

## CHAPTER 4

# GAS PIPING INSTALLATIONS

### SECTION 401 (IFGC) GENERAL

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

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

Utility service *pip*ing 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 storage system for liquefied petroleum gas shall be designed and installed in accordance with the *International Fire Code* and NFPA 58.

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

**401.4 Additional appliances.** Where an additional *appliance* is to be served, the existing *pip*ing 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 *pip*ing of adequate capacity shall be provided.

**401.5 Identification.** For other than steel pipe, exposed *pip*ing 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). The marking shall not be required on pipe located in the same room as the *appliance* served.

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

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

**401.8 Minimum sizes.** All pipe utilized for the installation, extension and *alteration* of any *pip*ing 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 Identification.** Each length of pipe and tubing and each pipe fitting, utilized in a fuel gas system, shall bear the identification of the manufacturer.

**[W] Exception:** The manufacturer's identification for fittings and pipe nipples shall be on each piece or shall be printed on the fitting or nipple packaging or provided documentation.

**401.10 Third-party testing and certification.** All piping, tubing and fittings shall comply with the applicable referenced standards, specifications and performance criteria of this code and shall be identified in accordance with Section 401.9. Piping, tubing and fittings shall either be tested by an approved third-party testing agency or certified by an approved *third-party certification agency*.

### 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 and supply gas to each *appliance* inlet at not less than the minimum supply pressure required by the *appliance*.

**402.2 Maximum gas demand.** The volumetric flow rate of gas to be provided, in cubic feet per hour, shall be calculated using the manufacturer's input ratings of the *appliances* served adjusted for altitude. Where an input rating is not indicated, the gas supplier, *appliance* manufacturer or a qualified agency shall be contacted, or the rating from Table 402.2 shall be used for estimating the volumetric flow rate of gas to be supplied.

The total connected hourly load shall be used as the basis for pipe sizing, assuming that all appliances 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 *pip*ing 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 pip*ing 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(37) are used to size *pip*ing 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 *pip*ing 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. Before Equations 4-1 or 4-2 are permitted to be used, plans stamped by a registered design professional shall be submitted and approved by the code official.

1. Low-pressure gas equation [Less than 1<sup>1</sup>/<sub>2</sub> pounds per square inch (psi) (10.3 kPa)]:

## GAS PIPING INSTALLATIONS

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

2. High-pressure gas equation [ $1\frac{1}{2}$  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).

**TABLE 402.4  
 $C_r$  AND  $Y$  VALUES FOR NATURAL GAS AND UNDILUTED  
 PROPANE AT STANDARD CONDITIONS**

GAS	EQUATION FACTORS	
	$C_r$	$Y$
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 = 0.2488 kPa,  
 1 pound per square inch = 6.895 kPa,  
 1 British thermal unit per hour = 0.293 W.

**402.4.1 Longest length method.** The pipe size of each section of gas *pipng* shall be determined using the longest length of *pipng* 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:

- 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 *pipng* and the load of the section.
- The pipe size of each section of branch *pipng* not previously sized shall be determined using the length of *pipng* from the *point of delivery* to the most remote *outlet* in each branch and the load of the section.

**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.

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

**402.5 Allowable pressure drop.** The design pressure loss in any *pipng* system under maximum probable flow conditions, from the *point of delivery* to the inlet connection of the *appliance*, shall be such that the supply pressure at the *appliance* is greater than or equal to the minimum pressure required by the *appliance*.

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.3 in. w.c.
<b>Specific Gravity</b>	0.60

PIPE SIZE (inch)														
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	131	273	514	1,060	1,580	3,050	4,860	8,580	17,500	31,700	51,300	105,000	191,000	303,000
20	90	188	353	726	1,090	2,090	3,340	5,900	12,000	21,800	35,300	72,400	132,000	208,000
30	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
40	62	129	243	499	747	1,440	2,290	4,050	8,270	15,000	24,200	49,800	90,400	143,000
50	55	114	215	442	662	1,280	2,030	3,590	7,330	13,300	21,500	44,100	80,100	127,000
60	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	72,600	115,000
70	46	95	179	368	552	1,060	1,690	3,000	6,110	11,100	17,900	36,800	66,800	106,000
80	42	89	167	343	514	989	1,580	2,790	5,680	10,300	16,700	34,200	62,100	98,400
90	40	83	157	322	482	928	1,480	2,610	5,330	9,650	15,600	32,100	58,300	92,300
100	38	79	148	304	455	877	1,400	2,470	5,040	9,110	14,800	30,300	55,100	87,200
125	33	70	131	269	403	777	1,240	2,190	4,460	8,080	13,100	26,900	48,800	77,300
150	30	63	119	244	366	704	1,120	1,980	4,050	7,320	11,900	24,300	44,200	70,000
175	28	58	109	224	336	648	1,030	1,820	3,720	6,730	10,900	22,400	40,700	64,400
200	26	54	102	209	313	602	960	1,700	3,460	6,260	10,100	20,800	37,900	59,900
250	23	48	90	185	277	534	851	1,500	3,070	5,550	8,990	18,500	33,500	53,100
300	21	43	82	168	251	484	771	1,360	2,780	5,030	8,150	16,700	30,400	48,100
350	19	40	75	154	231	445	709	1,250	2,560	4,630	7,490	15,400	28,000	44,300
400	18	37	70	143	215	414	660	1,170	2,380	4,310	6,970	14,300	26,000	41,200
450	17	35	66	135	202	389	619	1,090	2,230	4,040	6,540	13,400	24,400	38,600
500	16	33	62	127	191	367	585	1,030	2,110	3,820	6,180	12,700	23,100	36,500
550	15	31	59	121	181	349	556	982	2,000	3,620	5,870	12,100	21,900	34,700
600	14	30	56	115	173	333	530	937	1,910	3,460	5,600	11,500	20,900	33,100
650	14	29	54	110	165	318	508	897	1,830	3,310	5,360	11,000	20,000	31,700
700	13	27	52	106	159	306	488	862	1,760	3,180	5,150	10,600	19,200	30,400
750	13	26	50	102	153	295	470	830	1,690	3,060	4,960	10,200	18,500	29,300
800	12	26	48	99	148	285	454	802	1,640	2,960	4,790	9,840	17,900	28,300
850	12	25	46	95	143	275	439	776	1,580	2,860	4,640	9,530	17,300	27,400
900	11	24	45	93	139	267	426	752	1,530	2,780	4,500	9,240	16,800	26,600
950	11	23	44	90	135	259	413	731	1,490	2,700	4,370	8,970	16,300	25,800
1,000	11	23	43	87	131	252	402	711	1,450	2,620	4,250	8,720	15,800	25,100
1,100	10	21	40	83	124	240	382	675	1,380	2,490	4,030	8,290	15,100	23,800
1,200	NA	20	39	79	119	229	364	644	1,310	2,380	3,850	7,910	14,400	22,700
1,300	NA	20	37	76	114	219	349	617	1,260	2,280	3,680	7,570	13,700	21,800
1,400	NA	19	35	73	109	210	335	592	1,210	2,190	3,540	7,270	13,200	20,900
1,500	NA	18	34	70	105	203	323	571	1,160	2,110	3,410	7,010	12,700	20,100
1,600	NA	18	33	68	102	196	312	551	1,120	2,030	3,290	6,770	12,300	19,500
1,700	NA	17	32	66	98	189	302	533	1,090	1,970	3,190	6,550	11,900	18,800
1,800	NA	16	31	64	95	184	293	517	1,050	1,910	3,090	6,350	11,500	18,300
1,900	NA	16	30	62	93	178	284	502	1,020	1,850	3,000	6,170	11,200	17,700
2,000	NA	16	29	60	90	173	276	488	1,000	1,800	2,920	6,000	10,900	17,200

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. NA means a flow of less than 10 cfh.
2. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	0.60

PIPE SIZE (inch)														
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	81	170	320	657	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	65	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,700	95,700	152,000
70	60	126	237	486	728	1,400	2,230	3,950	8,050	14,600	23,600	48,500	88,100	139,000
80	56	117	220	452	677	1,300	2,080	3,670	7,490	13,600	22,000	45,100	81,900	130,000
90	52	110	207	424	635	1,220	1,950	3,450	7,030	12,700	20,600	42,300	76,900	122,000
100	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	72,600	115,000
125	44	92	173	355	532	1,020	1,630	2,890	5,890	10,600	17,200	35,400	64,300	102,000
150	40	83	157	322	482	928	1,480	2,610	5,330	9,650	15,600	32,100	58,300	92,300
175	37	77	144	296	443	854	1,360	2,410	4,910	8,880	14,400	29,500	53,600	84,900
200	34	71	134	275	412	794	1,270	2,240	4,560	8,260	13,400	27,500	49,900	79,000
250	30	63	119	244	366	704	1,120	1,980	4,050	7,320	11,900	24,300	44,200	70,000
300	27	57	108	221	331	638	1,020	1,800	3,670	6,630	10,700	22,100	40,100	63,400
350	25	53	99	203	305	587	935	1,650	3,370	6,100	9,880	20,300	36,900	58,400
400	23	49	92	189	283	546	870	1,540	3,140	5,680	9,190	18,900	34,300	54,300
450	22	46	86	177	266	512	816	1,440	2,940	5,330	8,620	17,700	32,200	50,900
500	21	43	82	168	251	484	771	1,360	2,780	5,030	8,150	16,700	30,400	48,100
550	20	41	78	159	239	459	732	1,290	2,640	4,780	7,740	15,900	28,900	45,700
600	19	39	74	152	228	438	699	1,240	2,520	4,560	7,380	15,200	27,500	43,600
650	18	38	71	145	218	420	669	1,180	2,410	4,360	7,070	14,500	26,400	41,800
700	17	36	68	140	209	403	643	1,140	2,320	4,190	6,790	14,000	25,300	40,100
750	17	35	66	135	202	389	619	1,090	2,230	4,040	6,540	13,400	24,400	38,600
800	16	34	63	130	195	375	598	1,060	2,160	3,900	6,320	13,000	23,600	37,300
850	16	33	61	126	189	363	579	1,020	2,090	3,780	6,110	12,600	22,800	36,100
900	15	32	59	122	183	352	561	992	2,020	3,660	5,930	12,200	22,100	35,000
950	15	31	58	118	178	342	545	963	1,960	3,550	5,760	11,800	21,500	34,000
1,000	14	30	56	115	173	333	530	937	1,910	3,460	5,600	11,500	20,900	33,100
1,100	14	28	53	109	164	316	503	890	1,810	3,280	5,320	10,900	19,800	31,400
1,200	13	27	51	104	156	301	480	849	1,730	3,130	5,070	10,400	18,900	30,000
1,300	12	26	49	100	150	289	460	813	1,660	3,000	4,860	9,980	18,100	28,700
1,400	12	25	47	96	144	277	442	781	1,590	2,880	4,670	9,590	17,400	27,600
1,500	11	24	45	93	139	267	426	752	1,530	2,780	4,500	9,240	16,800	26,600
1,600	11	23	44	89	134	258	411	727	1,480	2,680	4,340	8,920	16,200	25,600
1,700	11	22	42	86	130	250	398	703	1,430	2,590	4,200	8,630	15,700	24,800
1,800	10	22	41	84	126	242	386	682	1,390	2,520	4,070	8,370	15,200	24,100
1,900	10	21	40	81	122	235	375	662	1,350	2,440	3,960	8,130	14,800	23,400
2,000	NA	20	39	79	119	229	364	644	1,310	2,380	3,850	7,910	14,400	22,700

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. NA means a flow of less than 10 cfh.
2. All table entries have been rounded to three significant digits.

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	3.0 in. w.c.
<b>Specific Gravity</b>	0.60

INTENDED USE: Initial supply pressure of 8.0 inches w.c. or greater									
PIPE SIZE (inch)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas Per Hour								
10	454	949	1,787	3,669	5,497	10,588	16,875	29,832	43,678
20	312	652	1,228	2,522	3,778	7,277	11,598	20,503	30,020
30	250	524	986	2,025	3,034	5,844	9,314	16,465	24,107
40	214	448	844	1,733	2,597	5,001	7,971	14,092	20,632
50	190	397	748	1,536	2,302	4,433	7,065	12,489	18,286
60	172	360	678	1,392	2,085	4,016	6,401	11,316	16,569
70	158	331	624	1,280	1,919	3,695	5,889	10,411	15,243
80	147	308	580	1,191	1,785	3,437	5,479	9,685	14,181
90	138	289	544	1,118	1,675	3,225	5,140	9,087	13,305
100	131	273	514	1,056	1,582	3,046	4,856	8,584	12,568
125	116	242	456	936	1,402	2,700	4,303	7,608	11,139
150	105	219	413	848	1,270	2,446	3,899	6,893	10,092
175	96	202	380	780	1,169	2,251	3,587	6,342	9,285
200	90	188	353	726	1,087	2,094	3,337	5,900	8,638
250	80	166	313	643	964	1,856	2,958	5,229	7,656
300	72	151	284	583	873	1,681	2,680	4,738	6,937
350	66	139	261	536	803	1,547	2,456	4,359	6,382
400	62	129	243	499	747	1,439	2,294	4,055	5,937
450	58	121	228	468	701	1,350	2,152	3,804	5,570
500	55	114	215	442	662	1,275	2,033	3,594	5,262
550	52	109	204	420	629	1,211	1,931	3,413	4,997
600	50	104	195	400	600	1,156	1,842	3,256	4,767
650	47	99	187	384	575	1,107	1,764	3,118	4,565
700	46	95	179	368	552	1,063	1,695	2,996	4,386
750	44	92	173	355	532	1,024	1,632	2,886	4,225
800	42	89	167	343	514	989	1,576	2,787	4,080
850	41	86	162	332	497	957	1,526	2,697	3,949
900	40	83	157	322	482	928	1,479	2,615	3,828
950	39	81	152	312	468	901	1,436	2,539	3,718
1,000	38	79	148	304	455	877	1,397	2,470	3,616
1,100	36	75	141	289	432	833	1,327	2,346	3,435
1,200	34	71	134	275	412	794	1,266	2,238	3,277
1,300	33	68	128	264	395	761	1,212	2,143	3,138
1,400	31	65	123	253	379	731	1,165	2,059	3,014
1,500	30	63	119	244	366	704	1,122	1,983	2,904
1,600	29	61	115	236	353	680	1,083	1,915	2,804
1,700	28	59	111	228	342	658	1,048	1,854	2,714
1,800	27	57	108	221	331	638	1,017	1,797	2,631
1,900	27	56	105	215	322	619	987	1,745	2,555
2,000	26	54	102	209	313	602	960	1,698	2,485

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	6.0 in. w.c.
<b>Specific Gravity</b>	0.60

