# CHAPTER 4 GAS PIPING INSTALLATIONS

# SECTION 401 (IFGC) GENERAL

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

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

**401.2 Liquefied petroleum gas storage.** The 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 piping systems, sizes shall be maintained in accordance with this chapter.

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

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

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

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

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

# SECTION 402 (IFGS) PIPE SIZING

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

**402.2 Maximum gas demand.** The volume of gas to be provided, in cubic feet per hour, shall be determined directly from

the manufacturer's input ratings of the appliances served. 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 volume 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.

<b>TABLE 402.2</b>
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES

APPLIANCE	INPUT BTU/H (Approx.)
Space Heating Units	
Hydronic boiler	
Single family	100,000
Multifamily, per unit	60,000
Warm-air furnace	
Single family	100,000
Multifamily, per unit	60,000
Space and Water Heating Units	
Hydronic boiler	
Single family	120,000
Multifamily, per unit	75,000
Water Heating Appliances	
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
Cooking Appliances	
Built-in oven or broiler unit, domestic	25,000
Built-in top unit, domestic	40,000
Range, free-standing, domestic	65,000
Other Appliances	
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. **402.3 Sizing.** Gas piping shall be sized in accordance with one of the following:

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

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

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

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

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

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

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

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*, AND *Y* VALUES FOR NATURAL GAS AND UNDILUTED PROPANE AT STANDARD CONDITIONS

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

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

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

length of piping from the point of delivery to the most remote outlet and the load of the section.

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

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

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

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

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

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

**402.6.1 Liquefied petroleum gas systems.** The operating pressure for undiluted LP-gas systems shall not exceed 20 psig (140 kPa gauge). Buildings having systems designed to operate below  $-5^{\circ}$ F (-21°C) or with butane or a propanebutane mix shall be designed to either accommodate liquid LP-gas or prevent LP-gas vapor from condensing into a liquid.

**Exception:** Buildings or separate areas of buildings constructed in accordance with Chapter 10 of NFPA 58 and 1 used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

I

# TABLE 402.4(1) SCHEDULE 40 METALLIC PIPE

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

	Specific dravity 0.00													
		1	1			PIPE	SIZE (inc	h)	1	1	1	1		
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	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.

TABLE 402.4(2) SCHEDULE 40 METALLIC PIPE

	Gas	Natural
Inlet P	ressure	Less than 2 psi
Pressu	re Drop	0.5 in. w.c.
Specific	Gravity	0.60
ch)		

PIPE SIZE (inch)														
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	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 F	eet 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.

## TABLE 402.4(3) SCHEDULE 40 METALLIC PIPE

Gas	Natural
Inlet Pressure	2.0 psi
Pressure Drop	1.0 psi
	0.00

	PIPE SIZE (inch)										
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	3	4		
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026		
Length (ft)		1		Capacity in	Cubic Feet of G	as Per Hour	1				
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		

Specific Gravity 0.60

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.

TABLE 402.4(4)
SCHEDULE 40 METALLIC PIPE

Gas	Natural
Inlet Pressure	3.0 psi
Pressure Drop	2.0 psi
Specific Gravity	0.60

	PIPE SIZE (inch)									
Nominal	1/2	3/4	1	1 <sup>1</sup> /4	1 <sup>1</sup> / <sub>2</sub>	2	21/2	3	4	
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	
Length (ft)	0.022	0.824	1.049		Cubic Feet of G		2.409	5.008	4.020	
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	1,020	2,720	5,110	10,500	19,000	30,300	48,300	85,400		
40			4,380	8,990		25,900			174,000 149,000	
	1,110	2,320			13,500	23,900	41,300	73,100		
50 60	985 892	2,060	3,880	7,970	11,900	23,000	36,600	64,800 58,700	132,000 120,000	
		1,870	3,520	7,220	10,800		33,200	58,700		
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	

## TABLE 402.4(5) SCHEDULE 40 METALLIC PIPE

Gas	Natural
Inlet Pressure	5.0 psi
Pressure Drop	3.5 psi
	0.60

Specific Gravity 0.60

				PIPE S	IZE (inch)	1			
Nominal	<sup>1</sup> / <sub>2</sub>	3/4	1	11/4	11/2	2	21/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)		I	[	Capacity in	Cubic Feet of G	as Per Hour		1	1
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.

( & L ACR )		BLE 402.4(6) D COPPER TO 3/8 1/2 0.500 0.402 42	UBING 1/2 5/8 0.625 0.527	<b>TUBE SIZE (i</b> 5/8 3/4 0.750	nch) 3/4 7/8		re Drop Gravity 1 <sup>1</sup> / <sub>4</sub>	Less than 2 psi 0.3 in. w.c. 0.60	
ACR	<sup>3</sup> / <sub>8</sub> 0.375 0.305 20 14 11	1/2 0.500 0.402 42	<sup>5</sup> / <sub>8</sub> 0.625	5/8 3/4	3/4	Specific	Gravity 1 <sup>1</sup> / <sub>4</sub>		
ACR	<sup>3</sup> / <sub>8</sub> 0.375 0.305 20 14 11	1/2 0.500 0.402 42	<sup>5</sup> / <sub>8</sub> 0.625	5/8 3/4	3/4	1	11/4	0.60	
ACR	<sup>3</sup> / <sub>8</sub> 0.375 0.305 20 14 11	1/2 0.500 0.402 42	<sup>5</sup> / <sub>8</sub> 0.625	5/8 3/4	3/4	1	11/4		[
ACR	<sup>3</sup> / <sub>8</sub> 0.375 0.305 20 14 11	1/2 0.500 0.402 42	<sup>5</sup> / <sub>8</sub> 0.625	5/8 3/4	3/4	-			
ACR	<sup>3</sup> / <sub>8</sub> 0.375 0.305 20 14 11	1/2 0.500 0.402 42	<sup>5</sup> / <sub>8</sub> 0.625	3/4		-		11/2	2
	0.375 0.305 20 14 11	0.500 0.402 42	0.625		,0	11/8	13/8		
)	0.305 20 14 11	0.402			0.875	1.125	1.375	1.625	2.125
)	20 14 11	42		0.652	0.745	0.995	1.245	1.481	1.959
	14 11				Cubic Feet of G				
	11		85	148	210	448	806	1,270	2,650
		29	58	102	144	308	554	873	1,820
	10	23	47	82	116	247	445	701	1,460
		20	40	70	99	211	381	600	1,250
	NA	17	35	62	88	187	337	532	1,110
	NA	16	32	56	79	170	306	482	1,000
	NA	14	29	52	73	156	281	443	924
	NA	13	27	48	68	145	262	413	859
	NA	13	26	45	64	136	245	387	806
	NA	12	24	43	60	129	232	366	761
	NA	11	22	38	53	114	206	324	675
	NA	10	20	34	48	103	186	294	612
	NA	NA	18	31	45	95	171	270	563
	NA	NA	17	29	41	89	159	251	523
	NA	NA	15	26	37	78	141	223	464
	NA	NA	13	23	33	71	128	202	420
	NA	NA	12	22	31	65	118	186	387
	NA	NA	11	20	28	61	110	173	360
	NA	NA	11	19	27	57	103	162	338
	NA	NA	10	18	25	54	97	153	319
	NA	NA	NA	17	24	51	92	145	303
	NA	NA	NA	16	23	49	88	139	289
	NA	NA	NA	15	22	47	84	133	277
	NA	NA	NA	15	21	45	81	128	266
	NA	NA	NA	14	20	43	78	123	256
	NA	NA	NA	14	20	42	75	119	247
	NA	NA	NA	13	19	40	73	115	239
	NA	NA	NA	13	18	39	71	111	232
	NA	NA	NA	13	18	38	69	108	225
	NA	NA	NA	12	17	37	67	105	219
	NA	NA	NA		16		63		208
		NA	NA	11	16		60		199
									190
		NA	NA						183
			NA						176
			NA						170
		NA	NA	NA	13		50		164
								77	159
	NT A		NA	NA	12	26			155
		NA NA NA NA NA NA NA NA NA NA NA NA NA N	NA	NANA12NANANA11NANANA11NANANA10NA	NA         NA         NA         12         22           NA         NA         NA         11         20           NA         NA         NA         11         19           NA         NA         NA         10         18           NA         NA         NA         10         18           NA         NA         NA         16           NA         NA         NA         16           NA         NA         NA         15           NA         NA         NA         14           NA         NA         NA         13           NA         NA         NA         13           NA         NA         NA         13           NA         NA         NA         13           NA         NA         NA         12           NA         NA         NA         11           NA         NA         NA         11           NA         NA         NA         10           NA         NA         NA         NA           NA         NA         NA         NA           NA         NA         NA	NA         NA         NA         12         22         31           NA         NA         NA         11         20         28           NA         NA         NA         11         19         27           NA         NA         NA         10         18         25           NA         NA         NA         16         23           NA         NA         NA         NA         15         21           NA         NA         NA         NA         14         20           NA         NA         NA         NA         13         19           NA         NA         NA         NA         13         18           NA         NA         NA         NA         13         18           NA         NA         NA         NA         11         16           NA         NA         NA         NA         11         <	NA         NA         NA         12         22         31         65           NA         NA         NA         11         20         28         61           NA         NA         NA         11         19         27         57           NA         NA         NA         10         18         25         54           NA         NA         NA         NA         17         24         51           NA         NA         NA         NA         16         23         49           NA         NA         NA         NA         15         21         45           NA         NA         NA         NA         14         20         43           NA         NA         NA         NA         13         19         40           NA         NA         NA         NA         13         18         39           NA         NA         NA         NA         13         18         38           NA         NA         NA         NA         11         16         34           NA         NA         NA         NA         11         15	NA         NA         12         22         31         65         118           NA         NA         NA         11         20         28         61         110           NA         NA         NA         11         19         27         57         103           NA         NA         NA         10         18         25         54         97           NA         NA         NA         NA         10         18         25         54         97           NA         NA         NA         NA         NA         11         19         27         57         103           NA         NA         NA         NA         NA         11         12         11         92           NA         NA         NA         NA         NA         13         12         45         81           NA         NA         NA         NA         14         20         42         75           NA         NA         NA         NA         13         18         39         71           NA         NA         NA         NA         13         18         38         69	NA         NA         12         22         31         65         118         186           NA         NA         NA         11         20         28         61         110         173           NA         NA         NA         11         19         27         57         103         162           NA         NA         NA         10         18         25         54         97         153           NA         NA         NA         NA         16         23         49         88         139           NA         NA         NA         NA         15         22         47         84         133           NA         NA         NA         NA         14         20         43         78         123           NA         NA         NA         NA         14         20         42         75         119           NA         NA         NA         13         18         39         71         111           NA         NA         NA         13         18         38         69         108           NA         NA         NA         11

