will divert the gas flow to the atmosphere shall be installed on the cylinder prior to the commencement of the venting and purging operation. The vent tube shall be constructed of pipe or tubing materials approved for use with CNG in accordance with the *International Fire Code*.

The vent tube shall be capable of dispersing the gas a minimum of 10 feet (3048 mm) above grade level. The vent tube shall not be provided with a rain cap or other feature which would limit or obstruct the gas flow.

At the connection fitting of the vent tube and the CNG cylinder, a listed bidirectional detonation flame arrester shall be provided.

**413.8.2.6 Signage.** Approved NO SMOKING signs shall be posted within 10 feet (3048 mm) of the cylinder support structure or appurtenance. Approved CYLINDER SHALL BE BONDED signs shall be posted on the cylinder support structure or appurtenance.

**TABLE 415.1  
SUPPORT OF PIPING**

STEEL PIPE, NOMINAL SIZE OF PIPE (inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING (SMOOTH-WALL) (inch 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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**SECTION 414 (IFGC)**

**SUPPLEMENTAL AND STANDBY GAS SUPPLY**

**414.1 Use of air or oxygen under pressure.** Where air or oxygen under pressure is used in connection with the gas supply, effective means such as a backpressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. Where oxygen is used, installation shall be in accordance with NFPA 51.

**414.2 Interconnections for standby fuels.** Where supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, a device to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose.

**SECTION 415 (IFGS)**

**PIPING SUPPORT INTERVALS**

**415.1 Interval of support.** Piping shall be supported at intervals not exceeding the spacing specified in Table 415.1. Spacing of supports for CSST shall be in accordance with the CSST manufacturer’s instructions.