<b>INTENDED USE: Initial supply pressure of 11.0 inches w.c. or greater</b>									
<b>PIPE SIZE (inch)</b>									
<b>Nominal</b>	<b>1/2</b>	<b>3/4</b>	<b>1</b>	<b>1 1/4</b>	<b>1 1/2</b>	<b>2</b>	<b>2 1/2</b>	<b>3</b>	<b>4</b>
<b>Actual ID</b>	<b>0.622</b>	<b>0.824</b>	<b>1.049</b>	<b>1.380</b>	<b>1.610</b>	<b>2.067</b>	<b>2.469</b>	<b>3.068</b>	<b>4.026</b>
<b>Length (ft)</b>	<b>Capacity in Cubic Feet of Gas Per Hour</b>								
10	660	1,380	2,600	5,338	7,999	15,405	24,553	43,405	63,551
20	454	949	1,787	3,669	5,497	10,588	16,875	29,832	43,678
30	364	762	1,435	2,946	4,415	8,502	13,551	23,956	35,075
40	312	652	1,228	2,522	3,778	7,277	11,598	20,503	30,020
50	276	578	1,089	2,235	3,349	6,449	10,279	18,172	26,606
60	250	524	986	2,025	3,034	5,844	9,314	16,465	24,107
70	230	482	907	1,863	2,791	5,376	8,568	15,147	22,178
80	214	448	844	1,733	2,597	5,001	7,971	14,092	20,632
90	201	420	792	1,626	2,437	4,693	7,479	13,222	19,359
100	190	397	748	1,536	2,302	4,433	7,065	12,489	18,286
125	168	352	663	1,361	2,040	3,928	6,261	11,069	16,207
150	153	319	601	1,234	1,848	3,559	5,673	10,029	14,684
175	140	293	553	1,135	1,700	3,275	5,219	9,227	13,509
200	131	273	514	1,056	1,582	3,046	4,856	8,584	12,568
250	116	242	456	936	1,402	2,700	4,303	7,608	11,139
300	105	219	413	848	1,270	2,446	3,899	6,893	10,093
350	96	202	380	780	1,169	2,251	3,587	6,342	9,285
400	90	188	353	726	1,087	2,094	3,337	5,900	8,638
450	84	176	332	681	1,020	1,965	3,131	5,535	8,105
500	80	166	313	643	964	1,856	2,958	5,229	7,656
550	76	158	297	611	915	1,762	2,809	4,966	7,271
600	72	151	284	583	873	1,681	2,680	4,738	6,937
650	69	144	272	558	836	1,610	2,566	4,537	6,643
700	66	139	261	536	803	1,547	2,465	4,359	6,382
750	64	134	252	516	774	1,490	2,375	4,199	6,148
800	62	129	243	499	747	1,439	2,294	4,055	5,937
850	60	125	235	483	723	1,393	2,220	3,924	5,745
900	58	121	228	468	701	1,350	2,152	3,804	5,570
950	56	118	221	454	681	1,311	2,090	3,695	5,410
1,000	55	114	215	442	662	1,275	2,033	3,594	5,262
1,100	52	109	204	420	629	1,211	1,931	3,413	4,997
1,200	50	104	195	400	600	1,156	1,842	3,256	4,767
1,300	47	99	187	384	575	1,107	1,764	3,118	4,565
1,400	46	95	179	368	552	1,063	1,695	2,996	4,386
1,500	44	92	173	355	532	1,024	1,632	2,886	4,225
1,600	42	89	167	343	514	989	1,576	2,787	4,080
1,700	41	86	162	332	497	957	1,526	2,697	3,949
1,800	40	83	157	322	482	928	1,479	2,615	3,828
1,900	39	81	152	312	468	901	1,436	2,539	3,718
2,000	38	79	148	304	455	877	1,397	2,470	3,616

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(5)  
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 (inch)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas Per Hour								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	37,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	934	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
250	279	583	1,040	2,140	3,210	6,180	9,850	17,400	35,500
300	253	528	945	1,940	2,910	5,600	8,920	15,800	32,200
350	232	486	869	1,790	2,670	5,150	8,210	14,500	29,600
400	216	452	809	1,660	2,490	4,790	7,640	13,500	27,500
450	203	424	759	1,560	2,330	4,500	7,170	12,700	25,800
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
550	182	381	681	1,400	2,090	4,030	6,430	11,400	23,200
600	174	363	650	1,330	2,000	3,850	6,130	10,800	22,100
650	166	348	622	1,280	1,910	3,680	5,870	10,400	21,200
700	160	334	598	1,230	1,840	3,540	5,640	9,970	20,300
750	154	322	576	1,180	1,770	3,410	5,440	9,610	19,600
800	149	311	556	1,140	1,710	3,290	5,250	9,280	18,900
850	144	301	538	1,100	1,650	3,190	5,080	8,980	18,300
900	139	292	522	1,070	1,600	3,090	4,930	8,710	17,800
950	135	283	507	1,040	1,560	3,000	4,780	8,460	17,200
1,000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1,100	125	262	468	960	1,440	2,770	4,420	7,810	15,900
1,200	119	250	446	917	1,370	2,640	4,220	7,450	15,200
1,300	114	239	427	878	1,320	2,530	4,040	7,140	14,600
1,400	110	230	411	843	1,260	2,430	3,880	6,860	14,000
1,500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
1,600	102	214	382	784	1,180	2,260	3,610	6,380	13,000
1,700	99	207	370	759	1,140	2,190	3,490	6,170	12,600
1,800	96	200	358	736	1,100	2,120	3,390	5,980	12,200
1,900	93	195	348	715	1,070	2,060	3,290	5,810	11,900
2,000	91	189	339	695	1,040	2,010	3,200	5,650	11,500

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	3.0 psi
<b>Pressure Drop</b>	2.0 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (inch)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas Per Hour								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	73,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,800	20,800	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,800
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
250	412	862	1,620	3,330	5,000	9,620	15,300	27,100	55,300
300	374	781	1,470	3,020	4,530	8,720	13,900	24,600	50,100
350	344	719	1,350	2,780	4,170	8,020	12,800	22,600	46,100
400	320	669	1,260	2,590	3,870	7,460	11,900	21,000	42,900
450	300	627	1,180	2,430	3,640	7,000	11,200	19,700	40,200
500	283	593	1,120	2,290	3,430	6,610	10,500	18,600	38,000
550	269	563	1,060	2,180	3,260	6,280	10,000	17,700	36,100
600	257	537	1,010	2,080	3,110	5,990	9,550	16,900	34,400
650	246	514	969	1,990	2,980	5,740	9,150	16,200	33,000
700	236	494	931	1,910	2,860	5,510	8,790	15,500	31,700
750	228	476	897	1,840	2,760	5,310	8,470	15,000	30,500
800	220	460	866	1,780	2,660	5,130	8,180	14,500	29,500
850	213	445	838	1,720	2,580	4,960	7,910	14,000	28,500
900	206	431	812	1,670	2,500	4,810	7,670	13,600	27,700
950	200	419	789	1,620	2,430	4,670	7,450	13,200	26,900
1,000	195	407	767	1,580	2,360	4,550	7,240	12,800	26,100
1,100	185	387	729	1,500	2,240	4,320	6,890	12,200	24,800
1,200	177	369	695	1,430	2,140	4,120	6,570	11,600	23,700
1,300	169	353	666	1,370	2,050	3,940	6,290	11,100	22,700
1,400	162	340	640	1,310	1,970	3,790	6,040	10,700	21,800
1,500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
1,600	151	316	595	1,220	1,830	3,530	5,620	10,000	20,300
1,700	146	306	576	1,180	1,770	3,410	5,440	9,610	19,600
1,800	142	296	558	1,150	1,720	3,310	5,270	9,320	19,000
1,900	138	288	542	1,110	1,670	3,210	5,120	9,050	18,400
2,000	134	280	527	1,080	1,620	3,120	4,980	8,800	18,000

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(7)  
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 (inch)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas Per Hour								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
250	558	1,170	2,200	4,510	6,760	13,000	20,800	36,700	74,900
300	506	1,060	1,990	4,090	6,130	11,800	18,800	33,300	67,800
350	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
400	433	905	1,710	3,500	5,250	10,100	16,100	28,500	58,100
450	406	849	1,600	3,290	4,920	9,480	15,100	26,700	54,500
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
550	364	762	1,440	2,950	4,420	8,500	13,600	24,000	48,900
600	348	727	1,370	2,810	4,210	8,110	12,900	22,900	46,600
650	333	696	1,310	2,690	4,030	7,770	12,400	21,900	44,600
700	320	669	1,260	2,590	3,880	7,460	11,900	21,000	42,900
750	308	644	1,210	2,490	3,730	7,190	11,500	20,300	41,300
800	298	622	1,170	2,410	3,610	6,940	11,100	19,600	39,900
850	288	602	1,130	2,330	3,490	6,720	10,700	18,900	38,600
900	279	584	1,100	2,260	3,380	6,520	10,400	18,400	37,400
950	271	567	1,070	2,190	3,290	6,330	10,100	17,800	36,400
1,000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1,100	250	524	987	2,030	3,030	5,840	9,320	16,500	33,600
1,200	239	500	941	1,930	2,900	5,580	8,890	15,700	32,000
1,300	229	478	901	1,850	2,770	5,340	8,510	15,000	30,700
1,400	220	460	866	1,780	2,660	5,130	8,180	14,500	29,500
1,500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400
1,600	205	428	806	1,650	2,480	4,770	7,610	13,400	27,400
1,700	198	414	780	1,600	2,400	4,620	7,360	13,000	26,500
1,800	192	401	756	1,550	2,330	4,480	7,140	12,600	25,700
1,900	186	390	734	1,510	2,260	4,350	6,930	12,300	25,000
2,000	181	379	714	1,470	2,200	4,230	6,740	11,900	24,300

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(8)  
SEMIRIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.3 in. w.c.
<b>Specific Gravity</b>	0.60

		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
<b>Length (ft)</b>		<b>Capacity in Cubic Feet of Gas Per Hour</b>								
10		20	42	85	148	210	448	806	1,270	2,650
20		14	29	58	102	144	308	554	873	1,820
30		11	23	47	82	116	247	445	701	1,460
40		10	20	40	70	99	211	381	600	1,250
50		NA	17	35	62	88	187	337	532	1,110
60		NA	16	32	56	79	170	306	482	1,000
70		NA	14	29	52	73	156	281	443	924
80		NA	13	27	48	68	145	262	413	859
90		NA	13	26	45	64	136	245	387	806
100		NA	12	24	43	60	129	232	366	761
125		NA	11	22	38	53	114	206	324	675
150		NA	10	20	34	48	103	186	294	612
175		NA	NA	18	31	45	95	171	270	563
200		NA	NA	17	29	41	89	159	251	523
250		NA	NA	15	26	37	78	141	223	464
300		NA	NA	13	23	33	71	128	202	420
350		NA	NA	12	22	31	65	118	186	387
400		NA	NA	11	20	28	61	110	173	360
450		NA	NA	11	19	27	57	103	162	338
500		NA	NA	10	18	25	54	97	153	319
550		NA	NA	NA	17	24	51	92	145	303
600		NA	NA	NA	16	23	49	88	139	289
650		NA	NA	NA	15	22	47	84	133	277
700		NA	NA	NA	15	21	45	81	128	266
750		NA	NA	NA	14	20	43	78	123	256
800		NA	NA	NA	14	20	42	75	119	247
850		NA	NA	NA	13	19	40	73	115	239
900		NA	NA	NA	13	18	39	71	111	232
950		NA	NA	NA	13	18	38	69	108	225
1,000		NA	NA	NA	12	17	37	67	105	219
1,100		NA	NA	NA	12	16	35	63	100	208
1,200		NA	NA	NA	11	16	34	60	95	199
1,300		NA	NA	NA	11	15	32	58	91	190
1,400		NA	NA	NA	10	14	31	56	88	183
1,500		NA	NA	NA	NA	14	30	54	84	176
1,600		NA	NA	NA	NA	13	29	52	82	170
1,700		NA	NA	NA	NA	13	28	50	79	164
1,800		NA	NA	NA	NA	13	27	49	77	159
1,900		NA	NA	NA	NA	12	26	47	74	155
2,000		NA	NA	NA	NA	12	25	46	72	151

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. NA means a flow of less than 10 cfh.
3. All table entries have been rounded to three significant digits.

**TABLE 402.4(9)  
SEMIRIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	0.60

		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas Per Hour								
10	27	55	111	195	276	590	1,060	1,680	3,490	
20	18	38	77	134	190	406	730	1,150	2,400	
30	15	30	61	107	152	326	586	925	1,930	
40	13	26	53	92	131	279	502	791	1,650	
50	11	23	47	82	116	247	445	701	1,460	
60	10	21	42	74	105	224	403	635	1,320	
70	NA	19	39	68	96	206	371	585	1,220	
80	NA	18	36	63	90	192	345	544	1,130	
90	NA	17	34	59	84	180	324	510	1,060	
100	NA	16	32	56	79	170	306	482	1,000	
125	NA	14	28	50	70	151	271	427	890	
150	NA	13	26	45	64	136	245	387	806	
175	NA	12	24	41	59	125	226	356	742	
200	NA	11	22	39	55	117	210	331	690	
250	NA	NA	20	34	48	103	186	294	612	
300	NA	NA	18	31	44	94	169	266	554	
350	NA	NA	16	28	40	86	155	245	510	
400	NA	NA	15	26	38	80	144	228	474	
450	NA	NA	14	25	35	75	135	214	445	
500	NA	NA	13	23	33	71	128	202	420	
550	NA	NA	13	22	32	68	122	192	399	
600	NA	NA	12	21	30	64	116	183	381	
650	NA	NA	12	20	29	62	111	175	365	
700	NA	NA	11	20	28	59	107	168	350	
750	NA	NA	11	19	27	57	103	162	338	
800	NA	NA	10	18	26	55	99	156	326	
850	NA	NA	10	18	25	53	96	151	315	
900	NA	NA	NA	17	24	52	93	147	306	
950	NA	NA	NA	17	24	50	90	143	297	
1,000	NA	NA	NA	16	23	49	88	139	289	
1,100	NA	NA	NA	15	22	46	84	132	274	
1,200	NA	NA	NA	15	21	44	80	126	262	
1,300	NA	NA	NA	14	20	42	76	120	251	
1,400	NA	NA	NA	13	19	41	73	116	241	
1,500	NA	NA	NA	13	18	39	71	111	232	
1,600	NA	NA	NA	13	18	38	68	108	224	
1,700	NA	NA	NA	12	17	37	66	104	217	
1,800	NA	NA	NA	12	17	36	64	101	210	
1,900	NA	NA	NA	11	16	35	62	98	204	
2,000	NA	NA	NA	11	16	34	60	95	199	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. NA means a flow of less than 10 cfh.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(10)  
SEMIRIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	1.0 in. w.c.
<b>Specific Gravity</b>	0.60

<b>INTENDED USE: SIZING BETWEEN HOUSE LINE REGULATOR AND THE APPLIANCE</b>										
<b>TUBE SIZE (inch)</b>										
<b>Nominal</b>	<b>K &amp; L</b>	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2
	<b>ACR</b>	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
<b>Length (ft)</b>		<b>Capacity in Cubic Feet of Gas Per Hour</b>								
10		39	80	162	283	402	859	1,550	2,440	5,080
20		27	55	111	195	276	590	1,060	1,680	3,490
30		21	44	89	156	222	474	853	1,350	2,800
40		18	38	77	134	190	406	730	1,150	2,400
50		16	33	68	119	168	359	647	1,020	2,130
60		15	30	61	107	152	326	586	925	1,930
70		13	28	57	99	140	300	539	851	1,770
80		13	26	53	92	131	279	502	791	1,650
90		12	24	49	86	122	262	471	742	1,550
100		11	23	47	82	116	247	445	701	1,460
125		NA	20	41	72	103	219	394	622	1,290
150		NA	18	37	65	93	198	357	563	1,170
175		NA	17	34	60	85	183	329	518	1,080
200		NA	16	32	56	79	170	306	482	1,000
250		NA	14	28	50	70	151	271	427	890
300		NA	13	26	45	64	136	245	387	806
350		NA	12	24	41	59	125	226	356	742
400		NA	11	22	39	55	117	210	331	690
450		NA	10	21	36	51	110	197	311	647
500		NA	NA	20	34	48	103	186	294	612
550		NA	NA	19	32	46	98	177	279	581
600		NA	NA	18	31	44	94	169	266	554
650		NA	NA	17	30	42	90	162	255	531
700		NA	NA	16	28	40	86	155	245	510
750		NA	NA	16	27	39	83	150	236	491
800		NA	NA	15	26	38	80	144	228	474
850		NA	NA	15	26	36	78	140	220	459
900		NA	NA	14	25	35	75	135	214	445
950		NA	NA	14	24	34	73	132	207	432
1,000		NA	NA	13	23	33	71	128	202	420
1,100		NA	NA	13	22	32	68	122	192	399
1,200		NA	NA	12	21	30	64	116	183	381
1,300		NA	NA	12	20	29	62	111	175	365
1,400		NA	NA	11	20	28	59	107	168	350
1,500		NA	NA	11	19	27	57	103	162	338
1,600		NA	NA	10	18	26	55	99	156	326
1,700		NA	NA	10	18	25	53	96	151	315
1,800		NA	NA	NA	17	24	52	93	147	306
1,900		NA	NA	NA	17	24	50	90	143	297
2,000		NA	NA	NA	16	23	49	88	139	289

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. NA means a flow of less than 10 cfh.
3. All table entries have been rounded to three significant digits.