### 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.

### GAS PIPING INSTALLATIONS

# TABLE 402.4(7) SEMIRIGID COPPER TUBING

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

		1			TUBE SIZE (in	ch)	1			
	K & L	1/4	3/8	1/2	5/8	3/4	1	11/4	11/2	2
Nominal	ACR	3/8	1/2	5/8	3/4	7/ <sub>8</sub>	11/8	13/8		_
Out	side	0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Ins	side	0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Leng	ıth (ft)				Capacity in	Cubic Feet of	Gas Per Hour			
1	0	27	55	111	195	276	590	1,060	1,680	3,490
2	20	18	38	77	134	190	406	730	1,150	2,400
3	30	15	30	61	107	152	326	586	925	1,930
4	40	13	26	53	92	131	279	502	791	1,650
5	50	11	23	47	82	116	247	445	701	1,460
6	50	10	21	42	74	105	224	403	635	1,320
7	70	NA	19	39	68	96	206	371	585	1,220
	30	NA	18	36	63	90	192	345	544	1,130
	90	NA	17	34	59	84	180	324	510	1,060
	00	NA	16	32	56	79	170	306	482	1,000
	25	NA	14	28	50	70	151	271	427	890
	50	NA	13	26	45	64	136	245	387	806
	75	NA	12	20	41	59	125	215	356	742
	00	NA	11	24	39	55	117	210	331	690
	50	NA	NA	20	39	48	103	186	294	612
	00	NA	NA	18	31	40	94	169	294	554
	50	NA	NA	16	28	44	86	155		510
									245	
	00 50	NA	NA	15	26	38	80	144	228	474
	50	NA	NA	14	25	35	75	135	214	445
	<u>00</u>	NA	NA	13	23	33	71	128	202	420
	50	NA	NA	13	22	32	68	122	192	399
	00	NA	NA	12	21	30	64	116	183	381
	50	NA	NA	12	20	29	62	111	175	365
	00	NA	NA	11	20	28	59	107	168	350
	50	NA	NA	11	19	27	57	103	162	338
	00	NA	NA	10	18	26	55	99	156	326
	50	NA	NA	10	18	25	53	96	151	315
	00	NA	NA	NA	17	24	52	93	147	306
9:	50	NA	NA	NA	17	24	50	90	143	297
1,0	000	NA	NA	NA	16	23	49	88	139	289
	100	NA	NA	NA	15	22	46	84	132	274
1,2	200	NA	NA	NA	15	21	44	80	126	262
1,3	300	NA	NA	NA	14	20	42	76	120	251
1,4	400	NA	NA	NA	13	19	41	73	116	241
1,5	500	NA	NA	NA	13	18	39	71	111	232
1,6	500	NA	NA	NA	13	18	38	68	108	224
1,7	700	NA	NA	NA	12	17	37	66	104	217
1,8	800	NA	NA	NA	12	17	36	64	101	210
1,9	900	NA	NA	NA	11	16	35	62	98	204
	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.

		TABL	.E 402.4(8)					Gas	Natural		
			COPPER TU	BING			Inlet P	ressure	Less than 2 psi 1.0 in. w.c. 0.60		
							Pressu	re Drop			
							Specific	Gravity			
					TUBE SIZE (in	ch)					
	K&L	1/4	3/8	1/2	5/8	3/4	1	11/4	11/2	2	
Nominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8		_	
Out	side	0.375	0.500	0.625	0.750	0.875	1.125	1.37		2.125	
Ins	side	0.305	0.402	0.527	0.652	0.745	0.995	1.24	5 1.481	1.959	
Leng	th (ft)				Capacity in	Cubic Feet of	Gas Per Hour				
1	.0	39	80	162	283	402	859	1,55	0 2,440	5,080	
2	20	27	55	111	195	276	590	1,06	0 1,680	3,490	
3	30	21	44	89	156	222	474	853	1,350	2,800	
4	0	18	38	77	134	190	406	730	1,150	2,400	
5	50	16	33	68	119	168	359	647	1,020	2,130	
6	60	15	30	61	107	152	326	586	925	1,930	
7	70	13	28	57	99	140	300	539	851	1,770	
8	30	13	26	53	92	131	279	502	791	1,650	
9	00	12	24	49	86	122	262	471	742	1,550	
1	00	11	23	47	82	116	247	445	701	1,460	
12	25	NA	20	41	72	103	219	394	622	1,290	
1:	50	NA	18	37	65	93	198	357	563	1,170	
1	75	NA	17	34	60	85	183	329	518	1,080	
2	00	NA	16	32	56	79	170	306	482	1,000	
2:	50	NA	14	28	50	70	151	271	427	890	
3	00	NA	13	26	45	64	136	245	387	806	
3:	50	NA	12	24	41	59	125	226	356	742	
4	00	NA	11	22	39	55	117	210	331	690	
4	50	NA	10	21	36	51	110	197	311	647	
5	00	NA	NA	20	34	48	103	186	294	612	
5:	50	NA	NA	19	32	46	98	177	279	581	
6	00	NA	NA	18	31	44	94	169	266	554	
6	50	NA	NA	17	30	42	90	162	255	531	
7	00	NA	NA	16	28	40	86	155	245	510	
7:	50	NA	NA	16	27	39	83	150	236	491	
8	00	NA	NA	15	26	38	80	144	228	474	
8	50	NA	NA	15	26	36	78	140	220	459	
9	00	NA	NA	14	25	35	75	135	214	445	
9:	50	NA	NA	14	24	34	73	132	207	432	
1,0	000	NA	NA	13	23	33	71	128	202	420	
1,1	100	NA	NA	13	22	32	68	122	192	399	
1,2	200	NA	NA	12	21	30	64	116	183	381	
1,3	300	NA	NA	12	20	29	62	111	175	365	
1,4	400	NA	NA	11	20	28	59	107	168	350	
1,5	500	NA	NA	11	19	27	57	103	162	338	
1,6	500	NA	NA	10	18	26	55	99	156	326	
1,7	700	NA	NA	10	18	25	53	96	151	315	
1,8	300	NA	NA	NA	17	24	52	93	147	306	
1,9	900	NA	NA	NA	17	24	50	90	143	297	
2,0	000	NA	NA	NA	16	23	49	88	139	289	

### 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.

# TABLE 402.4(9) SEMIRIGID COPPER TUBING

Gas	Natural
Inlet Pressure	Less than 2.0 psi
Pressure Drop	17.0 in w.c.
Specific Gravity	0.60

		1.	2.		FUBE SIZE (in			. 1 .		-
	K & L	1/4	3/8	1/2	5/8	3/4	1	11/4	11/2	2
lominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8		
	tside	0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
	side	0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Lenç	gth (ft)			1	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
4	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
5	80	62	127	258	452	641	1,370	2,460	3,890	8,090
9	90	58	119	243	424	601	1,280	2,310	3,650	7,590
1	.00	55	113	229	400	568	1,210	2,180	3,440	7,170
1	.25	48	100	203	355	503	1,080	1,940	3,050	6,360
1	.50	44	90	184	321	456	974	1,750	2,770	5,760
1	.75	40	83	169	296	420	896	1,610	2,540	5,300
2	200	38	77	157	275	390	834	1,500	2,370	4,930
2	250	33	69	140	244	346	739	1,330	2,100	4,370
3	800	30	62	126	221	313	670	1,210	1,900	3,960
3	50	28	57	116	203	288	616	1,110	1,750	3,640
4	00	26	53	108	189	268	573	1,030	1,630	3,390
4	50	24	50	102	177	252	538	968	1,530	3,180
5	500	23	47	96	168	238	508	914	1,440	3,000
5	550	22	45	91	159	226	482	868	1,370	2,850
6	500	21	43	87	152	215	460	829	1,310	2,720
6	550	20	41	83	145	206	441	793	1,250	2,610
7	/00	19	39	80	140	198	423	762	1,200	2,500
7	/50	18	38	77	135	191	408	734	1,160	2,410
8	300	18	37	74	130	184	394	709	1,120	2,330
8	350	17	35	72	126	178	381	686	1,080	2,250
9	000	17	34	70	122	173	370	665	1,050	2,180
9	950	16	33	68	118	168	359	646	1,020	2,120
1.	000	16	32	66	115	163	349	628	991	2,060
	100	15	31	63	109	155	332	597	941	1,960
1,	200	14	29	60	104	148	316	569	898	1,870
	300	14	28	57	100	142	303	545	860	1,790
	400	13	27	55	96	136	291	524	826	1,720
	500	13	26	53	93	131	280	505	796	1,660
	600	12	25	51	89	127	271	487	768	1,600
	700	12	24	49	86	127	262	472	744	1,550
	800	11	24	48	84	119	254	457	721	1,500
	900	11	23	40	81	115	247	444	700	1,460
	000	11	23	45	79	112	247	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.

			E 402.4(10) COPPER TUI	BING			Inlet Pr Pressur		Natural 2.0 psi 1.0 psi		
						Specific Gravity 0.60					
				1	TUBE SIZE (in	ch)					
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 <sup>1</sup> /4	11/2	2	
Nominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8		_	
Out	tside	0.375	0.500	0.625	0.750	0.875	1.125	1.37	5 1.625	2.125	
Ins	side	0.305	0.402	0.527	0.652	0.745	0.995	1.24	5 1.481	1.959	
Leng	jth (ft)		1		Capacity in	Cubic Feet of (	Gas Per Hour		1		
1	10	245	506	1,030	1,800	2,550	5,450	9,82	0 15,500	32,200	
2	20	169	348	708	1,240	1,760	3,750	6,75	0 10,600	22,200	
3	30	135	279	568	993	1,410	3,010	5,42	0 8,550	17,800	
4	40	116	239	486	850	1,210	2,580	4,64	0 7,310	15,200	
	50	103	212	431	754	1,070	2,280	4,11	0 6,480	13,500	
(	50	93	192	391	683	969	2,070	3,73	0 5,870	12,200	
-	70	86	177	359	628	891	1,900	3,43	0 5,400	11,300	
8	30	80	164	334	584	829	1,770	3,19	0 5,030	10,500	
ç	90	75	154	314	548	778	1,660	2,99	0 4,720	9,820	
1	00	71	146	296	518	735	1,570	2,83	0 4,450	9,280	
1	25	63	129	263	459	651	1,390	2,50	0 3,950	8,220	
1	50	57	117	238	416	590	1,260	2,27	0 3,580	7,450	
1	75	52	108	219	383	543	1,160	2,09	0 3,290	6,850	
2	00	49	100	204	356	505	1,080	1,94	0 3,060	6,380	
2	50	43	89	181	315	448	956	1,72	0 2,710	5,650	
3	00	39	80	164	286	406	866	1,56	0 2,460	5,120	
3	50	36	74	150	263	373	797	1,43	0 2,260	4,710	
4	00	33	69	140	245	347	741	1,33	0 2,100	4,380	
4	50	31	65	131	230	326	696	1,25	0 1,970	4,110	
5	00	30	61	124	217	308	657	1,18	0 1,870	3,880	
5	50	28	58	118	206	292	624	1,12	0 1,770	3,690	
6	00	27	55	112	196	279	595	1,07	0 1,690	3,520	
6	50	26	53	108	188	267	570	1,03	0 1,620	3,370	
7	00	25	51	103	181	256	548	986	1,550	3,240	
7	50	24	49	100	174	247	528	950	1,500	3,120	
8	00	23	47	96	168	239	510	917	1,450	3,010	
8	50	22	46	93	163	231	493	888	1,400	2,920	
9	00	22	44	90	158	224	478	861	1,360	2,830	
9	50	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		2,540	
1,	200	18	38	77	135	192	409	737	1,160	2,420	
	300	18	36	74	129	183	392	705		2,320	
1,	400	17	35	71	124	176	376	678	1,070	2,230	
1,	500	16	34	68	120	170	363	653		2,140	
1,	600	16	33	66	116	164	350	630	994	2,070	
	700	15	31	64	112	159	339	610		2,000	
1,	800	15	30	62	108	154	329	592	933	1,940	
1,	900	14	30	60	105	149	319	575		1,890	
2,	000	14	29	59	102	145	310	559	881	1,830	

#### 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.

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

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

SPECIAL USE		То		ed by a single	house line reg	gulator not exc	ouse line regul ceeding 150 cu		ur.	
		1	1		TUBE SIZE (in		T		[	
	K&L	1/4	3/8	1/2	5/8	3/4	1	11/4	11/2	2
Nominal	ACR	3/8	1/2	5/ <sub>8</sub>	3/4	7/8	11/8	13/8		
Ou	tside	0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
In	side	0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Len	gth (ft)		1		Capacity in	Cubic Feet of	Gas Per Hour	1	1	
	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
1	100	87	180	366	640	907	1,940	3,490	5,500	11,500
1	125	77	159	324	567	804	1,720	3,090	4,880	10,200
1	150	70	144	294	514	729	1,560	2,800	4,420	9,200
1	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	1,400	2,300	4,560
	500	33	68	139	243	344	735	1,320	2,190	4,350
	500 550	33	65	139	243	330	733	1,320	2,090	4,330
					1			í í í í í í í í í í í í í í í í í í í	í í	í í
	700	30 29	63 60	128	223	317	676	1,220	1,920	4,000
	750	1	1	123	215	305	652	1,170	1,850	3,850
	300	28	58	119	208	295	629	1,130	1,790	3,720
	<u>350</u>	27	57	115	201	285	609 500	1,100	1,730	3,600
	900 250	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
	,000	25	52	105	184	261	558	1,000	1,580	3,300
	,100	24	49	100	175	248	530	954	1,500	3,130
	,200	23	47	95	167	237	505	910	1,430	2,990
	,300	22	45	91	160	227	484	871	1,370	2,860
	,400	21	43	88	153	218	465	837	1,320	2,750
	,500	20	42	85	148	210	448	806	1,270	2,650
	,600	19	40	82	143	202	432	779	1,230	2,560
	,700	19	39	79	138	196	419	753	1,190	2,470
	,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 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. 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.

			E 402.4(12) COPPER TUI	BING			Inlet Pr		Natural 5.0 psi 3.5 psi		
							Pressur	e Drop			
							Specific	Gravity	0.60	)	
				•	TUBE SIZE (ind	ch)					
	K & L	1/4	3/8	1/2	5/8	3/4	1	11/4		11/2	2
Nominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8		_	
Out	side	0.375	0.500	0.625	0.750	0.875	1.125	1.37	5	1.625	2.125
Ins	side	0.305	0.402	0.527	0.652	0.745	0.995	1.24	5	1.481	1.959
Leng	ıth (ft)				Capacity in (	Cubic Feet of	Gas Per Hour				
1	0	511	1,050	2,140	3,750	5,320	11,400	20,40	0	32,200	67,100
2	20	351	724	1,470	2,580	3,650	7,800	14,00	0	22,200	46,100
3	30	282	582	1,180	2,070	2,930	6,270	11,30	0	17,800	37,000
2	40	241	498	1,010	1,770	2,510	5,360	9,66	0	15,200	31,700
5	50	214	441	898	1,570	2,230	4,750	8,56	0	13,500	28,100
6	50	194	400	813	1,420	2,020	4,310	7,75	0	12,200	25,500
7	70	178	368	748	1,310	1,860	3,960	7,13	0	11,200	23,400
8	30	166	342	696	1,220	1,730	3,690	6,64	0	10,500	21,800
ç	90	156	321	653	1,140	1,620	3,460	6,23	0	9,820	20,400
1	00	147	303	617	1,080	1,530	3,270	5,88	0	9,270	19,300
1	25	130	269	547	955	1,360	2,900	5,21	0	8,220	17,100
1	50	118	243	495	866	1,230	2,620	4,72	0	7,450	15,500
1	75	109	224	456	796	1,130	2,410	4,35	0	6,850	14,300
2	00	101	208	424	741	1,050	2,250	4,04	0	6,370	13,300
2	50	90	185	376	657	932	1,990	3,58	0	5,650	11,800
3	00	81	167	340	595	844	1,800	3,25	0	5,120	10,700
3	50	75	154	313	547	777	1,660	2,99	0	4,710	9,810
4	00	69	143	291	509	722	1,540	2,78	0	4,380	9,120
4	50	65	134	273	478	678	1,450	2,61	0	4,110	8,560
5	00	62	127	258	451	640	1,370	2,46	0	3,880	8,090
5	50	58	121	245	429	608	1,300	2,34	0	3,690	7,680
6	00	56	115	234	409	580	1,240	2,23	0	3,520	7,330
6	50	53	110	224	392	556	1,190	2,14	0	3,370	7,020
7	00	51	106	215	376	534	1,140	2,05	0	3,240	6,740
7	50	49	102	207	362	514	1,100	1,98	0	3,120	6,490
8	00	48	98	200	350	497	1,060	1,91	0	3,010	6,270
8	50	46	95	194	339	481	1,030	1,85	0	2,910	6,070
9	00	45	92	188	328	466	1,000	1,79	0	2,820	5,880
9	50	43	90	182	319	452	967	1,74	0	2,740	5,710
1,0	000	42	87	177	310	440	940	1,69	0	2,670	5,560
1,	100	40	83	169	295	418	893	1,61	0	2,530	5,280
1,2	200	38	79	161	281	399	852	1,53	0	2,420	5,040
1,	300	37	76	154	269	382	816	1,47	0	2,320	4,820
1,4	400	35	73	148	259	367	784	1,41	0	2,220	4,630
1,:	500	34	70	143	249	353	755	1,36	0	2,140	4,460
1,0	500	33	68	138	241	341	729	1,31	0	2,070	4,310
1,	700	32	65	133	233	330	705	1,27	0	2,000	4,170
1,	800	31	63	129	226	320	684	1,23	0	1,940	4,040
1,9	900	30	62	125	219	311	664	1,20	0	1,890	3,930
2.0	000	29	60	122	213	302	646	1,16	0	1,830	3,820