**TABLE 402.4(11)  
SEMIRIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	17.0 in. w.c.
<b>Specific Gravity</b>	0.60

TUBE SIZE (inch)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas Per Hour								
10	190	391	796	1,390	1,970	4,220	7,590	12,000	24,900	
20	130	269	547	956	1,360	2,900	5,220	8,230	17,100	
30	105	216	439	768	1,090	2,330	4,190	6,610	13,800	
40	90	185	376	657	932	1,990	3,590	5,650	11,800	
50	79	164	333	582	826	1,770	3,180	5,010	10,400	
60	72	148	302	528	749	1,600	2,880	4,540	9,460	
70	66	137	278	486	689	1,470	2,650	4,180	8,700	
80	62	127	258	452	641	1,370	2,460	3,890	8,090	
90	58	119	243	424	601	1,280	2,310	3,650	7,590	
100	55	113	229	400	568	1,210	2,180	3,440	7,170	
125	48	100	203	355	503	1,080	1,940	3,050	6,360	
150	44	90	184	321	456	974	1,750	2,770	5,760	
175	40	83	169	296	420	896	1,610	2,540	5,300	
200	38	77	157	275	390	834	1,500	2,370	4,930	
250	33	69	140	244	346	739	1,330	2,100	4,370	
300	30	62	126	221	313	670	1,210	1,900	3,960	
350	28	57	116	203	288	616	1,110	1,750	3,640	
400	26	53	108	189	268	573	1,030	1,630	3,390	
450	24	50	102	177	252	538	968	1,530	3,180	
500	23	47	96	168	238	508	914	1,440	3,000	
550	22	45	91	159	226	482	868	1,370	2,850	
600	21	43	87	152	215	460	829	1,310	2,720	
650	20	41	83	145	206	441	793	1,250	2,610	
700	19	39	80	140	198	423	762	1,200	2,500	
750	18	38	77	135	191	408	734	1,160	2,410	
800	18	37	74	130	184	394	709	1,120	2,330	
850	17	35	72	126	178	381	686	1,080	2,250	
900	17	34	70	122	173	370	665	1,050	2,180	
950	16	33	68	118	168	359	646	1,020	2,120	
1,000	16	32	66	115	163	349	628	991	2,060	
1,100	15	31	63	109	155	332	597	941	1,960	
1,200	14	29	60	104	148	316	569	898	1,870	
1,300	14	28	57	100	142	303	545	860	1,790	
1,400	13	27	55	96	136	291	524	826	1,720	
1,500	13	26	53	93	131	280	505	796	1,660	
1,600	12	25	51	89	127	271	487	768	1,600	
1,700	12	24	49	86	123	262	472	744	1,550	
1,800	11	24	48	84	119	254	457	721	1,500	
1,900	11	23	47	81	115	247	444	700	1,460	
2,000	11	22	45	79	112	240	432	681	1,420	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(12)  
SEMIRIGID COPPER TUBING**

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

		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas Per Hour								
10	245	506	1,030	1,800	2,550	5,450	9,820	15,500	32,200	
20	169	348	708	1,240	1,760	3,750	6,750	10,600	22,200	
30	135	279	568	993	1,410	3,010	5,420	8,550	17,800	
40	116	239	486	850	1,210	2,580	4,640	7,310	15,200	
50	103	212	431	754	1,070	2,280	4,110	6,480	13,500	
60	93	192	391	683	969	2,070	3,730	5,870	12,200	
70	86	177	359	628	891	1,900	3,430	5,400	11,300	
80	80	164	334	584	829	1,770	3,190	5,030	10,500	
90	75	154	314	548	778	1,660	2,990	4,720	9,820	
100	71	146	296	518	735	1,570	2,830	4,450	9,280	
125	63	129	263	459	651	1,390	2,500	3,950	8,220	
150	57	117	238	416	590	1,260	2,270	3,580	7,450	
175	52	108	219	383	543	1,160	2,090	3,290	6,850	
200	49	100	204	356	505	1,080	1,940	3,060	6,380	
250	43	89	181	315	448	956	1,720	2,710	5,650	
300	39	80	164	286	406	866	1,560	2,460	5,120	
350	36	74	150	263	373	797	1,430	2,260	4,710	
400	33	69	140	245	347	741	1,330	2,100	4,380	
450	31	65	131	230	326	696	1,250	1,970	4,110	
500	30	61	124	217	308	657	1,180	1,870	3,880	
550	28	58	118	206	292	624	1,120	1,770	3,690	
600	27	55	112	196	279	595	1,070	1,690	3,520	
650	26	53	108	188	267	570	1,030	1,620	3,370	
700	25	51	103	181	256	548	986	1,550	3,240	
750	24	49	100	174	247	528	950	1,500	3,120	
800	23	47	96	168	239	510	917	1,450	3,010	
850	22	46	93	163	231	493	888	1,400	2,920	
900	22	44	90	158	224	478	861	1,360	2,830	
950	21	43	88	153	217	464	836	1,320	2,740	
1,000	20	42	85	149	211	452	813	1,280	2,670	
1,100	19	40	81	142	201	429	772	1,220	2,540	
1,200	18	38	77	135	192	409	737	1,160	2,420	
1,300	18	36	74	129	183	392	705	1,110	2,320	
1,400	17	35	71	124	176	376	678	1,070	2,230	
1,500	16	34	68	120	170	363	653	1,030	2,140	
1,600	16	33	66	116	164	350	630	994	2,070	
1,700	15	31	64	112	159	339	610	962	2,000	
1,800	15	30	62	108	154	329	592	933	1,940	
1,900	14	30	60	105	149	319	575	906	1,890	
2,000	14	29	59	102	145	310	559	881	1,830	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. All table entries have been rounded to three significant digits.

**TABLE 402.4(13)  
SEMRIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.5 psi
<b>Specific Gravity</b>	0.60

INTENDED USE		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.								
		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	3/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas Per Hour								
10	303	625	1,270	2,220	3,150	6,740	12,100	19,100	39,800	
20	208	430	874	1,530	2,170	4,630	8,330	13,100	27,400	
30	167	345	702	1,230	1,740	3,720	6,690	10,600	22,000	
40	143	295	601	1,050	1,490	3,180	5,730	9,030	18,800	
50	127	262	532	931	1,320	2,820	5,080	8,000	16,700	
60	115	237	482	843	1,200	2,560	4,600	7,250	15,100	
70	106	218	444	776	1,100	2,350	4,230	6,670	13,900	
80	98	203	413	722	1,020	2,190	3,940	6,210	12,900	
90	92	190	387	677	961	2,050	3,690	5,820	12,100	
100	87	180	366	640	907	1,940	3,490	5,500	11,500	
125	77	159	324	567	804	1,720	3,090	4,880	10,200	
150	70	144	294	514	729	1,560	2,800	4,420	9,200	
175	64	133	270	472	670	1,430	2,580	4,060	8,460	
200	60	124	252	440	624	1,330	2,400	3,780	7,870	
250	53	110	223	390	553	1,180	2,130	3,350	6,980	
300	48	99	202	353	501	1,070	1,930	3,040	6,320	
350	44	91	186	325	461	984	1,770	2,790	5,820	
400	41	85	173	302	429	916	1,650	2,600	5,410	
450	39	80	162	283	402	859	1,550	2,440	5,080	
500	36	75	153	268	380	811	1,460	2,300	4,800	
550	35	72	146	254	361	771	1,390	2,190	4,560	
600	33	68	139	243	344	735	1,320	2,090	4,350	
650	32	65	133	232	330	704	1,270	2,000	4,160	
700	30	63	128	223	317	676	1,220	1,920	4,000	
750	29	60	123	215	305	652	1,170	1,850	3,850	
800	28	58	119	208	295	629	1,130	1,790	3,720	
850	27	57	115	201	285	609	1,100	1,730	3,600	
900	27	55	111	195	276	590	1,060	1,680	3,490	
950	26	53	108	189	268	573	1,030	1,630	3,390	
1,000	25	52	105	184	261	558	1,000	1,580	3,300	
1,100	24	49	100	175	248	530	954	1,500	3,130	
1,200	23	47	95	167	237	505	910	1,430	2,990	
1,300	22	45	91	160	227	484	871	1,370	2,860	
1,400	21	43	88	153	218	465	837	1,320	2,750	
1,500	20	42	85	148	210	448	806	1,270	2,650	
1,600	19	40	82	143	202	432	779	1,230	2,560	
1,700	19	39	79	138	196	419	753	1,190	2,470	
1,800	18	38	77	134	190	406	731	1,150	2,400	
1,900	18	37	74	130	184	394	709	1,120	2,330	
2,000	17	36	72	126	179	383	690	1,090	2,270	

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 cubic foot per hour = 0.0283 m³/h, 1 degree = 0.01745 rad.

**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. Where 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 not greater than 1 inch w.c.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(14)  
SEMIRIGID COPPER TUBING**

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

		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
<b>Length (ft)</b>		<b>Capacity in Cubic Feet of Gas Per Hour</b>								
10	511	1,050	2,140	3,750	5,320	11,400	20,400	32,200	67,100	
20	351	724	1,470	2,580	3,650	7,800	14,000	22,200	46,100	
30	282	582	1,180	2,070	2,930	6,270	11,300	17,800	37,000	
40	241	498	1,010	1,770	2,510	5,360	9,660	15,200	31,700	
50	214	441	898	1,570	2,230	4,750	8,560	13,500	28,100	
60	194	400	813	1,420	2,020	4,310	7,750	12,200	25,500	
70	178	368	748	1,310	1,860	3,960	7,130	11,200	23,400	
80	166	342	696	1,220	1,730	3,690	6,640	10,500	21,800	
90	156	321	653	1,140	1,620	3,460	6,230	9,820	20,400	
100	147	303	617	1,080	1,530	3,270	5,880	9,270	19,300	
125	130	269	547	955	1,360	2,900	5,210	8,220	17,100	
150	118	243	495	866	1,230	2,620	4,720	7,450	15,500	
175	109	224	456	796	1,130	2,410	4,350	6,850	14,300	
200	101	208	424	741	1,050	2,250	4,040	6,370	13,300	
250	90	185	376	657	932	1,990	3,580	5,650	11,800	
300	81	167	340	595	844	1,800	3,250	5,120	10,700	
350	75	154	313	547	777	1,660	2,990	4,710	9,810	
400	69	143	291	509	722	1,540	2,780	4,380	9,120	
450	65	134	273	478	678	1,450	2,610	4,110	8,560	
500	62	127	258	451	640	1,370	2,460	3,880	8,090	
550	58	121	245	429	608	1,300	2,340	3,690	7,680	
600	56	115	234	409	580	1,240	2,230	3,520	7,330	
650	53	110	224	392	556	1,190	2,140	3,370	7,020	
700	51	106	215	376	534	1,140	2,050	3,240	6,740	
750	49	102	207	362	514	1,100	1,980	3,120	6,490	
800	48	98	200	350	497	1,060	1,910	3,010	6,270	
850	46	95	194	339	481	1,030	1,850	2,910	6,070	
900	45	92	188	328	466	1,000	1,790	2,820	5,880	
950	43	90	182	319	452	967	1,740	2,740	5,710	
1,000	42	87	177	310	440	940	1,690	2,670	5,560	
1,100	40	83	169	295	418	893	1,610	2,530	5,280	
1,200	38	79	161	281	399	852	1,530	2,420	5,040	
1,300	37	76	154	269	382	816	1,470	2,320	4,820	
1,400	35	73	148	259	367	784	1,410	2,220	4,630	
1,500	34	70	143	249	353	755	1,360	2,140	4,460	
1,600	33	68	138	241	341	729	1,310	2,070	4,310	
1,700	32	65	133	233	330	705	1,270	2,000	4,170	
1,800	31	63	129	226	320	684	1,230	1,940	4,040	
1,900	30	62	125	219	311	664	1,200	1,890	3,930	
2,000	29	60	122	213	302	646	1,160	1,830	3,820	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. All table entries have been rounded to three significant digits.

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	0.60

TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
5	46	63	115	134	225	270	471	546	895	1,037	1,790	2,070	3,660	4,140
10	32	44	82	95	161	192	330	383	639	746	1,260	1,470	2,600	2,930
15	25	35	66	77	132	157	267	310	524	615	1,030	1,200	2,140	2,400
20	22	31	58	67	116	137	231	269	456	536	888	1,050	1,850	2,080
25	19	27	52	60	104	122	206	240	409	482	793	936	1,660	1,860
30	18	25	47	55	96	112	188	218	374	442	723	856	1,520	1,700
40	15	21	41	47	83	97	162	188	325	386	625	742	1,320	1,470
50	13	19	37	42	75	87	144	168	292	347	559	665	1,180	1,320
60	12	17	34	38	68	80	131	153	267	318	509	608	1,080	1,200
70	11	16	31	36	63	74	121	141	248	295	471	563	1,000	1,110
80	10	15	29	33	60	69	113	132	232	277	440	527	940	1,040
90	10	14	28	32	57	65	107	125	219	262	415	498	887	983
100	9	13	26	30	54	62	101	118	208	249	393	472	843	933
150	7	10	20	23	42	48	78	91	171	205	320	387	691	762
200	6	9	18	21	38	44	71	82	148	179	277	336	600	661
250	5	8	16	19	34	39	63	74	133	161	247	301	538	591
300	5	7	15	17	32	36	57	67	95	148	226	275	492	540

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. 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.
2. 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.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	3.0 in. w.c.
<b>Specific Gravity</b>	0.60

INTENDED USE: Initial supply pressure of 8.0 inches w.c. or greater													
TUBE SIZE (EHD)													
Flow Designation	13	15	18	19	23	25	30	31	37	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas Per Hour												
5	120	160	277	327	529	649	1,180	1,370	2,140	4,430	5,010	8,800	10,100
10	83	112	197	231	380	462	828	958	1,530	3,200	3,560	6,270	7,160
15	67	90	161	189	313	379	673	778	1,250	2,540	2,910	5,140	5,850
20	57	78	140	164	273	329	580	672	1,090	2,200	2,530	4,460	5,070
25	51	69	125	147	245	295	518	599	978	1,960	2,270	4,000	4,540
30	46	63	115	134	225	270	471	546	895	1,790	2,070	3,660	4,140
40	39	54	100	116	196	234	407	471	778	1,550	1,800	3,180	3,590
50	35	48	89	104	176	210	363	421	698	1,380	1,610	2,850	3,210
60	32	44	82	95	161	192	330	383	639	1,260	1,470	2,600	2,930
70	29	41	76	88	150	178	306	355	593	1,170	1,360	2,420	2,720
80	27	38	71	82	141	167	285	331	555	1,090	1,280	2,260	2,540
90	26	36	67	77	133	157	268	311	524	1,030	1,200	2,140	2,400
100	24	34	63	73	126	149	254	295	498	974	1,140	2,030	2,280
150	19	27	52	60	104	122	206	240	409	793	936	1,660	1,860
200	17	23	45	52	91	106	178	207	355	686	812	1,440	1,610
250	15	21	40	46	82	95	159	184	319	613	728	1,290	1,440
300	13	19	37	42	75	87	144	168	234	559	665	1,180	1,320

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. 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.
2. 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.
3. All table entries have been rounded to three significant digits.

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	6.0 in. w.c.
<b>Specific Gravity</b>	0.60

INTENDED USE: Initial supply pressure of 11.0 inches w.c. or greater													
TUBE SIZE (EHD)													
Flow Designation	13	15	18	19	23	25	30	31	37	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas Per Hour												
5	173	229	389	461	737	911	1,690	1,950	3,000	6,280	7,050	12,400	14,260
10	120	160	277	327	529	649	1,180	1,370	2,140	4,430	5,010	8,800	10,100
15	96	130	227	267	436	532	960	1,110	1,760	3,610	4,100	7,210	8,260
20	83	112	197	231	380	462	828	958	1,530	3,120	3,560	6,270	7,160
25	74	99	176	207	342	414	739	855	1,370	2,790	3,190	5,620	6,400
30	67	90	161	189	313	379	673	778	1,250	2,540	2,910	5,140	5,850
40	57	78	140	164	273	329	580	672	1,090	2,200	2,530	4,460	5,070
50	51	69	125	147	245	295	518	599	978	1,960	2,270	4,000	4,540
60	46	63	115	134	225	270	471	546	895	1,790	2,070	3,660	4,140
70	42	58	106	124	209	250	435	505	830	1,660	1,920	3,390	3,840
80	39	54	100	116	196	234	407	471	778	1,550	1,800	3,180	3,590
90	37	51	94	109	185	221	383	444	735	1,460	1,700	3,000	3,390
100	35	48	89	104	176	210	363	421	698	1,380	1,610	2,850	3,210
150	28	39	73	85	145	172	294	342	573	1,130	1,320	2,340	2,630
200	24	34	63	73	126	149	254	295	498	974	1,140	2,030	2,280
250	21	30	57	66	114	134	226	263	447	870	1,020	1,820	2,040
300	19	27	52	60	104	122	206	240	409	793	936	1,660	1,860

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. 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.
2. 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.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	270	353	587	700	1,100	1,370	2,590	2,990	4,510	5,037	9,600	10,700	18,600	21,600
25	166	220	374	444	709	876	1,620	1,870	2,890	3,258	6,040	6,780	11,900	13,700
30	151	200	342	405	650	801	1,480	1,700	2,640	2,987	5,510	6,200	10,900	12,500
40	129	172	297	351	567	696	1,270	1,470	2,300	2,605	4,760	5,380	9,440	10,900
50	115	154	266	314	510	624	1,140	1,310	2,060	2,343	4,260	4,820	8,470	9,720
75	93	124	218	257	420	512	922	1,070	1,690	1,932	3,470	3,950	6,940	7,940
80	89	120	211	249	407	496	892	1,030	1,640	1,874	3,360	3,820	6,730	7,690
100	79	107	189	222	366	445	795	920	1,470	1,685	3,000	3,420	6,030	6,880
150	64	87	155	182	302	364	646	748	1,210	1,389	2,440	2,800	4,940	5,620
200	55	75	135	157	263	317	557	645	1,050	1,212	2,110	2,430	4,290	4,870
250	49	67	121	141	236	284	497	576	941	1,090	1,890	2,180	3,850	4,360
300	44	61	110	129	217	260	453	525	862	999	1,720	1,990	3,520	3,980
400	38	52	96	111	189	225	390	453	749	871	1,490	1,730	3,060	3,450
500	34	46	86	100	170	202	348	404	552	783	1,330	1,550	2,740	3,090

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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 the regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
2. CAUTION: Capacities shown in the table might exceed maximum capacity for a selected regulator. Consult with the 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 (feet) of tubing and  $n$  is the number of additional fittings and/or bends.
4. 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.
5. All table entries have been rounded to three significant digits.