#### Notes:

Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
 All table entries have been rounded to three significant digits.

### TABLE 402.4(13) CORRUGATED STAINLESS STEEL TUBING (CSST)

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

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

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

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	3.0 in. w.c.
Specific Gravity	0.60
	•

	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.

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

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

					•	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.

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

Gas	Natural
Inlet Pressure	2.0 psi
Pressure Drop	1.0 psi
Specific Gravity	0.60

	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											
10	270	353	587	700	1,100	1,370	2,590	2,990	4,510	9,600	10,700	18,600	21,600
25	166	220	374	444	709	876	1,620	1,870	2,890	6,040	6,780	11,900	13,700
30	151	200	342	405	650	801	1,480	1,700	2,640	5,510	6,200	10,900	12,500
40	129	172	297	351	567	696	1,270	1,470	2,300	4,760	5,380	9,440	10,900
50	115	154	266	314	510	624	1,140	1,310	2,060	4,260	4,820	8,470	9,720
75	93	124	218	257	420	512	922	1,070	1,690	3,470	3,950	6,940	7,940
80	89	120	211	249	407	496	892	1,030	1,640	3,360	3,820	6,730	7,690
100	79	107	189	222	366	445	795	920	1,470	3,000	3,420	6,030	6,880
150	64	87	155	182	302	364	646	748	1,210	2,440	2,800	4,940	5,620
200	55	75	135	157	263	317	557	645	1,050	2,110	2,430	4,290	4,870
250	49	67	121	141	236	284	497	576	941	1,890	2,180	3,850	4,360
300	44	61	110	129	217	260	453	525	862	1,720	1,990	3,520	3,980
400	38	52	96	111	189	225	390	453	749	1,490	1,730	3,060	3,450
500	34	46	86	100	170	202	348	404	552	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 <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.

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

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

					•	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											
10	523	674	1,080	1,300	2,000	2,530	4,920	5,660	8,300	18,100	19,800	34,400	40,400
25	322	420	691	827	1,290	1,620	3,080	3,540	5,310	11,400	12,600	22,000	25,600
30	292	382	632	755	1,180	1,480	2,800	3,230	4,860	10,400	11,500	20,100	23,400
40	251	329	549	654	1,030	1,280	2,420	2,790	4,230	8,970	10,000	17,400	20,200
50	223	293	492	586	926	1,150	2,160	2,490	3,790	8,020	8,930	15,600	18,100
75	180	238	403	479	763	944	1,750	2,020	3,110	6,530	7,320	12,800	14,800
80	174	230	391	463	740	915	1,690	1,960	3,020	6,320	7,090	12,400	14,300
100	154	205	350	415	665	820	1,510	1,740	2,710	5,650	6,350	11,100	12,800
150	124	166	287	339	548	672	1,230	1,420	2,220	4,600	5,200	9,130	10,500
200	107	143	249	294	478	584	1,060	1,220	1,930	3,980	4,510	7,930	9,090
250	95	128	223	263	430	524	945	1,090	1,730	3,550	4,040	7,110	8,140
300	86	116	204	240	394	479	860	995	1,590	3,240	3,690	6,500	7,430
400	74	100	177	208	343	416	742	858	1,380	2,800	3,210	5,650	6,440
500	66	89	159	186	309	373	662	766	1,040	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.

	TABLE 4	02.4(18)		Gas	Natural		
	POLYETHYLENE		Inlet	Pressure	Less than	2 psi	
			Press	ure Drop	0.3 in. w.c	2.	
			-	Specifi	c Gravity	0.60	
			PIPE SIZE (in.)				
Nominal OD	1/2	3/4	1	11/4	1	1/2	2
Designation	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR	11.00	SDR 11.00
Actual ID	0.660	0.860	1.077	1.328	1.	554	1.943
Length (ft)			Capacity in Cubic I	eet of Gas per Hour			
10	153	305	551	955	1,	440	2,590
20	105	210	379	656	9	91	1,780
30	84	169	304	527	7	'96	1,430
40	72	144	260	451	e	681	1,220
50	64	128	231	400	e	604	1,080
60	58	116	209	362	5	547	983
70	53	107	192	333	5	503	904
80	50	99	179	310	4	68	841
90	46	93	168	291	4	39	789
100	44	88	159	275	4	15	745
125	39	78	141	243	3	368	661
150	35	71	127	221	3	333	598
175	32	65	117	203	3	806	551
200	30	60	109	189	2	285	512
250	27	54	97	167	2	253	454
300	24	48	88	152	2	229	411
350	22	45	81	139	2	211	378
400	21	42	75	130	1	.96	352
450	19	39	70	122	1	84	330
500	18	37	66	115	1	.74	312

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

# TABLE 402.4(19) POLYETHYLENE PLASTIC PIPE

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

			PIPE SIZE (in.)			
Nominal OD	1/2	3/4	1	11/4	11/2	2
Designation	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943
Length (ft)			Capacity in Cubic F	eet of Gas per Hour		
10	201	403	726	1,260	1,900	3,410
20	138	277	499	865	1,310	2,350
30	111	222	401	695	1,050	1,880
40	95	190	343	594	898	1,610
50	84	169	304	527	796	1,430
60	76	153	276	477	721	1,300
70	70	140	254	439	663	1,190
80	65	131	236	409	617	1,110
90	61	123	221	383	579	1,040
100	58	116	209	362	547	983
125	51	103	185	321	485	871
150	46	93	168	291	439	789
175	43	86	154	268	404	726
200	40	80	144	249	376	675
250	35	71	127	221	333	598
300	32	64	115	200	302	542
350	29	59	106	184	278	499
400	27	55	99	171	258	464
450	26	51	93	160	242	435
500	24	48	88	152	229	411

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.

		00 ((00)	Γ		Gas	Natural	
	TABLE 4 POLYETHYLENE	E PLASTIC PIPE	Inlet P	ressure	2.0 psi		
			-		re Drop	1.0 psi	
				Specific		0.60	
				opecine	Gravity	0.00	
Nominal OD	1/-	3/4	PIPE SIZE (in.)	117.	1	17-	2
Designation	<sup>1</sup> / <sub>2</sub> SDR 9.33	SDR 11.0	SDR 11.00	1 <sup>1</sup> / <sub>4</sub> SDR 10.00		$\frac{1}{2}$ 11.00	SDR 11.00
Actual ID	0.660	0.860	1.077	1.328		554	1.943
Length (ft)	0.000	0.800	Capacity in Cubic F		1	554	1.943
10	1,860	3,720	6,710	11,600	17	,600	31,600
20	1,280	2,560	4,610	7,990		,100	21,700
30	1,030	2,050	3,710	6,420	· · · · · · · · · · · · · · · · · · ·	690	17,400
40	878	1,760	3,170	5,490	,	300	14,900
50	778	1,560	2,810	4,870		350	13,200
60	705	1,410	2,550	4,410		660	12,000
70	649	1,300	2,340	4,060		130	11,000
80	603	1,210	2,180	3,780		700	10,200
90	566	1,130	2,050	3,540	,	350	9,610
100	535	1,070	1,930	3,350		050	9,080
125	474	949	1,710	2,970	4,4	480	8,050
150	429	860	1,550	2,690	4,0	060	7,290
175	395	791	1,430	2,470	3,	730	6,710
200	368	736	1,330	2,300 3,470		6,240	
250	326	652	1,180	2,040 3,080		5,530	
300	295	591	1,070	1,850	2,7	790	5,010
350	272	544	981	1,700	2,	570	4,610
400	253	506	913	1,580	2,2	390	4,290
450	237	475	856	1,480	2,2	240	4,020
500	224	448	809	1,400	2,	120	3,800
550	213	426	768	1,330	2,0	010	3,610
600	203	406	733	1,270	1,9	920	3,440
650	194	389	702	1,220	1,8	840	3,300
700	187	374	674	1,170	1,7	760	3,170
750	180	360	649	1,130	1,7	700	3,050
800	174	348	627	1,090	1,0	640	2,950
850	168	336	607	1,050	1,:	590	2,850
900	163	326	588	1,020	1,:	540	2,770
950	158	317	572	990	1,:	500	2,690
1,000	154	308	556	963	1,4	450	2,610
1,100	146	293	528	915	1,380		2,480
1,200	139	279	504	873	1,	320	2,370
1,300	134	267	482	836	1,2	260	2,270
1,400	128	257	463	803	1,2	210	2,180
1,500	124	247	446	773	1,170		2,100
1,600	119	239	431	747	1,	130	2,030
1,700	115	231	417	723	1,0	090	1,960
1,800	112	224	404	701		060	1,900
1,900	109	218	393	680		030	1,850
2 000	106	212	202	(()	4.4	000	1 900

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.