**TABLE 402.4(19)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

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

TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	523	674	1,080	1,300	2,000	2,530	4,920	5,660	8,300	9,140	18,100	19,800	34,400	40,400
25	322	420	691	827	1,290	1,620	3,080	3,540	5,310	5,911	11,400	12,600	22,000	25,600
30	292	382	632	755	1,180	1,480	2,800	3,230	4,860	5,420	10,400	11,500	20,100	23,400
40	251	329	549	654	1,030	1,280	2,420	2,790	4,230	4,727	8,970	10,000	17,400	20,200
50	223	293	492	586	926	1,150	2,160	2,490	3,790	4,251	8,020	8,930	15,600	18,100
75	180	238	403	479	763	944	1,750	2,020	3,110	3,506	6,530	7,320	12,800	14,800
80	174	230	391	463	740	915	1,690	1,960	3,020	3,400	6,320	7,090	12,400	14,300
100	154	205	350	415	665	820	1,510	1,740	2,710	3,057	5,650	6,350	11,100	12,800
150	124	166	287	339	548	672	1,230	1,420	2,220	2,521	4,600	5,200	9,130	10,500
200	107	143	249	294	478	584	1,060	1,220	1,930	2,199	3,980	4,510	7,930	9,090
250	95	128	223	263	430	524	945	1,090	1,730	1,977	3,550	4,040	7,110	8,140
300	86	116	204	240	394	479	860	995	1,590	1,813	3,240	3,690	6,500	7,430
400	74	100	177	208	343	416	742	858	1,380	1,581	2,800	3,210	5,650	6,440
500	66	89	159	186	309	373	662	766	1,040	1,422	2,500	2,870	5,060	5,760

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds <sup>3</sup>/<sub>4</sub> psi, DO NOT USE THIS TABLE. Consult with the regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
2. CAUTION: Capacities shown in the table might exceed maximum capacity for a selected regulator. Consult with the 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 (feet) of tubing and  $n$  is the number of additional fittings and/or bends.
4. 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.
5. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.3 in. w.c.
<b>Specific Gravity</b>	0.60

PIPE SIZE (inch)								
Nominal OD	1/2	3/4	1	1 1/4	1 1/2	2	3	4
Designation	SDR 9	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Cubic Feet of Gas per Hour							
10	153	305	551	955	1,440	2,590	7,170	13,900
20	105	210	379	656	991	1,780	4,920	9,520
30	84	169	304	527	796	1,430	3,950	7,640
40	72	144	260	451	681	1,220	3,380	6,540
50	64	128	231	400	604	1,080	3,000	5,800
60	58	116	209	362	547	983	2,720	5,250
70	53	107	192	333	503	904	2,500	4,830
80	50	99	179	310	468	841	2,330	4,500
90	46	93	168	291	439	789	2,180	4,220
100	44	88	159	275	415	745	2,060	3,990
125	39	78	141	243	368	661	1,830	3,530
150	35	71	127	221	333	598	1,660	3,200
175	32	65	117	203	306	551	1,520	2,940
200	30	60	109	189	285	512	1,420	2,740
250	27	54	97	167	253	454	1,260	2,430
300	24	48	88	152	229	411	1,140	2,200
350	22	45	81	139	211	378	1,050	2,020
400	21	42	75	130	196	352	974	1,880
450	19	39	70	122	184	330	914	1,770
500	18	37	66	115	174	312	863	1,670

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

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

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2 psi
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	0.60

PIPE SIZE (inch)								
Nominal OD	1/2	3/4	1	1 1/4	1 1/2	2	3	4
Designation	SDR 9	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Cubic Feet of Gas per Hour							
10	201	403	726	1,260	1,900	3,410	9,450	18,260
20	138	277	499	865	1,310	2,350	6,490	12,550
30	111	222	401	695	1,050	1,880	5,210	10,080
40	95	190	343	594	898	1,610	4,460	8,630
50	84	169	304	527	796	1,430	3,950	7,640
60	76	153	276	477	721	1,300	3,580	6,930
70	70	140	254	439	663	1,190	3,300	6,370
80	65	131	236	409	617	1,110	3,070	5,930
90	61	123	221	383	579	1,040	2,880	5,560
100	58	116	209	362	547	983	2,720	5,250
125	51	103	185	321	485	871	2,410	4,660
150	46	93	168	291	439	789	2,180	4,220
175	43	86	154	268	404	726	2,010	3,880
200	40	80	144	249	376	675	1,870	3,610
250	35	71	127	221	333	598	1,660	3,200
300	32	64	115	200	302	542	1,500	2,900
350	29	59	106	184	278	499	1,380	2,670
400	27	55	99	171	258	464	1,280	2,480
450	26	51	93	160	242	435	1,200	2,330
500	24	48	88	152	229	411	1,140	2,200

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(22)  
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

PIPE SIZE (inch)								
Nominal OD	1/2	3/4	1	1 1/4	1 1/2	2	3	4
Designation	SDR 9	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Cubic Feet of Gas per Hour							
10	1,860	3,720	6,710	11,600	17,600	31,600	87,300	169,000
20	1,280	2,560	4,610	7,990	12,100	21,700	60,000	116,000
30	1,030	2,050	3,710	6,420	9,690	17,400	48,200	93,200
40	878	1,760	3,170	5,490	8,300	14,900	41,200	79,700
50	778	1,560	2,810	4,870	7,350	13,200	36,600	70,700
60	705	1,410	2,550	4,410	6,660	12,000	33,100	64,000
70	649	1,300	2,340	4,060	6,130	11,000	30,500	58,900
80	603	1,210	2,180	3,780	5,700	10,200	28,300	54,800
90	566	1,130	2,050	3,540	5,350	9,610	26,600	51,400
100	535	1,070	1,930	3,350	5,050	9,080	25,100	48,600
125	474	949	1,710	2,970	4,480	8,050	22,300	43,000
150	429	860	1,550	2,690	4,060	7,290	20,200	39,000
175	395	791	1,430	2,470	3,730	6,710	18,600	35,900
200	368	736	1,330	2,300	3,470	6,240	17,300	33,400
250	326	652	1,180	2,040	3,080	5,530	15,300	29,600
300	295	591	1,070	1,850	2,790	5,010	13,900	26,800
350	272	544	981	1,700	2,570	4,610	12,800	24,700
400	253	506	913	1,580	2,390	4,290	11,900	22,900
450	237	475	856	1,480	2,240	4,020	11,100	21,500
500	224	448	809	1,400	2,120	3,800	10,500	20,300
550	213	426	768	1,330	2,010	3,610	9,990	19,300
600	203	406	733	1,270	1,920	3,440	9,530	18,400
650	194	389	702	1,220	1,840	3,300	9,130	17,600
700	187	374	674	1,170	1,760	3,170	8,770	16,900
750	180	360	649	1,130	1,700	3,050	8,450	16,300
800	174	348	627	1,090	1,640	2,950	8,160	15,800
850	168	336	607	1,050	1,590	2,850	7,890	15,300
900	163	326	588	1,020	1,540	2,770	7,650	14,800
950	158	317	572	990	1,500	2,690	7,430	14,400
1,000	154	308	556	963	1,450	2,610	7,230	14,000
1,100	146	293	528	915	1,380	2,480	6,870	13,300
1,200	139	279	504	873	1,320	2,370	6,550	12,700
1,300	134	267	482	836	1,260	2,270	6,270	12,100
1,400	128	257	463	803	1,210	2,180	6,030	11,600
1,500	124	247	446	773	1,170	2,100	5,810	11,200
1,600	119	239	431	747	1,130	2,030	5,610	10,800
1,700	115	231	417	723	1,090	1,960	5,430	10,500
1,800	112	224	404	701	1,060	1,900	5,260	10,200
1,900	109	218	393	680	1,030	1,850	5,110	9,900
2,000	106	212	382	662	1,000	1,800	4,970	9,600

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(23)  
POLYETHYLENE PLASTIC TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2.0 psi
<b>Pressure Drop</b>	0.3 in. w.c.
<b>Specific Gravity</b>	0.60

Nominal OD	PLASTIC TUBING SIZE (CTS) (inch)	
	1/2	3/4
<b>Designation</b>	SDR 7	SDR 11
<b>Actual ID</b>	0.445	0.927
<b>Length (ft)</b>	<b>Capacity in Cubic Feet of Gas per Hour</b>	
10	54	372
20	37	256
30	30	205
40	26	176
50	23	156
60	21	141
70	19	130
80	18	121
90	17	113
100	16	107
125	14	95
150	13	86
175	12	79
200	11	74
225	10	69
250	NA	65
275	NA	62
300	NA	59
350	NA	54
400	NA	51
450	NA	47
500	NA	45

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. NA means a flow of less than 10 cfh.
2. All table entries have been rounded to three significant digits.

**TABLE 402.4(24)  
POLYETHYLENE PLASTIC TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	Less than 2.0 psi
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	0.60

Nominal OD	PLASTIC TUBING SIZE (CTS) (inch)	
	1/2	3/4
<b>Designation</b>	SDR 7	SDR 11
<b>Actual ID</b>	0.445	0.927
<b>Length (ft)</b>	<b>Capacity in Cubic Feet of Gas per Hour</b>	
10	72	490
20	49	337
30	39	271
40	34	232
50	30	205
60	27	186
70	25	171
80	23	159
90	22	149
100	21	141
125	18	125
150	17	113
175	15	104
200	14	97
225	13	91
250	12	86
275	11	82
300	11	78
350	10	72
400	NA	67
450	NA	63
500	NA	59

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. NA means a flow of less than 10 cfh.
2. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(25)  
SCHEDULE 40 METALLIC PIPE**

<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

INTENDED USE	Pipe sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator).								
	PIPE SIZE (inch)								
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	3,320	6,950	13,100	26,900	40,300	77,600	124,000	219,000	446,000
20	2,280	4,780	9,000	18,500	27,700	53,300	85,000	150,000	306,000
30	1,830	3,840	7,220	14,800	22,200	42,800	68,200	121,000	246,000
40	1,570	3,280	6,180	12,700	19,000	36,600	58,400	103,000	211,000
50	1,390	2,910	5,480	11,300	16,900	32,500	51,700	91,500	187,000
60	1,260	2,640	4,970	10,200	15,300	29,400	46,900	82,900	169,000
70	1,160	2,430	4,570	9,380	14,100	27,100	43,100	76,300	156,000
80	1,080	2,260	4,250	8,730	13,100	25,200	40,100	70,900	145,000
90	1,010	2,120	3,990	8,190	12,300	23,600	37,700	66,600	136,000
100	956	2,000	3,770	7,730	11,600	22,300	35,600	62,900	128,000
125	848	1,770	3,340	6,850	10,300	19,800	31,500	55,700	114,000
150	768	1,610	3,020	6,210	9,300	17,900	28,600	50,500	103,000
175	706	1,480	2,780	5,710	8,560	16,500	26,300	46,500	94,700
200	657	1,370	2,590	5,320	7,960	15,300	24,400	43,200	88,100
250	582	1,220	2,290	4,710	7,060	13,600	21,700	38,300	78,100
300	528	1,100	2,080	4,270	6,400	12,300	19,600	34,700	70,800
350	486	1,020	1,910	3,930	5,880	11,300	18,100	31,900	65,100
400	452	945	1,780	3,650	5,470	10,500	16,800	29,700	60,600
450	424	886	1,670	3,430	5,140	9,890	15,800	27,900	56,800
500	400	837	1,580	3,240	4,850	9,340	14,900	26,300	53,700
550	380	795	1,500	3,070	4,610	8,870	14,100	25,000	51,000
600	363	759	1,430	2,930	4,400	8,460	13,500	23,900	48,600
650	347	726	1,370	2,810	4,210	8,110	12,900	22,800	46,600
700	334	698	1,310	2,700	4,040	7,790	12,400	21,900	44,800
750	321	672	1,270	2,600	3,900	7,500	12,000	21,100	43,100
800	310	649	1,220	2,510	3,760	7,240	11,500	20,400	41,600
850	300	628	1,180	2,430	3,640	7,010	11,200	19,800	40,300
900	291	609	1,150	2,360	3,530	6,800	10,800	19,200	39,100
950	283	592	1,110	2,290	3,430	6,600	10,500	18,600	37,900
1,000	275	575	1,080	2,230	3,330	6,420	10,200	18,100	36,900
1,100	261	546	1,030	2,110	3,170	6,100	9,720	17,200	35,000
1,200	249	521	982	2,020	3,020	5,820	9,270	16,400	33,400
1,300	239	499	940	1,930	2,890	5,570	8,880	15,700	32,000
1,400	229	480	903	1,850	2,780	5,350	8,530	15,100	30,800
1,500	221	462	870	1,790	2,680	5,160	8,220	14,500	29,600
1,600	213	446	840	1,730	2,590	4,980	7,940	14,000	28,600
1,700	206	432	813	1,670	2,500	4,820	7,680	13,600	27,700
1,800	200	419	789	1,620	2,430	4,670	7,450	13,200	26,900
1,900	194	407	766	1,570	2,360	4,540	7,230	12,800	26,100
2,000	189	395	745	1,530	2,290	4,410	7,030	12,400	25,400

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(26)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	10.0 psi
<b>Pressure Drop</b>	3.0 psi
<b>Specific Gravity</b>	1.50