1,800

1,000

2,000

### TABLE 402.4(21) POLYETHYLENE PLASTIC TUBING

	Gas	Natural			
Inle	t Pressure	Less than 2.0 psi			
Pres	sure Drop	0.3 in. w.c.			
Speci	Specific Gravity		0.60		
	PLA	STIC TUBING	G SIZE (CTS) (in.)		
Nominal OD	1	/ <sub>2</sub>	<sup>3</sup> / <sub>4</sub>		
Designation	SDR	7.00	SDR 11.00		
Actual ID	0.4	145	0.927		
Length (ft)	Capaci	ty in Cubic F	eet of Gas per Hour		
10	5	4	372		
20	3	7	256		
30	3	0	205		
40	2	.6	176		
50	2	.3	156		
60	2	.1	141		
70	19		130		
80	18		121		
90	1	7	113		
100	1	6	107		
125	1	4	95		
150	1	3	86		
175	1	2	79		
200	1	1	74		
225	1	0	69		
250	N	A	65		
275	N	A	62		
300	N	A	59		
350	NA		54		
400	NA		51		
450	N	A	47		
500	N	A	45		

### TABLE 402.4(22) POLYETHYLENE PLASTIC TUBING

Inle	Gas t Pressure	Natural Less than 2.0 psi			
	Pressure Drop		0.5 in. w.c.		
	Specific Gravity		0.60		
•		G SIZE (CTS) (in.)			
Naminal OD			<sup>3</sup> / <sub>4</sub>		
Nominal OD					
Designation		. 7.00	SDR 11.00		
Actual ID		145	0.927		
Length (ft)	Capaci	ty in Cubic F	eet of Gas per Hour		
10	7	/2	490		
20	4	9	337		
30	3	9	271		
40	3	34	232		
50	3	80	205		
60	2	27	186		
70	2	25	171		
80	23		159		
90	2	22	149		
100	2	21	141		
125	1	8	125		
150	1	.7	113		
175	1	.5	104		
200	1	4	97		
225	1	.3	91		
250	1	2	86		
275	1	.1	82		
300	11		78		
350	10		72		
400	N	ΙA	67		
450	N	ΙA	63		
500	N	ſΑ	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 =  $0.0283 \text{ m}^3/\text{h}$ , 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.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa 1 inch wat

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 =  $0.0283 \text{ m}^3/\text{h}$ , 1 degree = 0.01745 rad.

Notes:

1. NA means a flow of less than 10 cfh.

# TABLE 402.4(23) SCHEDULE 40 METALLIC PIPE

Gas	Undiluted Propane
Inlet Pressure	10.0 psi
Pressure Drop	1.0 psi
Specific Gravity	1.50

SPECIAL USE         Pipe sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator).						tor).			
Number	17	21	1	11/	PIPE SIZE (in.)		21/	2	4
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	3,320	6,950	12 100	26,900	Thousands of E 40,300		124.000	219,000	446,000
10 20	<i>,</i>	, í	13,100	,		77,600	124,000	í í	,
20 30	2,280	4,780	9,000	18,500	27,700	53,300 42,800	85,000 68,200	150,000	306,000
		,	7,220	14,800	22,200			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.

# TABLE 402.4(24) SCHEDULE 40 METALLIC PIPE

Gas	Undiluted Propane
Inlet Pressure	10.0 psi
Pressure Drop	3.0 psi
Specific Gravity	1.50

		Dim	Pipe sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator).							
SPECIAL USE Pipe sizing between first stage (high-pres PIPE SIZE (in)						ulator) and sec	ona stage (IOW-	pressure regula	lor).	
Nominal	1/2	3/4	1	1 <sup>1</sup> / <sub>4</sub>	12E (IN)	2	21/2	3	4	
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	
	0.022	0.824	1.049	•	Thousands of E		2.409	5.008	4.020	
Length (ft)	5,890	12,300	23,200	47,600			219,000	387,000	780.000	
10 20	4,050		í í	32,700	71,300 49,000	137,000			789,000	
	· · · · ·	8,460	15,900	<i>.</i>		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 57,500	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.

TABLE 402.4(25)
SCHEDULE 40 METALLIC PIPE

Gas	Undiluted Propane
Inlet Pressure	2.0 psi
Pressure Drop	1.0 psi
Specific Gravity	1.50

PIPE SIZE (in.)												
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	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 E	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			

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

Gas	Undiluted Propane
Inlet Pressure	11.0 in. w.c.
Pressure Drop	0.5 in. w.c.
Specific Gravity	1.50

		Bing sizing between first stage (high pressure regulator) and second stage (low pressure regulator)											
SPECIAI	LUSE	Pipe sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator). PIPE SIZE (in.)											
	1,	21			1		21/						
Nominal	1/2	3/4	1	11/4	11/2	2	21/2	3	4.026				
Actual ID	0.622	0.824	824         1.049         1.380         1.610         2.067         2.469         3.068           Capacity in Thousands of Btu per Hour										
Length (ft)	201	(00	1.150				10.000	10.100	20.000				
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			892	1,340	2,570	4,100	7,250	14,800					
80	0 101 212 400 821		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			2,190 4,4					
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	76	150	226	436	694	1,230	2,500				
1,900	19	38	71	146	219	422	672	1,190	2,300				
2,000	18	37	69	140	219	409	652	1,150	2,420				

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.

	TADI	F 400 4/07)		Gas Undiluted Propane							
		E 402.4(27) COPPER TUE	BING			Inlet Pr		10.0	1	-	
						Pressur		1.0	1		
									1		
						Specific (	Gravity	1.50	)		
SPECIAL USE		Sizing betwe	een first stage	(high-pressure		d second stag	e (low-pre	essur	e regulator).		
	1.	21	1.	TUBE SIZE (in			11/		11/	2	
K&L	1/4 3/8	<sup>3</sup> / <sub>8</sub> 1/ <sub>2</sub>	1/2 5/8	5/8 3/4	<sup>3</sup> / <sub>4</sub> 7/ <sub>8</sub>	1 1 <sup>1</sup> /8	1 <sup>1</sup> /4 1 <sup>3</sup> /8		11/2	2	
Nominal ACR Outside	0.375	0.500	0.625	0.750	0.875	1.125	1.375		1.625	2.125	
Inside	0.305	0.300	0.623	0.652	0.875	0.995	1.245		1.481	1.959	
Length (ft)	0.303	0.402	0.327		housands of		1.24.	)	1.401	1.939	
10	513	1,060	2,150	3,760	5,330	11,400	20,50	0	32,300	67,400	
20	352	727	1,480	2,580	3,670	7,830	14,10		22,200	46,300	
30	283	584	1,190	2,080	2,940	6,290	11,30	0	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	
750 800	<u> </u>	102 99	208 201	364 351	516 498	1,100 1,060	1,980 1,920		3,130 3,020	6,520 6,290	
850	48	99	195	340	498 482	1,080	1,920		2,920	6,090	
900	40	90	193	330	468	1,030	1,800		2,920	5,910	
950	43	93	189	320	408	970	1,800		2,840	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	1,310		2,320	4,840	
1,400	35	73	148	260	368	787	1,420		2,320	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	

60

122

### Notes:

2,000

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

214

304

648

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

29

1,840

3,830

1,170

# GAS PIPING INSTALLATIONS

# TABLE 402.4(28) SEMIRIGID COPPER TUBING

Gas	Undiluted Propane
Inlet Pressure	11.0 in. w.c.
Pressure Drop	0.5 in. w.c.
Specific Gravity	1.50

SPECI	AL USE	Sizing between first stage (high-pressure regulator) and second stage (low-pressure regulator)												
			TUBE SIZE (in.)           1/.         3/.         1         11/.         11/.         2											
-	K & L	1/4	3/8	1/2	5/8	3/4	1	11/4	11/2	2				
Nominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8						
	tside	0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125				
	side	0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959				
	jth (ft)					Thousands of								
	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				
	50	17	35	71	125	177	378	681	1,070	2,240				
	70	16	32	66	115	163	348	626	988	2,060				
	30	15	30	61	107	152	324	583	919	1,910				
	90	14	28	57	100	142	304	547	862	1,800				
	00	13	27	54	95	134	287	517	814	1,700				
	25	11	24	48	84	119	254	458	722	1,500				
	50	10	21	44	76	108	230	415	654	1,360				
	75	NA	20	40	70	99	212	382	602	1,250				
2	00	NA	18	37	65	92	197	355	560	1,170				
2	50	NA	16	33	58	82	175	315	496	1,030				
3	00	NA	15	30	52	74	158	285	449	936				
3.	50	NA	14	28	48	68	146	262	414	861				
4	00	NA	13	26	45	63	136	244	385	801				
4	50	NA	12	24	42	60	127	229	361	752				
5	00	NA	11	23	40	56	120	216	341	710				
5.	50	NA	11	22	38	53	114	205	324	674				
6	00	NA	10	21	36	51	109	196	309	643				
6	50	NA	NA	20	34	49	104	188	296	616				
7	00	NA	NA	19	33	47	100	180	284	592				
7.	50	NA	NA	18	32	45	96	174	274	570				
8	00	NA	NA	18	31	44	93	168	264	551				
8	50	NA	NA	17	30	42	90	162	256	533				
9	00	NA	NA	17	29	41	87	157	248	517				
9	50	NA	NA	16	28	40	85	153	241	502				
1,0	000	NA	NA	16	27	39	83	149	234	488				
1,1	100	NA	NA	15	26	37	78	141	223	464				
1,2	200	NA	NA	14	25	35	75	135	212	442				
1,3	300	NA	NA	14	24	34	72	129	203	423				
1,4	400	NA	NA	13	23	32	69	124	195	407				
1,5	500	NA	NA	13	22	31	66	119	188	392				
1,0	600	NA	NA	12	21	30	64	115	182	378				
1,7	700	NA	NA	12	20	29	62	112	176	366				
1,8	800	NA	NA	11	20	28	60	108	170	355				
1,9	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.

			E 402.4(29) COPPER TUI	BING		Inlet Pr		2.0 psi			
							Pressur	e Drop	1.0 psi		
							Specific (	Gravity	1.50		
					TUBE SIZE (ir	ı.)				-	
-	K & L	1/4	3/8	1/2	5/8	3/4	1	$1^{1}/_{4}$	11/2	2	
Nominal	ACR	3/8	1/2	5/8	3/4	7/8	11/8	13/8			
Out	tside	0.375	0.500	0.625	0.750	0.875	1.125	1.37	5 1.625	2.125	
Ins	side	0.305	0.402	0.527	0.652	0.745	0.995	1.24	5 1.481	1.959	
Leng	gth (ft)		i		Capacity in	Thousands of	Btu per Hour				
1	10	413	852	1,730	3,030	4,300	9,170	16,50	0 26,000	54,200	
2	20	284	585	1,190	2,080	2,950	6,310	11,40	0 17,900	37,300	
3	30	228	470	956	1,670	2,370	5,060	9,12	0 14,400	29,900	
4	40	195	402	818	1,430	2,030	4,330	7,80	0 12,300	25,600	
	50	173	356	725	1,270	1,800	3,840	6,92		22,700	
	50	157	323	657	1,150	1,630	3,480	6,27		20,600	
	70	144	297	605	1,060	1,500	3,200	5,76		18,900	
	80	134	276	562	983	1,390	2,980	5,36		17,600	
ç	90	126	259	528	922	1,310	2,790	5,03	0 7,930	16,500	
1	00	119	245	498	871	1,240	2,640	4,75		15,600	
1	25	105	217	442	772	1,100	2,340	4,21	0 6,640	13,800	
1	50	95	197	400	700	992	2,120	3,82		12,500	
	75	88	181	368	644	913	1,950	3,51		11,500	
2	.00	82	168	343	599	849	1,810	3,27		10,700	
	50	72	149	304	531	753	1,610	2,90	0 4,560	9,510	
3	00	66	135	275	481	682	1,460	2,62	0 4,140	8,610	
3	50	60	124	253	442	628	1,340	2,41	0 3,800	7,920	
4	00	56	116	235	411	584	1,250	2,25		7,370	
4	50	53	109	221	386	548	1,170	2,11		6,920	
5	00	50	103	209	365	517	1,110	1,99		6,530	
5	50	47	97	198	346	491	1,050	1,89	0 2,980	6,210	
6	00	45	93	189	330	469	1,000	1,80		5,920	
	50	43	89	181	316	449	959	1,73	0 2,720	5,670	
	00	41	86	174	304	431	921	1,66		5,450	
	50	40	82	168	293	415	888	1,60		5,250	
	00	39	80	162	283	401	857	1,54		5,070	
	50	37	77	157	274	388	829	1,49		4,900	
	00	36	75	152	265	376	804	1,45		4,750	
	50	35	72	147	258	366	781	1,41		4,620	
	000	34	71	143	251	356	760	1,37		4,490	
	100	32	67	136	238	338	721	1,30		4,270	
	200	31	64	130	227	322	688	1,24		4,070	
	300	30	61	124	217	309	659	1,19		3,900	
	400	28	59	120	209	296	633	1,14		3,740	
	500	27	57	115	201	286	610	1,10		3,610	
	600 700	26	55	111	194	276	589	1,06		3,480	
	700	26	53	108	188	267	570	1,03		3,370	
	800	25	51	104	182	259	553	1,00		3,270	
	900 000	24 23	50 48	101 99	177 172	251 244	537 522	<u>966</u> 940		3,170 3,090	

### 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) CORRUGATED STAINLESS STEEL TUBING (CSST)

Gas	Undiluted Propane
Inlet Pressure	11.0 in. w.c.
Pressure Drop	0.5 in. w.c.
Specific Gravity	1.50

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

TABLE 402.4(31)
CORRUGATED STAINLESS STEEL TUBING (CSST)

	Gas	Undiluted Propane
	Inlet Pressure	2.0 psi
	Pressure Drop	1.0 psi
	Specific Gravity	1.50
<b>D</b> \		

		-			-	TUBE SIZE	(EHD)						
Flow Designation	13	15	18	19	23	25	30	31	37	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	15,200	16,800	29,400	34,200
25	262	347	591	701	1,120	1,380	2,560	2,950	4,560	9,550	10,700	18,800	21,700
30	238	316	540	640	1,030	1,270	2,330	2,690	4,180	8,710	9,790	17,200	19,800
40	203	271	469	554	896	1,100	2,010	2,320	3,630	7,530	8,500	14,900	17,200
50	181	243	420	496	806	986	1,790	2,070	3,260	6,730	7,610	13,400	15,400
75	147	196	344	406	663	809	1,460	1,690	2,680	5,480	6,230	11,000	12,600
80	140	189	333	393	643	768	1,410	1,630	2,590	5,300	6,040	10,600	12,200
100	124	169	298	350	578	703	1,260	1,450	2,330	4,740	5,410	9,530	10,900
150	101	137	245	287	477	575	1,020	1,180	1,910	3,860	4,430	7,810	8,890
200	86	118	213	248	415	501	880	1,020	1,660	3,340	3,840	6,780	7,710
250	77	105	191	222	373	448	785	910	1,490	2,980	3,440	6,080	6,900
300	69	96	173	203	343	411	716	829	1,360	2,720	3,150	5,560	6,300
400	60	82	151	175	298	355	616	716	1,160	2,350	2,730	4,830	5,460
500	53	72	135	158	268	319	550	638	1,030	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 = 6.895 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  $\frac{1}{2}$  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.

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

Gas	Undiluted Propane
Inlet Pressure	5.0 psi
Pressure Drop	3.5 psi
Specific Gravity	1.50

					-	TUBE SIZE	(EHD)						
Flow Designation	13	15	18	19	23	25	30	31	37	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	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	18,000	19,900	34,700	40,400
30	461	603	999	1,190	1,870	2,340	4,430	5,100	7,680	16,400	18,200	31,700	36,900
40	396	520	867	1,030	1,630	2,030	3,820	4,400	6,680	14,200	15,800	27,600	32,000
50	352	463	777	926	1,460	1,820	3,410	3,930	5,990	12,700	14,100	24,700	28,600
75	284	376	637	757	1,210	1,490	2,770	3,190	4,920	10,300	11,600	20,300	23,400
80	275	363	618	731	1,170	1,450	2,680	3,090	4,770	9,990	11,200	19,600	22,700
100	243	324	553	656	1,050	1,300	2,390	2,760	4,280	8,930	10,000	17,600	20,300
150	196	262	453	535	866	1,060	1,940	2,240	3,510	7,270	8,210	14,400	16,600
200	169	226	393	464	755	923	1,680	1,930	3,050	6,290	7,130	12,500	14,400
250	150	202	352	415	679	828	1,490	1,730	2,740	5,620	6,390	11,200	12,900
300	136	183	322	379	622	757	1,360	1,570	2,510	5,120	5,840	10,300	11,700
400	117	158	279	328	542	657	1,170	1,360	2,180	4,430	5,070	8,920	10,200
500	104	140	251	294	488	589	1,050	1,210	1,950	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.