INTENDED USE	Pipe sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator).								
PIPE SIZE (inch)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	5,890	12,300	23,200	47,600	71,300	137,000	219,000	387,000	789,000
20	4,050	8,460	15,900	32,700	49,000	94,400	150,000	266,000	543,000
30	3,250	6,790	12,800	26,300	39,400	75,800	121,000	214,000	436,000
40	2,780	5,810	11,000	22,500	33,700	64,900	103,000	183,000	373,000
50	2,460	5,150	9,710	19,900	29,900	57,500	91,600	162,000	330,000
60	2,230	4,670	8,790	18,100	27,100	52,100	83,000	147,000	299,000
70	2,050	4,300	8,090	16,600	24,900	47,900	76,400	135,000	275,000
80	1,910	4,000	7,530	15,500	23,200	44,600	71,100	126,000	256,000
90	1,790	3,750	7,060	14,500	21,700	41,800	66,700	118,000	240,000
100	1,690	3,540	6,670	13,700	20,500	39,500	63,000	111,000	227,000
125	1,500	3,140	5,910	12,100	18,200	35,000	55,800	98,700	201,000
150	1,360	2,840	5,360	11,000	16,500	31,700	50,600	89,400	182,000
175	1,250	2,620	4,930	10,100	15,200	29,200	46,500	82,300	167,800
200	1,160	2,430	4,580	9,410	14,100	27,200	43,300	76,500	156,100
250	1,030	2,160	4,060	8,340	12,500	24,100	38,400	67,800	138,400
300	935	1,950	3,680	7,560	11,300	21,800	34,800	61,500	125,400
350	860	1,800	3,390	6,950	10,400	20,100	32,000	56,500	115,300
400	800	1,670	3,150	6,470	9,690	18,700	29,800	52,600	107,300
450	751	1,570	2,960	6,070	9,090	17,500	27,900	49,400	100,700
500	709	1,480	2,790	5,730	8,590	16,500	26,400	46,600	95,100
550	673	1,410	2,650	5,450	8,160	15,700	25,000	44,300	90,300
600	642	1,340	2,530	5,200	7,780	15,000	23,900	42,200	86,200
650	615	1,290	2,420	4,980	7,450	14,400	22,900	40,500	82,500
700	591	1,240	2,330	4,780	7,160	13,800	22,000	38,900	79,300
750	569	1,190	2,240	4,600	6,900	13,300	21,200	37,400	76,400
800	550	1,150	2,170	4,450	6,660	12,800	20,500	36,200	73,700
850	532	1,110	2,100	4,300	6,450	12,400	19,800	35,000	71,400
900	516	1,080	2,030	4,170	6,250	12,000	19,200	33,900	69,200
950	501	1,050	1,970	4,050	6,070	11,700	18,600	32,900	67,200
1,000	487	1,020	1,920	3,940	5,900	11,400	18,100	32,000	65,400
1,100	463	968	1,820	3,740	5,610	10,800	17,200	30,400	62,100
1,200	442	923	1,740	3,570	5,350	10,300	16,400	29,000	59,200
1,300	423	884	1,670	3,420	5,120	9,870	15,700	27,800	56,700
1,400	406	849	1,600	3,280	4,920	9,480	15,100	26,700	54,500
1,500	391	818	1,540	3,160	4,740	9,130	14,600	25,700	52,500
1,600	378	790	1,490	3,060	4,580	8,820	14,100	24,800	50,700
1,700	366	765	1,440	2,960	4,430	8,530	13,600	24,000	49,000
1,800	355	741	1,400	2,870	4,300	8,270	13,200	23,300	47,600
1,900	344	720	1,360	2,780	4,170	8,040	12,800	22,600	46,200
2,000	335	700	1,320	2,710	4,060	7,820	12,500	22,000	44,900

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.  
**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(27)  
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

INTENDED USE	Pipe sizing between 2 psig service and line pressure regulator.								
	PIPE SIZE (inch)								
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	2,680	5,590	10,500	21,600	32,400	62,400	99,500	176,000	359,000
20	1,840	3,850	7,240	14,900	22,300	42,900	68,400	121,000	247,000
30	1,480	3,090	5,820	11,900	17,900	34,500	54,900	97,100	198,000
40	1,260	2,640	4,980	10,200	15,300	29,500	47,000	83,100	170,000
50	1,120	2,340	4,410	9,060	13,600	26,100	41,700	73,700	150,000
60	1,010	2,120	4,000	8,210	12,300	23,700	37,700	66,700	136,000
70	934	1,950	3,680	7,550	11,300	21,800	34,700	61,400	125,000
80	869	1,820	3,420	7,020	10,500	20,300	32,300	57,100	116,000
90	815	1,700	3,210	6,590	9,880	19,000	30,300	53,600	109,000
100	770	1,610	3,030	6,230	9,330	18,000	28,600	50,600	103,000
125	682	1,430	2,690	5,520	8,270	15,900	25,400	44,900	91,500
150	618	1,290	2,440	5,000	7,490	14,400	23,000	40,700	82,900
175	569	1,190	2,240	4,600	6,890	13,300	21,200	37,400	76,300
200	529	1,110	2,080	4,280	6,410	12,300	19,700	34,800	71,000
250	469	981	1,850	3,790	5,680	10,900	17,400	30,800	62,900
300	425	889	1,670	3,440	5,150	9,920	15,800	27,900	57,000
350	391	817	1,540	3,160	4,740	9,120	14,500	25,700	52,400
400	364	760	1,430	2,940	4,410	8,490	13,500	23,900	48,800
450	341	714	1,340	2,760	4,130	7,960	12,700	22,400	45,800
500	322	674	1,270	2,610	3,910	7,520	12,000	21,200	43,200
550	306	640	1,210	2,480	3,710	7,140	11,400	20,100	41,100
600	292	611	1,150	2,360	3,540	6,820	10,900	19,200	39,200
650	280	585	1,100	2,260	3,390	6,530	10,400	18,400	37,500
700	269	562	1,060	2,170	3,260	6,270	9,990	17,700	36,000
750	259	541	1,020	2,090	3,140	6,040	9,630	17,000	34,700
800	250	523	985	2,020	3,030	5,830	9,300	16,400	33,500
850	242	506	953	1,960	2,930	5,640	9,000	15,900	32,400
900	235	490	924	1,900	2,840	5,470	8,720	15,400	31,500
950	228	476	897	1,840	2,760	5,310	8,470	15,000	30,500
1,000	222	463	873	1,790	2,680	5,170	8,240	14,600	29,700
1,100	210	440	829	1,700	2,550	4,910	7,830	13,800	28,200
1,200	201	420	791	1,620	2,430	4,680	7,470	13,200	26,900
1,300	192	402	757	1,550	2,330	4,490	7,150	12,600	25,800
1,400	185	386	727	1,490	2,240	4,310	6,870	12,100	24,800
1,500	178	372	701	1,440	2,160	4,150	6,620	11,700	23,900
1,600	172	359	677	1,390	2,080	4,010	6,390	11,300	23,000
1,700	166	348	655	1,340	2,010	3,880	6,180	10,900	22,300
1,800	161	337	635	1,300	1,950	3,760	6,000	10,600	21,600
1,900	157	327	617	1,270	1,900	3,650	5,820	10,300	21,000
2,000	152	318	600	1,230	1,840	3,550	5,660	10,000	20,400

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(28)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	11.0 in. w.c.
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	1.50

INTENDED USE	Pipe sizing between single- or second-stage (low pressure) regulator and appliance.								
	PIPE SIZE (inch)								
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	291	608	1,150	2,350	3,520	6,790	10,800	19,100	39,000
20	200	418	787	1,620	2,420	4,660	7,430	13,100	26,800
30	160	336	632	1,300	1,940	3,750	5,970	10,600	21,500
40	137	287	541	1,110	1,660	3,210	5,110	9,030	18,400
50	122	255	480	985	1,480	2,840	4,530	8,000	16,300
60	110	231	434	892	1,340	2,570	4,100	7,250	14,800
80	101	212	400	821	1,230	2,370	3,770	6,670	13,600
100	94	197	372	763	1,140	2,200	3,510	6,210	12,700
125	89	185	349	716	1,070	2,070	3,290	5,820	11,900
150	84	175	330	677	1,010	1,950	3,110	5,500	11,200
175	74	155	292	600	899	1,730	2,760	4,880	9,950
200	67	140	265	543	814	1,570	2,500	4,420	9,010
250	62	129	243	500	749	1,440	2,300	4,060	8,290
300	58	120	227	465	697	1,340	2,140	3,780	7,710
350	51	107	201	412	618	1,190	1,900	3,350	6,840
400	46	97	182	373	560	1,080	1,720	3,040	6,190
450	42	89	167	344	515	991	1,580	2,790	5,700
500	40	83	156	320	479	922	1,470	2,600	5,300
550	37	78	146	300	449	865	1,380	2,440	4,970
600	35	73	138	283	424	817	1,300	2,300	4,700
650	33	70	131	269	403	776	1,240	2,190	4,460
700	32	66	125	257	385	741	1,180	2,090	4,260
750	30	64	120	246	368	709	1,130	2,000	4,080
800	29	61	115	236	354	681	1,090	1,920	3,920
850	28	59	111	227	341	656	1,050	1,850	3,770
900	27	57	107	220	329	634	1,010	1,790	3,640
950	26	55	104	213	319	613	978	1,730	3,530
1,000	25	53	100	206	309	595	948	1,680	3,420
1,100	25	52	97	200	300	578	921	1,630	3,320
1,200	24	50	95	195	292	562	895	1,580	3,230
1,300	23	48	90	185	277	534	850	1,500	3,070
1,400	22	46	86	176	264	509	811	1,430	2,930
1,500	21	44	82	169	253	487	777	1,370	2,800
1,600	20	42	79	162	243	468	746	1,320	2,690
1,700	19	40	76	156	234	451	719	1,270	2,590
1,800	19	39	74	151	226	436	694	1,230	2,500
1,900	18	38	71	146	219	422	672	1,190	2,420
2,000	18	37	69	142	212	409	652	1,150	2,350

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(29)  
SEMIRIGID COPPER TUBING**

<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

INTENDED USE		Sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator).								
		TUBE SIZE (in.)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Thousands of Btu per Hour								
10	513	1,060	2,150	3,760	5,330	11,400	20,500	32,300	67,400	
20	352	727	1,480	2,580	3,670	7,830	14,100	22,200	46,300	
30	283	584	1,190	2,080	2,940	6,290	11,300	17,900	37,200	
40	242	500	1,020	1,780	2,520	5,380	9,690	15,300	31,800	
50	215	443	901	1,570	2,230	4,770	8,590	13,500	28,200	
60	194	401	816	1,430	2,020	4,320	7,780	12,300	25,600	
70	179	369	751	1,310	1,860	3,980	7,160	11,300	23,500	
80	166	343	699	1,220	1,730	3,700	6,660	10,500	21,900	
90	156	322	655	1,150	1,630	3,470	6,250	9,850	20,500	
100	147	304	619	1,080	1,540	3,280	5,900	9,310	19,400	
125	131	270	549	959	1,360	2,910	5,230	8,250	17,200	
150	118	244	497	869	1,230	2,630	4,740	7,470	15,600	
175	109	225	457	799	1,130	2,420	4,360	6,880	14,300	
200	101	209	426	744	1,060	2,250	4,060	6,400	13,300	
250	90	185	377	659	935	2,000	3,600	5,670	11,800	
300	81	168	342	597	847	1,810	3,260	5,140	10,700	
350	75	155	314	549	779	1,660	3,000	4,730	9,840	
400	70	144	292	511	725	1,550	2,790	4,400	9,160	
450	65	135	274	480	680	1,450	2,620	4,130	8,590	
500	62	127	259	453	643	1,370	2,470	3,900	8,120	
550	59	121	246	430	610	1,300	2,350	3,700	7,710	
600	56	115	235	410	582	1,240	2,240	3,530	7,350	
650	54	111	225	393	558	1,190	2,140	3,380	7,040	
700	51	106	216	378	536	1,140	2,060	3,250	6,770	
750	50	102	208	364	516	1,100	1,980	3,130	6,520	
800	48	99	201	351	498	1,060	1,920	3,020	6,290	
850	46	96	195	340	482	1,030	1,850	2,920	6,090	
900	45	93	189	330	468	1,000	1,800	2,840	5,910	
950	44	90	183	320	454	970	1,750	2,750	5,730	
1,000	42	88	178	311	442	944	1,700	2,680	5,580	
1,100	40	83	169	296	420	896	1,610	2,540	5,300	
1,200	38	79	161	282	400	855	1,540	2,430	5,050	
1,300	37	76	155	270	383	819	1,470	2,320	4,840	
1,400	35	73	148	260	368	787	1,420	2,230	4,650	
1,500	34	70	143	250	355	758	1,360	2,150	4,480	
1,600	33	68	138	241	343	732	1,320	2,080	4,330	
1,700	32	66	134	234	331	708	1,270	2,010	4,190	
1,800	31	64	130	227	321	687	1,240	1,950	4,060	
1,900	30	62	126	220	312	667	1,200	1,890	3,940	
2,000	29	60	122	214	304	648	1,170	1,840	3,830	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. All table entries have been rounded to three significant digits.

**TABLE 402.4(30)  
SEMIRIGID COPPER TUBING**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	11.0 in. w.c.
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	1.50

INTENDED USE		Sizing between single or second stage (low-pressure regulator) and appliance.								
		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Thousands of Btu per Hour								
10		45	93	188	329	467	997	1,800	2,830	5,890
20		31	64	129	226	321	685	1,230	1,950	4,050
30		25	51	104	182	258	550	991	1,560	3,250
40		21	44	89	155	220	471	848	1,340	2,780
50		19	39	79	138	195	417	752	1,180	2,470
60		17	35	71	125	177	378	681	1,070	2,240
70		16	32	66	115	163	348	626	988	2,060
80		15	30	61	107	152	324	583	919	1,910
90		14	28	57	100	142	304	547	862	1,800
100		13	27	54	95	134	287	517	814	1,700
125		11	24	48	84	119	254	458	722	1,500
150		10	21	44	76	108	230	415	654	1,360
175		NA	20	40	70	99	212	382	602	1,250
200		NA	18	37	65	92	197	355	560	1,170
250		NA	16	33	58	82	175	315	496	1,030
300		NA	15	30	52	74	158	285	449	936
350		NA	14	28	48	68	146	262	414	861
400		NA	13	26	45	63	136	244	385	801
450		NA	12	24	42	60	127	229	361	752
500		NA	11	23	40	56	120	216	341	710
550		NA	11	22	38	53	114	205	324	674
600		NA	10	21	36	51	109	196	309	643
650		NA	NA	20	34	49	104	188	296	616
700		NA	NA	19	33	47	100	180	284	592
750		NA	NA	18	32	45	96	174	274	570
800		NA	NA	18	31	44	93	168	264	551
850		NA	NA	17	30	42	90	162	256	533
900		NA	NA	17	29	41	87	157	248	517
950		NA	NA	16	28	40	85	153	241	502
1,000		NA	NA	16	27	39	83	149	234	488
1,100		NA	NA	15	26	37	78	141	223	464
1,200		NA	NA	14	25	35	75	135	212	442
1,300		NA	NA	14	24	34	72	129	203	423
1,400		NA	NA	13	23	32	69	124	195	407
1,500		NA	NA	13	22	31	66	119	188	392
1,600		NA	NA	12	21	30	64	115	182	378
1,700		NA	NA	12	20	29	62	112	176	366
1,800		NA	NA	11	20	28	60	108	170	355
1,900		NA	NA	11	19	27	58	105	166	345
2,000		NA	NA	11	19	27	57	102	161	335

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. NA means a flow of less than 10,000 Btu/hr.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(31)  
SEMIRIGID 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

INTENDED USE		Tube sizing between 2 psig service and line pressure regulator.								
		TUBE SIZE (inch)								
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Thousands of Btu per Hour								
10	413	852	1,730	3,030	4,300	9,170	16,500	26,000	54,200	
20	284	585	1,190	2,080	2,950	6,310	11,400	17,900	37,300	
30	228	470	956	1,670	2,370	5,060	9,120	14,400	29,900	
40	195	402	818	1,430	2,030	4,330	7,800	12,300	25,600	
50	173	356	725	1,270	1,800	3,840	6,920	10,900	22,700	
60	157	323	657	1,150	1,630	3,480	6,270	9,880	20,600	
70	144	297	605	1,060	1,500	3,200	5,760	9,090	18,900	
80	134	276	562	983	1,390	2,980	5,360	8,450	17,600	
90	126	259	528	922	1,310	2,790	5,030	7,930	16,500	
100	119	245	498	871	1,240	2,640	4,750	7,490	15,600	
125	105	217	442	772	1,100	2,340	4,210	6,640	13,800	
150	95	197	400	700	992	2,120	3,820	6,020	12,500	
175	88	181	368	644	913	1,950	3,510	5,540	11,500	
200	82	168	343	599	849	1,810	3,270	5,150	10,700	
250	72	149	304	531	753	1,610	2,900	4,560	9,510	
300	66	135	275	481	682	1,460	2,620	4,140	8,610	
350	60	124	253	442	628	1,340	2,410	3,800	7,920	
400	56	116	235	411	584	1,250	2,250	3,540	7,370	
450	53	109	221	386	548	1,170	2,110	3,320	6,920	
500	50	103	209	365	517	1,110	1,990	3,140	6,530	
550	47	97	198	346	491	1,050	1,890	2,980	6,210	
600	45	93	189	330	469	1,000	1,800	2,840	5,920	
650	43	89	181	316	449	959	1,730	2,720	5,670	
700	41	86	174	304	431	921	1,660	2,620	5,450	
750	40	82	168	293	415	888	1,600	2,520	5,250	
800	39	80	162	283	401	857	1,540	2,430	5,070	
850	37	77	157	274	388	829	1,490	2,350	4,900	
900	36	75	152	265	376	804	1,450	2,280	4,750	
950	35	72	147	258	366	781	1,410	2,220	4,620	
1,000	34	71	143	251	356	760	1,370	2,160	4,490	
1,100	32	67	136	238	338	721	1,300	2,050	4,270	
1,200	31	64	130	227	322	688	1,240	1,950	4,070	
1,300	30	61	124	217	309	659	1,190	1,870	3,900	
1,400	28	59	120	209	296	633	1,140	1,800	3,740	
1,500	27	57	115	201	286	610	1,100	1,730	3,610	
1,600	26	55	111	194	276	589	1,060	1,670	3,480	
1,700	26	53	108	188	267	570	1,030	1,620	3,370	
1,800	25	51	104	182	259	553	1,000	1,570	3,270	
1,900	24	50	101	177	251	537	966	1,520	3,170	
2,000	23	48	99	172	244	522	940	1,480	3,090	

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**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. All table entries have been rounded to three significant digits.