	TABLE 402.4(33)				Gas		Undiluted Propane	
POLYETHYLENE PLASTIC PIPE				Inlet Pressure		11.0 in. w.c.		
				Press	ure Drop	0.5 in. w.	с.	
				Specifi	c Gravity	1.50		
			PIPE SIZE (in.)					
Nominal OD	1/2	3/4	1	11/4	1	1/ <sub>2</sub>	2	
Designation	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00 SDR 11.00			SDR 11.00	
Actual ID	0.660	0.860	1.077	1.328	1.	554	54 1.943	
Length (ft)			Capacity in Thousa	ands of Btu per Hour				
10	340	680	1,230	2,130	3,	210	5,770	
20	233	468	844	1,460	2,	210	3,970	
30	187	375	677	1,170	1,	770	3,180	
40	160	321	580	1,000	1,	520	2,730	
50	142	285	514	890	1,	340	2,420	
60	129	258	466	807	1,	220	2,190	
70	119	237	428	742	1,	120	2,010	
80	110	221	398	690	1,	040	1,870	
90	103	207	374	648	9	78	1,760	
100	98	196	353	612	9	24	1,660	
125	87	173	313	542	8	19	1,470	
150	78	157	284	491	7	42	1,330	
175	72	145	261	452	6	83	1,230	
200	67	135	243	420	6	35	1,140	
250	60	119	215	373	5	63	1,010	
300	54	108	195	338	5	10	916	
350	50	99	179	311	4	.69	843	
400	46	92	167	289	4	-36	784	
450	43	87	157	271	4	.09	736	
500	41	82	148	256	3	87	695	

# TABLE 402.4(34) POLYETHYLENE PLASTIC PIPE

Gas	Undiluted Propane
Inlet Pressure	2.0 psi
Pressure Drop	1.0 psi
Specific Gravity	1.50

			PIPE SIZE (in.)		1			
Nominal OD	1/2	3/4	1	1 <sup>1</sup> /4	11/2	2		
Designation	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00		
Actual ID	0.660	0.860	1.077	1.328	1.554	1.943		
Length (ft)	Capacity in Thousands of Btu per Hour							
10	3,130	6,260	11,300	19,600	29,500	53,100		
20	2,150	4,300	7,760	13,400	20,300	36,500		
30	1,730	3,450	6,230	10,800	16,300	29,300		
40	1,480	2,960	5,330	9,240	14,000	25,100		
50	1,310	2,620	4,730	8,190	12,400	22,200		
60	1,190	2,370	4,280	7,420	11,200	20,100		
70	1,090	2,180	3,940	6,830	10,300	18,500		
80	1,010	2,030	3,670	6,350	9,590	17,200		
90	952	1,910	3,440	5,960	9,000	16,200		
100	899	1,800	3,250	5,630	8,500	15,300		
125	797	1,600	2,880	4,990	7,530	13,500		
150	722	1,450	2,610	4,520	6,830	12,300		
175	664	1,330	2,400	4,160	6,280	11,300		
200	618	1,240	2,230	3,870	5,840	10,500		
250	548	1,100	1,980	3,430	5,180	9,300		
300	496	994	1,790	3,110	4,690	8,430		
350	457	914	1,650	2,860	4,320	7,760		
400	425	851	1,530	2,660	4,020	7,220		
450	399	798	1,440	2,500	3,770	6,770		
500	377	754	1,360	2,360	3,560	6,390		
550	358	716	1,290	2,240	3,380	6,070		
600	341	683	1,230	2,140	3,220	5,790		
650	327	654	1,180	2,040	3,090	5,550		
700	314	628	1,130	1,960	2,970	5,330		
750	302	605	1,090	1,890	2,860	5,140		
800	292	585	1,050	1,830	2,760	4,960		
850	283	566	1,020	1,770	2,670	4,800		
900	274	549	990	1,710	2,590	4,650		
950	266	533	961	1,670	2,520	4,520		
1,000	259	518	935	1,620	2,450	4,400		
1,100	246	492	888	1,540	2,320	4,170		
1,200	234	470	847	1,470	2,220	3,980		
1,300	225	450	811	1,410	2,120	3,810		
1,400	216	432	779	1,350	2,040	3,660		
1,500	208	416	751	1,300	1,960	3,530		
1,600	200	402	725	1,260	1,900	3,410		
1,700	194	389	702	1,220	1,840	3,300		
1,800	188	377	680	1,180	1,780	3,200		
1,900	183	366	661	1,140	1,730	3,110		
2,000	178	356	643	1,110	1,680	3,020		

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.

Inlet Press Pressure I Specific Gra Nominal OD Designation	Drop avity Pla 1 SDR	/ <sub>2</sub>	c.	
Pressure I Specific Gra Nominal OD	Drop avity Pla 1 SDR	0.5 in. w.c. 1.50 astic Tubing	Size (CTS) (in.)	
Specific Gra	avity Pla 1 SDR	1.50 astic Tubing	Size (CTS) (in.)	
Nominal OD	Pla 1 SDR	astic Tubing $I_2$		
	1 SDR	/ <sub>2</sub>		
	SDR		3/	
Designation			'4	
	04	. 7.00	SDR 11.00	
Actual ID	0	145	0.927	
Length (ft)	Capaci	ty in Cubic F	eet of Gas per Hour	
10	12	21	828	
20	8	3	569	
30	67		457	
40	57		391	
50	5	1	347	
60	46		314	
70	42		289	
80	3	9	269	
90	37		252	
100	35		238	
125	3	1	211	
150	28		191	
175	26		176	
200	2	4	164	
225	22		154	
250	21		145	
275	20		138	
300	1	9	132	
350	1	8	121	
400	1	6	113	
450	1	5	106	
500		5	100	

# TABLE 402.4(35) POLYETHYLENE PLASTIC TUBING

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.

# SECTION 403 (IFGS) PIPING MATERIALS

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

**403.2 Used materials.** Pipe, fittings, valves and other materials shall not be used again except where they are free of foreign

materials and have been ascertained to be adequate for the service intended.

**403.3 Other materials.** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service, and, in addition, shall be recommended for that service by the manufacturer 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 B 36.10, 10M;
- 2. ASTM A 53; or
- 3. ASTM A 106.

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

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

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

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

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

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

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

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

**403.5.4 Corrugated stainless steel tubing.** Corrugated stainless steel tubing shall be listed in accordance with ANSI LC 1/CSA 6.26.

**403.6 Plastic pipe, tubing and fittings.** Plastic pipe, tubing and fittings used to supply fuel gas shall be used outdoors, underground, only, and shall conform to ASTM D 2513. Pipe shall be marked "Gas" and "ASTM D 2513."

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

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

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

**403.6.3 Regulator vent piping.** Plastic pipe, tubing and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to 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 (see Section 406.1.2).

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

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

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

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

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

**403.10 Metallic piping joints and fittings.** The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tight-

ness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force caused by the internal pressure and any additional forces caused by temperature expansion or contraction, vibration, fatigue or the weight of the pipe and its contents.

TABLE 403.9.2 SPECIFICATIONS FOR THREADING METALLIC PIPE

IRON PIPE SIZE (inches)	APPROXIMATE LENGTH OF THREADED PORTION (inches)	APPROXIMATE NUMBER OF THREADS TO BE CUT
<sup>1</sup> / <sub>2</sub>	3/4	10
3/4	<sup>3</sup> / <sub>4</sub>	10
1	7/8	10
11/4	1	11
11/2	1	11
2	1	11
21/2	1 <sup>1</sup> / <sub>2</sub>	12
3	1 <sup>1</sup> / <sub>2</sub>	12
4	15/8	13

For SI: 1 inch = 25.4 mm.

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

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

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

**403.10.4 Metallic fittings.** Metallic fittings 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 mix-tures.
- 8. Special fittings. Fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless or compressiontype 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 piping material.
- 2. Heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gas-tight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat fusion fittings shall be marked "ASTM D 2513."
- 3. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used.
- 4. Plastic piping joints and fittings for use in liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

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

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

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

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

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

# SECTION 404 (IFGC) PIPING SYSTEM INSTALLATION

**404.1 Prohibited locations.** Piping shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. Piping installed downstream of the point of delivery shall not extend through any townhouse unit other than the unit served by such piping.

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

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

## **Exceptions:**

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

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

**404.5 Protection against physical damage.** In concealed locations, where piping other than black or galvanized steel is installed through holes or notches in wood studs, joists, rafters or similar members less than 1.5 inches (38 mm) from the nearlest edge of the member, the pipe shall be protected by shield plates. Shield plates shall be a minimum of  ${}^{1}\!/_{16}$ -inch-thick (1.6 mm) steel, shall cover the area of the pipe where the member is notched or bored and shall extend a minimum of 4 inches (102 mm) above sole plates, below top plates and to each side of a stud, joist or rafter.

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

**404.7** Above-ground outdoor piping. All piping installed outdoors shall be elevated not less than  $3^{1}/_{2}$  inches (152 mm) above ground and where installed across roof surfaces, shall be elevated not less than  $3^{1}/_{2}$  inches (152 mm) above the roof surface. Piping installed above ground, outdoors, and installed across the surface of roofs shall be securely supported and located where it will be protected from physical damage. Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. Where piping is encased in a protective pipe sleeve, the annular space between the piping and the sleeve shall be sealed.

**404.8 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 piping underground. Ferrous metal exposed in exterior locations shall be protected from corrosion in a manner satisfactory to the code official. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

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

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

**404.8.3 Coating application.** Joints in gas piping shall not be coated prior to testing and approval.

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

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

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

**404.11 Piping underground beneath buildings.** Piping installed underground beneath buildings is prohibited except where the piping is encased in a conduit of wrought iron, plastic pipe, or steel pipe designed to withstand the superimposed loads. Such conduit shall extend into an occupiable portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is capable of withstanding the full pressure of the gas pipe, the conduit shall be designed for the

same pressure as the pipe. Such conduit shall extend not less than 4 inches (102 mm) outside the building, shall be vented above grade to the outdoors, and shall be installed so as to prevent the entrance of water and insects. The conduit shall be protected from corrosion in accordance with Section 404.8.

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

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

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

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

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

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

#### **Exceptions:**

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

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

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

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

Exception: Approved gas filters.

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

**404.17 Isolation.** Metallic piping 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.

# 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 piping 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 piping installations shall be inspected and pressure tested to determine that the materials, design, fabrication and installation practices comply with the requirements of this code.

**406.1.1 Inspections.** Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of nondestructive inspection techniques, such as magnetic-

particle, radiographic, ultrasonic, etc., shall not be required unless specifically listed herein or in the engineering design.

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

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

**406.1.3 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 piping and the existing piping shall be tested with a noncorrosive leak-detecting fluid or other approved leak-detecting methods.

**406.1.4 Section testing.** A piping 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 piping 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 piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication.

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

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

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

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

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

**406.3.3 Appliance and equipment disconnection.** Where the piping 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 piping system by disconnecting them and capping the outlet(s).

**406.3.4 Valve isolation.** Where the piping 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 piping system by closing the individual appliance or equipment shutoff valve(s).

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

**406.4 Test pressure measurement.** Test pressure shall be measured with a manometer or with a pressure-measuring device designed and calibrated to read, record or indicate a pressure loss caused by leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test 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  $1^{1}/_{2}$  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 piping 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  $1/_2$  hour for each 500 cubic feet (14 m<sup>3</sup>) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet (0.28 m<sup>3</sup>) 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 piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects.

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

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

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

**406.6 Piping system, appliance 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 piping systems that have been pressure tested in accordance with Section 406.

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

**406.6.3 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 piping 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 piping system has been checked for leakage in accordance with Section 406.6.3 and determined to be free of leakage and purged in accordance with Section 406.7.2.

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

**406.7.1 Removal from service.** Where gas piping is to be opened for servicing, addition or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors, or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures.

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

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

NOMINAL PIPE SIZE (inches)	LENGTH OF PIPING REQUIRING PURGING	
21/2	> 50 feet	
3	> 30 feet	
4	> 15 feet	
6	> 10 feet	
8 or larger	Any length	

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

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

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

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

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

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

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

#### SECTION 407 (IFGC) PIPING SUPPORT

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

**407.2 Design and installation.** Piping shall be supported with pipe hooks, metal pipe straps, bands, brackets or hangers suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58 and shall be spaced in accordance with Section 415. Supports, hangers and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.

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

**408.1 Slopes.** Piping for other than dry gas conditions shall be sloped not less than  $\frac{1}{4}$  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 gas utilization equipment, a sediment trap shall be installed downstream of the equipment shutoff valve as close to the inlet of the equipment as practical. The sediment trap shall be either a tee fitting with a capped nipple in the bottom opening of the run of the tee or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers 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 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.

**409.3.1 Multiple tenant buildings.** In multiple tenant buildings, where a common piping system is installed to supply other than one- and two-family dwellings, shutoff valves shall be provided for each tenant. Each tenant shall have access to the shutoff valve serving that tenant's space.

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

#### TABLE 409.1.1 MANUAL GAS VALVE STANDARDS

	APPLIANCE SHUTOFF	OTHER VALVE APPLICATIONS			
VALVE STANDARDS	VALVE APPLICATION UP TO <sup>1</sup> / <sub>2</sub> psig PRESSURE	UP TO <sup>1</sup> / <sub>2</sub> psig PRESSURE	UP TO 2 psig PRESSURE	UP TO 5 psig PRESSURE	UP TO 125 psig PRESSURE
ANSI Z21.15	X	_			
CSA Requirement 3-88	X	Х	Xa	Xb	
ASME B16.44	X	Х	Xa	X <sup>b</sup>	
ASME B16.33	X	Х	X	Х	Х

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

a. If labeled 2G.

b. If labeled 5G.

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

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

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

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

**409.5.1 Shutoff valve in fireplace.** Equipment shutoff valves located in the firebox of a fireplace shall be installed in accordance with the appliance manufacturer's instructions.

### 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 l 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 piping.** Vent piping shall be not smaller than the vent connection on the pressure regulating device. Vent piping 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 piping 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.

### 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 piping 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 installation 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.
- Listed and labeled appliance connectors complying with ANSI Z21.69 and listed for use with food service equipment having casters, or that is otherwise subject to movement for cleaning, and other large movable equipment.
- 8. Listed and labeled outdoor appliance connectors in compliance with ANSI Z21.75/CSA 6.27 and installed in accordance with the manufacturer's installation instructions.

**411.1.1 Commercial cooking appliances.** Commercial cooking appliances that are moved for cleaning and sanitation purposes shall be connected to the piping system with an appliance connector listed as complying with ANSI Z21.69.

**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 3 feet (914 mm), except for range and domestic clothes dryer connectors, which shall not exceed 6 feet (1829 mm) in overall length. Measurement shall be made along the centerline of the connector. Only one connector shall be used for each appliance.

**Exception:** Rigid metallic piping used to connect an appliance to the piping system shall be permitted to have a total length greater than 3 feet (914 mm), provided that the connecting pipe is sized as part of the piping system in accordance with Section 402 and the location of the equipment 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.

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

**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 piping by means of an approved flexible connector designed and labeled for the application. Such flexible connectors shall be installed and protected against physical damage in accordance with the manufacturer's installation instructions.

**411.2 Manufactured home connections.** Manufactured homes shall be connected to the distribution piping 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.

#### 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 piping 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 or buildings having combustible overhangs, property which could be built on public streets, or 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 piping. 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 piping 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 valves; and pressure regulators and piping 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 line 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 piping system without causing damage to the piping 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.** Piping 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 piping, regulators and equipment settings shall be provided to the code official for review and approval. The drawing shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

**[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, piping, 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 noncombustible materials.

**[F] 413.9.2.3 Separation.** The structure or appurtenance used for stabilizing the cylinder shall be separated from

4-46

the site equipment, features and exposures and shall be located in accordance with Table 413.9.2.3.

**[F] 413.9.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with the *International Code Council Electrical Code—Administrative Provisions*. 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 CYLIN-DER SHALL BE BONDED signs shall be posted on the cylinder support structure or appurtenance.

#### [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

## SECTION 414 (IFGC) SUPPLEMENTAL AND STANDBY GAS SUPPLY

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

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

## SECTION 415 (IFGS) PIPING SUPPORT INTERVALS

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

SUFFORT OF FIFING			
STEEL PIPE, NOMINAL SIZE OF PIPE (inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING (SMOOTH-WALL) (inch O.D.)	SPACING OF SUPPORTS (feet)
<sup>1</sup> / <sub>2</sub>	6	<sup>1</sup> / <sub>2</sub>	4
<sup>3</sup> / <sub>4</sub> or 1	8	$\frac{5}{8}$ or $\frac{3}{4}$	6
1 <sup>1</sup> / <sub>4</sub> or larger (horizontal)	10	<sup>7</sup> / <sub>8</sub> or 1 (Horizontal)	8
$1^{1}/_{4}$ or larger (vertical)	Every floor level	1 or Larger (vertical)	Every floor level

TABLE 415.1 SUPPORT OF PIPING

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 piping 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 piping 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 down-stream system.
- 2. 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 properly maintained; and inspection procedures shall be devised or suitable instrumentation installed to detect failures or malfunctions of such devices; and replacements or repairs shall be promptly 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:

- 1. Pipe connections to the service or line regulator do not exceed 2 inches (51 mm) nominal diameter.
- 2. The regulator is self-contained with no external static or control piping.

- 3. 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.
- 4. 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.
- 5. 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:

- 1. Spring-loaded relief device.
- 2. 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.
- 3. A monitoring regulator installed in series with the service or line pressure regulator.
- 4. 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.
- 5. 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.
- 6. 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.** Precautions shall be taken to prevent unauthorized operation of any shutoff valve that will make a pressure-relieving valve or pressure-limiting device inoperative. The following are acceptable methods for complying with this provision:

- 1. 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.
- 2. 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.