**TABLE 402.4(32)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	11.0 in. w.c.
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	1.50

INTENDED USE: SIZING BETWEEN SINGLE OR SECOND STAGE (Low Pressure) REGULATOR AND THE APPLIANCE SHUTOFF VALVE														
TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Thousands of Btu per Hour													
5	72	99	181	211	355	426	744	863	1,420	1,638	2,830	3,270	5,780	6,550
10	50	69	129	150	254	303	521	605	971	1,179	1,990	2,320	4,110	4,640
15	39	55	104	121	208	248	422	490	775	972	1,620	1,900	3,370	3,790
20	34	49	91	106	183	216	365	425	661	847	1,400	1,650	2,930	3,290
25	30	42	82	94	164	192	325	379	583	762	1,250	1,480	2,630	2,940
30	28	39	74	87	151	177	297	344	528	698	1,140	1,350	2,400	2,680
40	23	33	64	74	131	153	256	297	449	610	988	1,170	2,090	2,330
50	20	30	58	66	118	137	227	265	397	548	884	1,050	1,870	2,080
60	19	26	53	60	107	126	207	241	359	502	805	961	1,710	1,900
70	17	25	49	57	99	117	191	222	330	466	745	890	1,590	1,760
80	15	23	45	52	94	109	178	208	307	438	696	833	1,490	1,650
90	15	22	44	50	90	102	169	197	286	414	656	787	1,400	1,550
100	14	20	41	47	85	98	159	186	270	393	621	746	1,330	1,480
150	11	15	31	36	66	75	123	143	217	324	506	611	1,090	1,210
200	9	14	28	33	60	69	112	129	183	283	438	531	948	1,050
250	8	12	25	30	53	61	99	117	163	254	390	476	850	934
300	8	11	23	26	50	57	90	107	147	234	357	434	777	854

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Notes:**

1. 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.
2. 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.
3. All table entries have been rounded to three significant digits.

**GAS PIPING INSTALLATIONS**

**TABLE 402.4(33)  
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

INTENDED USE: SIZING BETWEEN 2 PSI SERVICE AND THE LINE PRESSURE REGULATOR														
TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Thousands of Btu per Hour													
10	426	558	927	1,110	1,740	2,170	4,100	4,720	7,130	7,958	15,200	16,800	29,400	34,200
25	262	347	591	701	1,120	1,380	2,560	2,950	4,560	5,147	9,550	10,700	18,800	21,700
30	238	316	540	640	1,030	1,270	2,330	2,690	4,180	4,719	8,710	9,790	17,200	19,800
40	203	271	469	554	896	1,100	2,010	2,320	3,630	4,116	7,530	8,500	14,900	17,200
50	181	243	420	496	806	986	1,790	2,070	3,260	3,702	6,730	7,610	13,400	15,400
75	147	196	344	406	663	809	1,460	1,690	2,680	3,053	5,480	6,230	11,000	12,600
80	140	189	333	393	643	768	1,410	1,630	2,590	2,961	5,300	6,040	10,600	12,200
100	124	169	298	350	578	703	1,260	1,450	2,330	2,662	4,740	5,410	9,530	10,900
150	101	137	245	287	477	575	1,020	1,180	1,910	2,195	3,860	4,430	7,810	8,890
200	86	118	213	248	415	501	880	1,020	1,660	1,915	3,340	3,840	6,780	7,710
250	77	105	191	222	373	448	785	910	1,490	1,722	2,980	3,440	6,080	6,900
300	69	96	173	203	343	411	716	829	1,360	1,578	2,720	3,150	5,560	6,300
400	60	82	151	175	298	355	616	716	1,160	1,376	2,350	2,730	4,830	5,460
500	53	72	135	158	268	319	550	638	1,030	1,237	2,100	2,450	4,330	4,880

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895kPa, 1-inch water column = 0.2488 kPa,  
1 British thermal unit per hour = 0.293 1 W, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 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 the regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
2. CAUTION: Capacities shown in the table might exceed maximum capacity for a selected regulator. Consult with the 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 (feet) of tubing and  $n$  is the number of additional fittings and/or bends.
4. 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.
5. All table entries have been rounded to three significant digits.

**TABLE 402.4(34)  
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

TUBE SIZE (EHD)														
Flow Designation	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Thousands of Btu per Hour													
10	826	1,070	1,710	2,060	3,150	4,000	7,830	8,950	13,100	14,441	28,600	31,200	54,400	63,800
25	509	664	1,090	1,310	2,040	2,550	4,860	5,600	8,400	9,339	18,000	19,900	34,700	40,400
30	461	603	999	1,190	1,870	2,340	4,430	5,100	7,680	8,564	16,400	18,200	31,700	36,900
40	396	520	867	1,030	1,630	2,030	3,820	4,400	6,680	7,469	14,200	15,800	27,600	32,000
50	352	463	777	926	1,460	1,820	3,410	3,930	5,990	6,717	12,700	14,100	24,700	28,600
75	284	376	637	757	1,210	1,490	2,770	3,190	4,920	5,539	10,300	11,600	20,300	23,400
80	275	363	618	731	1,170	1,450	2,680	3,090	4,770	5,372	9,990	11,200	19,600	22,700
100	243	324	553	656	1,050	1,300	2,390	2,760	4,280	4,830	8,930	10,000	17,600	20,300
150	196	262	453	535	866	1,060	1,940	2,240	3,510	3,983	7,270	8,210	14,400	16,600
200	169	226	393	464	755	923	1,680	1,930	3,050	3,474	6,290	7,130	12,500	14,400
250	150	202	352	415	679	828	1,490	1,730	2,740	3,124	5,620	6,390	11,200	12,900
300	136	183	322	379	622	757	1,360	1,570	2,510	2,865	5,120	5,840	10,300	11,700
400	117	158	279	328	542	657	1,170	1,360	2,180	2,498	4,430	5,070	8,920	10,200
500	104	140	251	294	488	589	1,050	1,210	1,950	2,247	3,960	4,540	8,000	9,110

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 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 the regulator manufacturer for pressure drops and capacity factors. Pressure drop across regulator may vary with the flow rate.
2. CAUTION: Capacities shown in the table might exceed maximum capacity of selected regulator. Consult with the 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.
4. 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.
5. All table entries have been rounded to three significant digits.

GAS PIPING INSTALLATIONS

**TABLE 402.4(35)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	11.0 in. w.c.
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	1.50

INTENDED USE	PE pipe sizing between integral two-stage regulator at tank or second stage (low-pressure regulator) and building.							
PIPE SIZE (inch)								
Nominal OD	1/2	3/4	1	1 1/4	1 1/2	2	3	4
Designation	SDR 9	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Thousands of Btu per Hour							
10	340	680	1,230	2,130	3,210	5,770	16,000	30,900
20	233	468	844	1,460	2,210	3,970	11,000	21,200
30	187	375	677	1,170	1,770	3,180	8,810	17,000
40	160	321	580	1,000	1,520	2,730	7,540	14,600
50	142	285	514	890	1,340	2,420	6,680	12,900
60	129	258	466	807	1,220	2,190	6,050	11,700
70	119	237	428	742	1,120	2,010	5,570	10,800
80	110	221	398	690	1,040	1,870	5,180	10,000
90	103	207	374	648	978	1,760	4,860	9,400
100	98	196	353	612	924	1,660	4,590	8,900
125	87	173	313	542	819	1,470	4,070	7,900
150	78	157	284	491	742	1,330	3,690	7,130
175	72	145	261	452	683	1,230	3,390	6,560
200	67	135	243	420	635	1,140	3,160	6,100
250	60	119	215	373	563	1,010	2,800	5,410
300	54	108	195	338	510	916	2,530	4,900
350	50	99	179	311	469	843	2,330	4,510
400	46	92	167	289	436	784	2,170	4,190
450	43	87	157	271	409	736	2,040	3,930
500	41	82	148	256	387	695	1,920	3,720

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

**TABLE 402.4(36)  
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

INTENDED USE	PE pipe sizing between 2 psig service regulator and line pressure regulator.							
	PIPE SIZE (inch)							
Nominal OD	1/2	3/4	1	1 1/4	1 1/2	2	3	4
Designation	SDR 9	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
Length (ft)	Capacity in Thousands of Btu per Hour							
10	3,130	6,260	11,300	19,600	29,500	53,100	147,000	284,000
20	2,150	4,300	7,760	13,400	20,300	36,500	101,000	195,000
30	1,730	3,450	6,230	10,800	16,300	29,300	81,100	157,000
40	1,480	2,960	5,330	9,240	14,000	25,100	69,400	134,100
50	1,310	2,620	4,730	8,190	12,400	22,200	61,500	119,000
60	1,190	2,370	4,280	7,420	11,200	20,100	55,700	108,000
70	1,090	2,180	3,940	6,830	10,300	18,500	51,300	99,100
80	1,010	2,030	3,670	6,350	9,590	17,200	47,700	92,200
90	952	1,910	3,440	5,960	9,000	16,200	44,700	86,500
100	899	1,800	3,250	5,630	8,500	15,300	42,300	81,700
125	797	1,600	2,880	4,990	7,530	13,500	37,500	72,400
150	722	1,450	2,610	4,520	6,830	12,300	33,900	65,600
175	664	1,330	2,400	4,160	6,280	11,300	31,200	60,300
200	618	1,240	2,230	3,870	5,840	10,500	29,000	56,100
250	548	1,100	1,980	3,430	5,180	9,300	25,700	49,800
300	496	994	1,790	3,110	4,690	8,430	23,300	45,100
350	457	914	1,650	2,860	4,320	7,760	21,500	41,500
400	425	851	1,530	2,660	4,020	7,220	12,000	38,600
450	399	798	1,440	2,500	3,770	6,770	18,700	36,200
500	377	754	1,360	2,360	3,560	6,390	17,700	34,200
550	358	716	1,290	2,240	3,380	6,070	16,800	32,500
600	341	683	1,230	2,140	3,220	5,790	16,000	31,000
650	327	654	1,180	2,040	3,090	5,550	15,400	29,700
700	314	628	1,130	1,960	2,970	5,330	14,700	28,500
750	302	605	1,090	1,890	2,860	5,140	14,200	27,500
800	292	585	1,050	1,830	2,760	4,960	13,700	26,500
850	283	566	1,020	1,770	2,670	4,800	13,300	25,700
900	274	549	990	1,710	2,590	4,650	12,900	24,900
950	266	533	961	1,670	2,520	4,520	12,500	24,200
1,000	259	518	935	1,620	2,450	4,400	12,200	23,500
1,100	246	492	888	1,540	2,320	4,170	11,500	22,300
1,200	234	470	847	1,470	2,220	3,980	11,000	21,300
1,300	225	450	811	1,410	2,120	3,810	10,600	20,400
1,400	216	432	779	1,350	2,040	3,660	10,100	19,600
1,500	208	416	751	1,300	1,960	3,530	9,760	18,900
1,600	201	402	725	1,260	1,900	3,410	9,430	18,200
1,700	194	389	702	1,220	1,840	3,300	9,130	17,600
1,800	188	377	680	1,180	1,780	3,200	8,850	17,100
1,900	183	366	661	1,140	1,730	3,110	8,590	16,600
2,000	178	356	643	1,110	1,680	3,020	8,360	16,200

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 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.01745 rad.

**Note:** All table entries have been rounded to three significant digits.

GAS PIPING INSTALLATIONS

**TABLE 402.4(37)  
POLYETHYLENE PLASTIC TUBING**

<b>Gas</b>	Undiluted Propane
<b>Inlet Pressure</b>	11.0 in. w.c.
<b>Pressure Drop</b>	0.5 in. w.c.
<b>Specific Gravity</b>	1.50

INTENDED USE	PE pipe sizing between integral two-stage regulator at tank or second stage (low-pressure regulator) and building.	
	Plastic Tubing Size (CTS) (inch)	
<b>Nominal OD</b>	1/2	1
<b>Designation</b>	SDR 7	SDR 11
<b>Actual ID</b>	0.445	0.927
<b>Length (ft)</b>	Capacity in Cubic Feet of Gas per Hour	
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
450	15	106
500	15	100

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 = 0.293 1 W,  
 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 degree = 0.0 1745 rad.

**Note:** All table entries have been rounded to three significant digits.

**402.6 Maximum design operating pressure.** The maximum design operating pressure for *pipng* 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 *pipng* system is welded.
2. The *pipng* is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
3. The *pipng* 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 rooms.
4. The *pipng* is a temporary installation for buildings under construction.
5. The piping serves appliances or *equipment* used for agricultural purposes.
6. The *pipng* system is an LP-gas *pipng* system with a design operating pressure greater than 20 psi (137.9 kPa) and complies with NFPA 58.

Plans for piping systems over 5 psig (34.5 kPa) shall be designed by an engineer licensed to practice in the State of Washington, and shall not be installed until approved by the code official.

**402.6.1 Liquefied petroleum gas systems.** LP-gas 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.

## SECTION 403 (IFGS) PIPING MATERIALS

**403.1 General.** Materials used for *pipng* 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 and shall be *approved* by the code official.

**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 B36.10, 10M;

2. ASTM A 53/A53M; 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.

**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 *listed* in accordance with ANSI LC 1/CSA 6.26.

**403.6 Plastic pipe, tubing and fittings.** Polyethylene plastic pipe, tubing and fittings used to supply fuel gas shall conform to the 2009 edition of ASTM D 2513. Such pipe shall be marked "Gas" and "ASTM D 2513."

Plastic pipe, tubing and fittings, other than polyethylene, shall be identified and conform to the 2008 edition of ASTM D 2513. Such 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

## GAS PIPING INSTALLATIONS

used, and shall be designed and certified to meet the requirements of Category I of the 2009 edition 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.

**403.6.3 Regulator vent piping.** Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to ANSI/UL 651. PVC vent *piping* shall not be installed indoors.

**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. No gas piping shall be strained or pinched, and no appliance shall be supported by, or develop any strain or stress on, its supply piping.

**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.

**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.

**403.9.3 Thread joint compounds.** Thread joint compounds 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.

**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.

**403.10.1.1 Welding.** All welding in the piping system shall be done in accordance with ASME Boiler and Pressure Vessel Code Section IX.

**403.10.2 Tubing joints.** Tubing joints shall be made with *approved* gas tubing fittings, brazed with a material having a melting point in excess of 1,000°F (538°C) or made with press-connect fittings complying with ANSI LC-4. 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 shall comply with the following:

1. Threaded fittings in sizes larger than 4 inches (102 mm) shall not be used except where *approved*.
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 except where *approved*.
  - 5.5. Fittings in sizes 6 inches (152 mm) and larger shall not be used except where *approved*.
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; installed or braced to prevent separation of the joint by gas pressure or external physical damage; and shall be *approved*.

**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 *pipng* 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 *pipng* 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 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 *pipng* joints and fittings for use in liquefied petroleum gas *pipng* systems shall be in accordance with NFPA 58.

**403.12 Flanges.** All flanges shall comply with ASME B16.1, ASME B16.20 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 *pipng* system, and the chemical constituents of the gas being conducted, without change to its chemical and physical properties. The effects of fire exposure to the joint shall be consid-

ered in choosing material. Acceptable materials include metal (plain or corrugated), composition, 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 Installation of materials.** All materials used shall be installed in strict accordance with the standards under which the materials are accepted and approved. In the absence of such installation procedures, the manufacturer's instructions shall be followed. Where the requirements of referenced standards or manufacturer's instructions do not conform to minimum provisions of this code, the provisions of this code shall apply.

**404.2 CSST.** CSST piping systems shall be installed in accordance with the terms of their approval, the conditions of listing, the manufacturer's instructions and this code.

**404.3 Prohibited locations.** *Pipng* shall not be installed in or through a ducted supply, return or exhaust, or a clothes chute, chimney or gas vent, dumbwaiter or elevator shaft. *Pipng* installed downstream of the *point of delivery* shall not extend through any townhouse unit other than the unit served by such *pipng*.

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

**404.5 Piping in concealed locations.** Portions of a *pipng* 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.

**404.6 Underground penetrations prohibited.** Gas *pipng* shall not penetrate building foundation walls at any point below grade. Gas *pipng* shall enter and exit a building at a point above grade and the annular space between the pipe and the wall shall be sealed.

**404.7 Protection against physical damage.** In concealed locations, where *pipng* other than black or galvanized steel is installed through holes or notches in wood studs, joists, rafters or similar members less than 1½ inches (38 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (1.463 mm) (No. 16 gage) 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.

**404.8 Piping in solid floors.** *Pipng* in solid floors shall be laid in channels in the floor and covered in a manner that will allow *access* to the *pipng* with a minimum amount of damage to the building. Where such *pipng* is subject to exposure

## GAS PIPING INSTALLATIONS

to excessive moisture or corrosive substances, the *pipng* shall be protected in an *approved* manner. As an alternative to installation in channels, the *pipng* shall be installed in a conduit of Schedule 40 steel, wrought iron, PVC or ABS pipe in accordance with Section 404.8.1 or 404.8.2.

### 404.8.1 Conduit with one end terminating outdoors.

The 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 *pipng* shall be sealed to prevent the possible entrance of any gas leakage. The conduit shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor. If 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 prevent the entrance of water and insects.

### 404.8.2 Conduit with both ends terminating indoors.

Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. The conduit shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor.

**404.9 Above-ground outdoor piping.** All *pipng* installed outdoors shall be elevated not less than 3 $\frac{1}{2}$  inches (152 mm) above ground and where installed across roof surfaces, shall be elevated not less than 3 $\frac{1}{2}$  inches (152 mm) above the roof surface. *Pipng* 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 *pipng* shall also be protected against corrosion by coating or wrapping with an inert material. Where *pipng* is encased in a protective pipe sleeve, the annular space between the *pipng* and the sleeve shall be sealed.

**404.10 Isolation.** Metallic *pipng* and metallic tubing that conveys fuel gas from an LP-gas storage container shall be provided with an *approved* dielectric fitting to electrically isolate the underground portion of the pipe or tube from the above ground portion that enters a building. Such dielectric fitting shall be installed above ground, outdoors.

**404.11 Protection against corrosion.** 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 *pipng* underground. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. *Pipng* shall not be laid in contact with cinders.

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

**404.11.2 Protective coatings and wrapping.** Pipe protective coatings and wrappings shall be *approved* for the application and shall be factory applied.

**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.

**404.12 Minimum burial depth.** Underground *pipng* systems shall be installed a minimum depth of 12 inches (305 mm) below grade, except as provided for in Section 404.12.1.

**404.12.1 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.

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

**404.14 Piping underground beneath buildings.** *Pipng* installed underground beneath buildings is prohibited except where the *pipng* is encased in a conduit of wrought iron, plastic pipe, steel pipe or other *approved* conduit material designed to withstand the superimposed loads. The conduit shall be protected from corrosion in accordance with Section 404.11 and shall be installed in accordance with Section 404.14.1 or 404.14.2.

### 404.14.1 Conduit with one end terminating outdoors.

The 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 *pipng* shall be sealed to prevent the possible entrance of any gas leakage. The conduit shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor. 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 of the building, shall be vented above grade to the outdoors and shall be installed so as to prevent the entrance of water and insects.

### 404.14.2 Conduit with both ends terminating indoors.

Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. The conduit shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor.

**404.15 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.

**404.16 Location of outlets.** The unthreaded portion of *pipng 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 *pipng* 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.

**404.17 Plastic pipe.** The installation of plastic pipe shall comply with Sections 404.17.1 through 404.17.3.

**404.17.1 Limitations.** Plastic pipe shall be installed outdoors 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 *pipng* material for fuel gas use in buildings.
3. Plastic pipe shall be permitted under outdoor patio, walkway and driveway slabs provided that the burial depth complies with Section 404.12.

**404.17.2 Connections.** Connections made outdoors and underground between metallic and plastic *pipng* shall be made only with transition fittings conforming with ASTM D 2513 Category I or ASTM F 1973.

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

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

**Exceptions:**

1. Approved gas filters.
2. An approved fitting or device where the gas piping system has been sized to accommodate the pressure drop of the fitting or device.

**404.19 Testing of piping.** Before any system of *pipng* is put in service or concealed, it shall be tested to ensure that it is gas tight. Testing, inspection and purging of *pipng* 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 tools 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 *pipng* manufacturer specifies the use of special bending tools or procedures, such tools or procedures shall be used.

**405.4 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 *pipng* installations shall be visually 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.

**406.1.2 Repairs and additions.** In the event repairs or additions are made after the pressure test, the affected *pipng* shall be tested. Minor repairs and additions, as determined by the code official, 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.

**406.1.3 New branches.** Where new branches are installed to new *appliances*, only the newly installed branches shall be required to be pressure tested. Connections between the new *pipng* and the existing *pipng* shall be tested with a

noncorrosive leak-detecting fluid or other *approved* leak-detecting methods.

**406.1.4 Section testing.** A *pipng* system shall be permitted to be tested as a complete unit or in sections. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the *pipng* system and test medium in an adjacent section, unless two valves are installed in series with a valved “telltale” located between these valves. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve-closing mechanism, is designed to safely withstand the test pressure.

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

**406.1.6 Pipe clearing.** Prior to testing, the interior of the pipe shall be cleared of all foreign material.

**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 Appliance and equipment isolation.** *Appliances* and *equipment* that are not to be included in the test shall be either disconnected from the *pipng* 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 Appliance and equipment disconnection.** Where the *pipng* system is connected to *appliances* or *equipment* designed for operating pressures of less than the test pressure, such *appliances* or *equipment* shall be isolated from the *pipng* system by disconnecting them and capping the outlet(s).

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

**406.3.5 Testing precautions.** All testing of *pipng* systems shall be performed in a manner that protects the safety of employees and the public during the test.

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

**406.4.1 Test pressure.** The test pressure to be used shall be no less than 1½ times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the *pipng* greater than 50 percent of the specified minimum yield strength of the pipe.

**406.4.2 Test duration.** Test duration shall be not less than ½ hour for each 500 cubic feet (14 m³) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet (0.28 m³) or a system in a single-family dwelling, the test duration shall be not less than 10 minutes. The duration of the test shall not be required to exceed 24 hours.

**406.5 Detection of leaks and defects.** The *pipng* 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 *pipng* system shall be repaired or replaced and retested.

**406.6 Piping system and equipment leakage check.** Leakage checking 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 *pipng* systems that have been pressure tested in accordance with Section 406.

**406.6.2 Before turning gas on.** During the process of turning gas on into a system of new gas *pipng*, 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 Leak check.** 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 *pipng* system shall be checked for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

**406.6.4 Placing appliances and equipment in operation.** *Appliances* and *equipment* shall not be placed in operation until after the *pipng* system has been checked for leakage in accordance with Section 406.6.3, the piping system has been purged in accordance with Section 406.7 and the connections to the appliances have been checked for leakage.

**406.7 Purging.** The purging of piping shall be in accordance with Sections 406.7.1 through 406.7.3.

**406.7.1 Piping systems required to be purged outdoors.** The purging of piping systems shall be in accordance with the provisions of Sections 406.7.1.1 through 406.7.1.4 where the piping system meets either of the following:

1. The design operating gas pressure is greater than 2 psig (13.79 kPa).
2. The piping being purged contains one or more sections of pipe or tubing meeting the size and length criteria of Table 406.7.1.1.

**406.7.1.1 Removal from service.** Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented in accordance with Section 406.7.1.3. Where gas piping meeting the criteria of Table 406.7.1.1 is removed from service, the residual fuel gas in the piping shall be displaced with an inert gas.

**TABLE 406.7.1.1  
SIZE AND LENGTH OF PIPING**

NOMINAL PIPE SIZE (inches) <sup>a</sup>	LENGTH OF PIPING (feet)
≥ 2½ < 3	> 50
≥ 3 < 4	> 30
≥ 4 < 6	> 15
≥ 6 < 8	> 10
≥ 8	Any length

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

a. CSST EHD size of 62 is equivalent to nominal 2-inch pipe or tubing size.

**406.7.1.2 Placing in operation.** Where gas piping containing air and meeting the criteria of Table 406.7.1.1 is placed in operation, the air in the piping shall first be displaced with an inert gas. The inert gas shall then be displaced with fuel gas in accordance with Section 406.7.1.3.

**406.7.1.3 Outdoor discharge of purged gases.** The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location. Purging operations shall comply with all of the following requirements:

1. The point of discharge shall be controlled with a shutoff valve.
2. The point of discharge shall be located at least 10 feet (3048 mm) from sources of ignition, at least 10 feet (3048 mm) from building openings and at least 25 feet (7620 mm) from mechanical air intake openings.
3. During discharge, the open point of discharge shall be continuously attended and monitored with a combustible gas indicator that complies with Section 406.7.1.4.
4. Purging operations introducing fuel gas shall be stopped when 90 percent fuel gas by volume is detected within the pipe.
5. Persons not involved in the purging operations shall be evacuated from all areas within 10 feet (3048 mm) of the point of discharge.

**406.7.1.4 Combustible gas indicator.** Combustible gas indicators shall be listed and shall be calibrated in accordance with the manufacturer’s instructions. Combustible gas indicators shall numerically display a volume scale from zero percent to 100 percent in 1 percent or smaller increments.

**406.7.2 Piping systems allowed to be purged indoors or outdoors.** The purging of piping systems shall be in accordance with the provisions of Section 406.7.2.1 where the piping system meets both of the following:

1. The design operating gas pressure is 2 psig (13.79 kPa) or less.
2. The piping being purged is constructed entirely from pipe or tubing not meeting the size and length criteria of Table 406.7.1.1.

**406.7.2.1 Purging procedure.** The piping system shall be purged in accordance with one or more of the following:

1. The piping shall be purged with fuel gas and shall discharge to the outdoors.
2. The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through an appliance burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.
3. The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.
4. The piping shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector in accordance with Section 406.7.2.2. Purging shall be stopped when fuel gas is detected.
5. The piping shall be purged by the gas supplier in accordance with written procedures.

**406.7.2.2 Combustible gas detector.** Combustible gas detectors shall be listed and shall be calibrated or tested in accordance with the manufacturer’s instructions. Combustible gas detectors shall be capable of indicating the presence of fuel gas.

**406.7.3 Purging appliances and equipment.** After the piping system has been placed in operation, appliances and equipment shall be purged before being placed into operation.

**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 metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers or building structural components, suitable for the size of *piping*, of adequate strength and qual-

**GAS PIPING INSTALLATIONS**

ity, and located at intervals so as to prevent or damp out excessive vibration. *Piping* shall be anchored to prevent undue strains on connected *appliances* and 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.** *Piping* for other than dry gas conditions shall be sloped not less than 1/4 inch in 15 feet (6.3 mm in 4572 mm) to prevent traps.

**408.2 Drips.** Where wet gas exists, a drip shall be provided at any point in the line of pipe where condensate could collect. A drip shall also be provided at the outlet of the meter and shall be installed so as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before the condensate will run back into the meter.

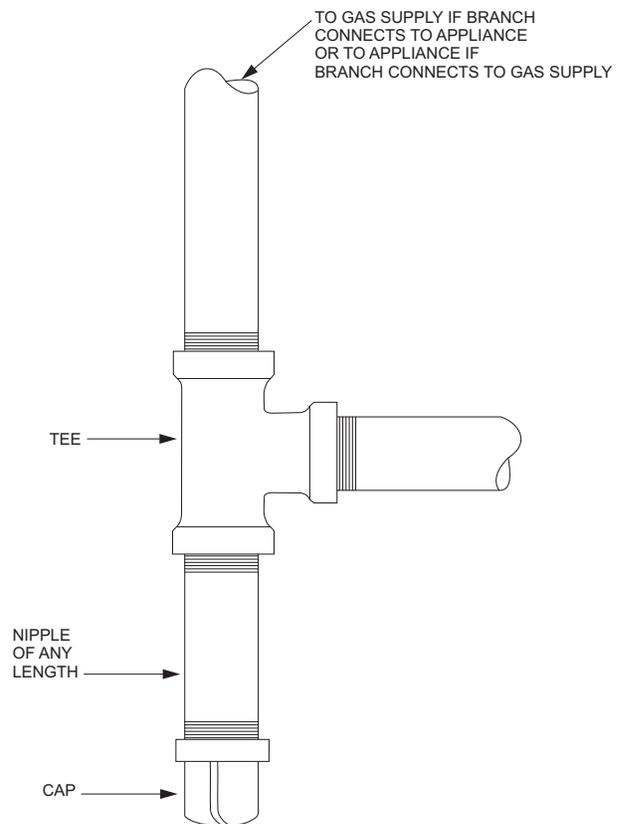
**408.3 Location of drips.** Drips shall be provided with ready access to permit cleaning or emptying. A drip shall not be located where the condensate is subject to freezing.

**408.4 Sediment trap.** Where a sediment trap is not incorporated as part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical. The sediment trap shall be either a tee fitting having a capped nipple of any length installed vertically in the bottommost opening of the tee as illustrated in Figure 408.4 or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative vented appliances for installation in vented fireplaces, gas fireplaces, 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; shall be constructed of materials compatible with the *piping*; and shall comply with the standard



**FIGURE 408.4  
METHOD OF INSTALLING A TEE FITTING SEDIMENT TRAP**

that is applicable for the pressure and application, in accordance with Table 409.1.1.

**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.** Every meter shall be equipped with a shutoff valve located on the supply side of the meter.

**409.3 Shutoff valves for multiple-house 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.

**TABLE 409.1.1  
MANUAL GAS VALVE STANDARDS**

VALVE STANDARDS	APPLIANCE SHUTOFF VALVE APPLICATION UP TO 1/2 psig PRESSURE	OTHER VALVE APPLICATIONS			
		UP TO 1/2 psig PRESSURE	UP TO 2 psig PRESSURE	UP TO 5 psig PRESSURE	UP TO 125 psig PRESSURE
ANSI Z21.15	X	—	—	—	—
ASME B16.44	X	X	X <sup>a</sup>	X <sup>b</sup>	—
ASME B16.33	X	X	X	X	X

For SI: 1 pound per square inch gauge = 6.895 kPa.

a. If labeled 2G.

b. If labeled 5G.

**409.3.1 Multiple tenant buildings.** In multiple tenant buildings, where a common *pipng* 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 *pipng* 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 Appliance shutoff valve.** Each *appliance* shall be provided with a shutoff valve in accordance with Section 409.5.1, 409.5.2 or 409.5.3.

**409.5.1 Located within same room.** The shutoff valve shall be located in the same room as the *appliance*. The shutoff valve shall be within 6 feet (1829 mm) of the *appliance*, and shall be installed upstream of the union, connector or quick disconnect device it serves. Such shutoff valves shall be provided with *access*. *Appliance* shutoff valves located in the firebox of a *fireplace* shall be installed in accordance with the *appliance* manufacturer's instructions.

**409.5.2 Vented decorative appliances and room heaters.** Shutoff valves for vented decorative appliances, room heaters and decorative appliances for installation in vented *fireplaces* shall be permitted to be installed in an area remote from the appliances where such valves are provided with ready *access*. Such valves shall be permanently identified and shall serve no other *appliance*. The *pipng* from the shutoff valve to within 6 feet (1829 mm) of the *appliance* shall be designed, sized and installed in accordance with Sections 401 through 408.

**409.5.3 Located at manifold.** Where the *appliance* shutoff valve is installed at a manifold, such shutoff valve shall be located within 50 feet (15 240 mm) of the *appliance* served and shall be readily accessible and permanently identified. The *pipng* from the manifold to within 6 feet (1829 mm) of the *appliance* shall be designed, sized and installed in accordance with Sections 401 through 408.

**409.6 Shutoff valve for laboratories.** Where provided with two or more fuel gas outlets, including table-, bench- and hood-mounted outlets, each laboratory space in educational, research, commercial and industrial occupancies shall be provided with a single dedicated shutoff valve through which all such gas outlets shall be supplied. The dedicated shutoff valve shall be readily accessible, located within the laboratory space served, located adjacent to the egress door from the space and shall be identified by approved signage stating "Gas Shutoff."

## 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. *Access* shall be provided to pressure regulators. 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 tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument.

**410.3 Venting of regulators.** Pressure regulators that require a vent shall be vented directly to the outdoors. The vent shall be designed to prevent the entry of insects, water and foreign objects.

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

**410.3.1 Vent pipng.** Vent *pipng* for relief vents and breather vents shall be constructed of materials allowed for gas *pipng* in accordance with Section 403. Vent *pipng* shall be not smaller than the vent connection on the pressure regulating device. Vent *pipng* serving relief vents and combination relief and breather vents shall be run independently to the outdoors and shall serve only a single device vent. Vent *pipng* serving only breather vents is permitted to be connected in a manifold arrangement where sized in accordance with an *approved* design that minimizes back-pressure in the event of diaphragm rupture. Regulator vent *pipng* shall not exceed the length specified in the regulator manufacturer's instructions.

**410.4 Excess flow valves.** Where automatic *excess flow valves* are installed, they shall be listed for the application and shall be sized and installed in accordance with the manufacturer's instructions.

**410.5 Flashback arrestor check valve.** Where fuel gas is used with oxygen in any hot work operation, a listed protective device that serves as a combination flashback arrestor and backflow check valve shall be installed at an approved location on both the fuel gas and oxygen supply lines. Where the pressure of the piped fuel gas supply is insufficient to ensure such safe operation, approved equipment shall be installed between the gas meter and the appliance that increases pressure to the level required for such safe operation.

### SECTION 411 (IFGC) APPLIANCE AND MANUFACTURED HOME CONNECTIONS

**411.1 Connecting appliances.** Except as required by Section 411.1.1, *appliances* shall be connected to the *pipng* system by one of the following:

1. Rigid metallic pipe and fittings.
2. Corrugated stainless steel tubing (CSST) where installed in accordance with the manufacturer's instructions.
3. 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.
4. *Listed* and *labeled appliance* connectors in compliance with ANSI Z21.24 and installed in accordance with the manufacturer's instructions and located entirely in the same room as the *appliance*.
5. *Listed* and *labeled* quick-disconnect devices used in conjunction with *listed* and *labeled appliance* connectors.
6. *Listed* and *labeled* convenience outlets used in conjunction with *listed* and *labeled appliance* connectors.
7. *Listed* and *labeled* outdoor *appliance* connectors in compliance with ANSI Z21.75/CSA 6.27 and installed in accordance with the manufacturer's instructions.

**411.1.1 Commercial cooking appliances.** Commercial cooking *appliances* installed on casters and *appliances* that are moved for cleaning and sanitation purposes shall be connected to the *pipng* system with an *appliance* connector listed as complying with ANSI Z21.69 or in accordance with Item 1 or 3 of Section 411.1.

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

**411.1.3 Connector installation.** *Appliance* fuel connectors shall be installed in accordance with the manufacturer's instructions and Sections 411.1.3.1 through 411.1.3.4.

**411.1.3.1 Maximum length.** Connectors shall have an overall length not to exceed 6 feet (1829 mm). Mea-

surement shall be made along the centerline of the connector. Only one connector shall be used for each *appliance*.

**Exception:** Rigid metallic *pipng* used to connect an *appliance* to the *pipng* system shall be permitted to have a total length greater than 6 feet (1829 mm), provided that the connecting pipe is sized as part of the *pipng* system in accordance with Section 402 and the location of the *appliance* shutoff valve complies with Section 409.5.

**411.1.3.2 Minimum size.** Connectors shall have the capacity for the total demand of the connected *appliance*.

**411.1.3.3 Prohibited locations and penetrations.** Connectors shall not be concealed within, or extended through, walls, floors, partitions, ceilings or *appliance* housings.

**Exceptions:**

1. Connectors constructed of materials allowed for *pipng* systems in accordance with Section 403 shall be permitted to pass through walls, floors, partitions and ceilings where installed in accordance with Section 409.5.2 or 409.5.3.
2. Rigid steel pipe connectors shall be permitted to extend through openings in *appliance* housings.
3. *Fireplace* inserts that are factory equipped with grommets, sleeves or other means of protection in accordance with the listing of the *appliance*.
4. Semirigid tubing and *listed* connectors shall be permitted to extend through an opening in an *appliance* housing, cabinet or casing where the tubing or connector is protected against damage.

**411.1.3.4 Shutoff valve.** 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.

**411.1.4 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 *pipng* 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.

**411.1.5 (IFGS) Connection of gas engine-powered air conditioners.** Internal combustion engines shall not be rigidly connected to the gas supply *pipng*.

**411.1.6 Unions.** A union fitting shall be provided for *appliances* connected by rigid metallic pipe. Such unions shall be accessible and located within 6 feet (1829 mm) of the *appliance*.

**411.2 Manufactured home connections.** Manufactured homes shall be connected to the distribution *pip*ing system by one of the following materials:

1. Metallic pipe in accordance with Section 403.4.
2. Metallic tubing in accordance with Section 403.5.
3. *Listed* and *labeled* connectors in compliance with ANSI Z21.75/CSA 6.27 and installed in accordance with the manufacturer's installation instructions.

**411.3 Suspended low-intensity infrared tube heaters.** Suspended low-intensity infrared tube heaters shall be connected to the building *pip*ing system with a connector *listed* for the application complying with ANSI Z21.24/CGA 6.10. The connector shall be installed as specified by the tube heater manufacturer's instructions.

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

**[F] 412.1 General.** Motor fuel-dispensing facilities for LP-gas fuel shall be in accordance with this section and the *International Fire Code*. The operation of LP-gas motor fuel-dispensing facilities shall be regulated by the *International Fire Code*

**[F] 412.2 Storage and dispensing.** Storage vessels and *equipment* used for the storage or dispensing of LP-gas shall be *approved* or *listed* in accordance with Sections 412.3 and 412.4

**[F] 412.3 Approved equipment.** Containers; pressure-relief devices, including pressure-relief valves; and pressure regulators and *pip*ing used for LP-gas shall be *approved*.

**[F] 412.4 Listed equipment.** Hoses, hose connections, vehicle fuel connections, dispensers, LP-gas pumps and electrical *equipment* used for LP-gas shall be listed.

**[F] 412.5 Attendants.** Motor vehicle fueling operations shall be conducted by qualified attendants or in accordance with Section 412.8 by persons trained in the proper handling of LP-gas.

**[F] 412.6 Location.** In addition to the fuel dispensing requirements of the *International Fire Code*, the point of transfer for dispensing operations shall be 25 feet (7620 mm) or more from buildings having combustible exterior wall surfaces, buildings having noncombustible exterior wall surfaces that are not part of a 1-hour fire-resistance-rated assembly, buildings having combustible overhangs, lot lines of property that could be built on, public streets, sidewalks and railroads; and at least 10 feet (3048 mm) from driveways and buildings having noncombustible exterior wall surfaces that are part of a fire-resistance-rated assembly having a rating of 1 hour or more.

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

Liquefied petroleum gas containers shall be located in accordance with the *International Fire Code*. Liquefied

petroleum gas storage and dispensing *equipment* shall be located outdoors and in accordance with the *International Fire Code*.

**[F] 412.7 Installation of dispensing devices and equipment.** The installation and operation of LP-gas dispensing systems shall be in accordance with this section and the *International Fire Code*. Liquefied petroleum gas dispensers and dispensing stations shall be installed in accordance with manufacturers' specifications and their listing.

**[F] 412.7.1 Valves.** A manual shutoff valve and an excess flow-control check valve shall be located in the liquid line between the pump and the dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.

An excess flow-control check valve or an emergency shutoff valve shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid *pip*ing. A differential backpressure valve shall be considered equivalent protection. A *listed* shutoff valve shall be located at the discharge end of the transfer hose.

**[F] 412.7.2 Hoses.** Hoses and *pip*ing for the dispensing of LP-gas shall be provided with hydrostatic relief valves. The hose length shall not exceed 18 feet (5486 mm). An *approved* method shall be provided to protect the hose against mechanical damage.

**[F] 412.7.3 Vehicle impact protection.** Vehicle impact protection for LP-gas storage containers, pumps and dispensers shall be provided in accordance with the *International Fire Code*.

**[F] 412.8 Private fueling of motor vehicles.** Self-service LP-gas dispensing systems, including key, code and card lock dispensing systems, shall not be open to the public and shall be limited to the filling of permanently mounted fuel containers on LP-gas powered vehicles. In addition to the requirements in the *International Fire Code*, self-service LP-gas dispensing systems shall be provided with an emergency shutoff switch located within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, dispensers and the owner of the dispensing facility shall ensure the safe operation of the system and the training of users.

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

**[F] 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*.

**[F] 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 through 413.2.3.

**[F] 413.2.1 Approved equipment.** Containers; compressors; pressure-relief devices, including pressure-relief

## GAS PIPING INSTALLATIONS

valves; and pressure regulators and *pipng* used for CNG shall be *approved*.

**[F] 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*.

**[F] 413.2.3 General.** Residential fueling *appliances* shall be *listed*. The capacity of a residential fueling *appliance* shall not exceed 5 standard cubic feet per minute (0.14 standard cubic meter/min) of natural gas.

**[F] 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 or in vaults in accordance with the *International Fire Code*.
3. Residential fueling *appliances* and *equipment* shall be allowed to be installed indoors in accordance with the *equipment* manufacturer's instructions and Section 413.4.3.

**[F] 413.3.1 Location on property.** In addition to the fuel-dispensing requirements of the *International Fire Code*, compression, storage and dispensing *equipment* not located in vaults complying with the *International Fire Code* and other than residential fueling appliances shall not be installed:

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

**Exception:** Dispensing *equipment* need not be separated from canopies that provide weather protection for the dispensing *equipment* and are 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.

**[F] 413.4 Residential fueling appliance installation.** Residential fueling *appliances* shall be installed in accordance with Sections 413.4.1 through 413.4.3.

**[F] 413.4.1 Gas connections.** Residential fueling appliances shall be connected to the premises' gas *pipng* system without causing damage to the *pipng* system or the connection to the internal *appliance* apparatus.

**[F] 413.4.2 Outdoor installation.** Residential fueling *appliances* located outdoors shall be installed on a firm, noncombustible base.

**[F] 413.4.3 Indoor installation.** Where located indoors, residential fueling *appliances* shall be vented to the outdoors. A gas detector set to operate at one-fifth of the lower limit of flammability of natural gas shall be installed in the room or space containing the *appliance*. The detector shall be located within 6 inches (152 mm) of the highest point in the room or space. The detector shall stop the operation of the *appliance* and activate an audible or a visual alarm.

**[F] 413.5 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.

**[F] 413.6 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.

**[F] 413.7 Valves.** *Pipng* to *equipment* shall be provided with a remote manual shutoff valve. Such valve shall be provided with ready access.

**[F] 413.8 Emergency shutdown control.** 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 system 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.

**[F] 413.9 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 413.9.1 or 413.9.2.

**[F] 413.9.1 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 *pipng*, regulators and *equipment* settings shall be provided to the code official for review and approval. The drawing shall illustrate the *pipng* and regulator arrange-

ment and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shut-down devices.

**[F] 413.9.2 Atmospheric venting.** Atmospheric venting of motor vehicle fuel cylinders shall be in accordance with Sections 413.9.2.1 through 413.9.2.6.

**[F] 413.9.2.1 Plans and specifications.** A drawing illustrating the location of the vessel support, *pipng*, the method of grounding and bonding, and other requirements specified herein shall be provided to the code official for review and approval.

**[F] 413.9.2.2 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 *non-combustible materials*.

**[F] 413.9.2.3 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 413.9.2.3.

**[F] TABLE 413.9.2.3  
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.

**[F] 413.9.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with ((NFPA 70)) *the Seattle Electrical Code*. The cylinder valve shall be bonded prior to the commencement of venting operations.

**[F] 413.9.2.5 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.

**[F] 413.9.2.6 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.

**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 pipng*. 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.

**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 416 (IFGS)  
OVERPRESSURE PROTECTION DEVICES**

**416.1 General.** Overpressure protection devices shall be provided in accordance with this section to prevent the pressure in the *pipng* system from exceeding the pressure that would cause unsafe operation of any connected and properly adjusted *appliances*.

**416.2 Protection methods.** The requirements of this section shall be considered to be met and a *pipng* system deemed to have overpressure protection where a service or line pressure regulator plus one other device are installed such that the following occur:

1. Each device limits the pressure to a value that does not exceed the maximum working pressure of the downstream system.

## GAS PIPING INSTALLATIONS

- The individual failure of either device does not result in the overpressurization of the downstream system.

**416.3 Device maintenance.** The pressure regulating, limiting and relieving devices shall be maintained; and inspection procedures shall be devised or instrumentation installed to detect failures or malfunctions of such devices; and replacements or repairs shall be made.

**416.4 Where required.** A pressure-relieving or pressure-limiting device shall not be required where: (1) the gas does not contain materials that could seriously interfere with the operation of the service or line pressure regulator; (2) the operating pressure of the gas source is 60 psi (414 kPa) or less; and (3) the service or line pressure regulator has all of the following design features or characteristics:

- Pipe connections to the service or line regulator do not exceed 2 inches (51 mm) nominal diameter.
- The regulator is self-contained with no external static or control *piping*.
- The regulator has a single port valve with an orifice diameter not greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet.
- The valve seat is made of resilient material designed to withstand abrasion of the gas, impurities in the gas and cutting by the valve, and to resist permanent deformation where it is pressed against the valve port.
- The regulator is capable, under normal operating conditions, of regulating the downstream pressure within the necessary limits of accuracy and of limiting the discharge pressure under no-flow conditions to not more than 150 percent of the discharge pressure maintained under flow conditions.

**416.5 Devices.** Pressure-relieving or pressure-limiting devices shall be one of the following:

- Spring-loaded relief device.
- Pilot-loaded back pressure regulator used as a relief valve and designed so that failure of the pilot system or external control *piping* will cause the regulator relief valve to open.
- A monitoring regulator installed in series with the service or line pressure regulator.
- A series regulator installed upstream from the service or line regulator and set to continuously limit the pressure on the inlet of the service or line regulator to the maximum working pressure of the downstream *piping* system.
- An automatic shutoff device installed in series with the service or line pressure regulator and set to shut off when the pressure on the downstream *piping* system reaches the maximum working pressure or some other predetermined pressure less than the maximum working pressure. This device shall be designed so that it will remain closed until manually reset.
- A liquid seal relief device that can be set to open accurately and consistently at the desired pressure.

The devices shall be installed either as an integral part of the service or line pressure regulator or as separate units. Where separate pressure-relieving or pressure-limiting devices are installed, they shall comply with Sections 416.5.1 through 416.5.6.

**416.5.1 Construction and installation.** Pressure relieving and pressure-limiting devices shall be constructed of materials so that the operation of the devices will not be impaired by corrosion of external parts by the atmosphere or of internal parts by the gas. Pressure-relieving and pressure-limiting devices shall be designed and installed so that they can be operated to determine whether the valve is free. The devices shall also be designed and installed so that they can be tested to determine the pressure at which they will operate and examined for leakage when in the closed position.

**416.5.2 External control piping.** External control *piping* shall be protected from falling objects, excavations and other causes of damage and shall be designed and installed so that damage to any control *piping* will not render both the regulator and the overpressure protective device inoperative.

**416.5.3 Setting.** Each pressure-relieving or pressure-limiting device shall be set so that the pressure does not exceed a safe level beyond the maximum allowable working pressure for the connected *piping* and appliances.

**416.5.4 Unauthorized operation.** Where unauthorized operation of any shutoff valve can make a pressure relieving valve or pressure limiting device inoperative, one of the following shall apply:

- The valve shall be locked in the open position. Authorized personnel shall be instructed in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.
- Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and the isolating valves and three-way valves shall be arranged so that only one safety device can be rendered inoperative at a time.

**416.5.5 Vents.** The discharge stacks, vents and outlet parts of all pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks and vents shall be designed to prevent the entry of water, insects and other foreign material that could cause blockage. The discharge stack or vent line shall be at least the same size as the outlet of the pressure-relieving device.

**416.5.6 Size of fittings, pipe and openings.** The fittings, pipe and openings located between the system to be protected and the pressure-relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity.