## CHAPTER 4 <br> 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) <br> 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 I 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.

TABLE 402.2
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES

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

For SI: 1 British thermal unit per hour $=0.293 \mathrm{~W}, 1$ gallon $=3.785 \mathrm{~L}$, 1 gallon per minute $=3.785 \mathrm{~L} / \mathrm{m}$.
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]:

$$
\begin{equation*}
D=\frac{Q^{0.381}}{18.93\left[\frac{\left(P_{1}^{2}-P_{2}^{2}\right) \times Y}{C_{r} \times L}\right]^{0.206}} \tag{Equation4-2}
\end{equation*}
$$

where:
$D=$ Inside diameter of pipe, inches (mm).
$Q=$ Input rate appliance(s), cubic feet per hour at $60^{\circ} \mathrm{F}$ $\left(16^{\circ} \mathrm{C}\right)$ and 30 -inch mercury column
$P_{1}=$ Upstream pressure, $\mathrm{psia}\left(P_{1}+14.7\right)$
$P_{2}=$ Downstream pressure, psia $\left(P_{2}+14.7\right)$
$L=$ Equivalent length of pipe, feet
$\Delta H=$ Pressure drop, inch water column (27.7 inch water column $=1 \mathrm{psi}$ )

TABLE 402.4 $C_{r}$ AND $Y$ VALUES FOR NATURAL GAS AND UNDILUTED PROPANE AT STANDARD CONDITIONS

| GAS | EQUATION FACTORS |  |
| :---: | :---: | :---: |
|  | $\boldsymbol{c}_{\boldsymbol{r}}$ | $\boldsymbol{Y}$ |
| Natural gas | 0.6094 | 0.9992 |
| Undiluted propane | 1.2462 | 0.9910 |

For SI: 1 cubic foot $=0.028 \mathrm{~m}^{3}, 1$ foot $=305 \mathrm{~mm}, 1$-inch water column $=$ $0.249 \mathrm{kPa}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$ British thermal unit per hour $=0.293 \mathrm{~W}$.
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:
3. The piping system is welded.
4. The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
5. 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.
6. 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 $-5^{\circ} \mathrm{F}\left(-21^{\circ} \mathrm{C}\right)$ 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 used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes

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

| TABLE 402.4(2) SCHEDULE 40 METALLIC PIPE |  |  |  |  |  |  |  | Gas |  |  |  | Natural |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  | Inlet Pressure |  |  |  | Less than 2 psi |  |  |
|  |  |  |  |  |  |  |  | Pressure Drop |  |  |  | 0.5 in. w.c. |  |  |
|  |  |  |  |  |  |  |  | Specific Gravity |  |  |  | 0.60 |  |  |
| 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 Feet of Gas Per Hour |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 172 | 360 | 678 | 1,390 | 2,090 | 4,020 | 6,400 | 11,300 | 23,100 | 41,800 | 67,600 | 139,000 | 252,000 | 399,000 |
| 20 | 118 | 247 | 466 | 957 | 1,430 | 2,760 | 4,400 | 7,780 | 15,900 | 28,700 | 46,500 | 95,500 | 173,000 | 275,000 |
| 30 | 95 | 199 | 374 | 768 | 1,150 | 2,220 | 3,530 | 6,250 | 12,700 | 23,000 | 37,300 | 76,700 | 139,000 | 220,000 |
| 40 | 81 | 170 | 320 | 657 | 985 | 1,900 | 3,020 | 5,350 | 10,900 | 19,700 | 31,900 | 65,600 | 119,000 | 189,000 |
| 50 | 72 | 151 | 284 | 583 | 873 | 1,680 | 2,680 | 4,740 | 9,660 | 17,500 | 28,300 | 58,200 | 106,000 | 167,000 |
| 60 | 65 | 137 | 257 | 528 | 791 | 1,520 | 2,430 | 4,290 | 8,760 | 15,800 | 25,600 | 52,700 | 95,700 | 152,000 |
| 70 | 60 | 126 | 237 | 486 | 728 | 1,400 | 2,230 | 3,950 | 8,050 | 14,600 | 23,600 | 48,500 | 88,100 | 139,000 |
| 80 | 56 | 117 | 220 | 452 | 677 | 1,300 | 2,080 | 3,670 | 7,490 | 13,600 | 22,000 | 45,100 | 81,900 | 130,000 |
| 90 | 52 | 110 | 207 | 424 | 635 | 1,220 | 1,950 | 3,450 | 7,030 | 12,700 | 20,600 | 42,300 | 76,900 | 122,000 |
| 100 | 50 | 104 | 195 | 400 | 600 | 1,160 | 1,840 | 3,260 | 6,640 | 12,000 | 19,500 | 40,000 | 72,600 | 115,000 |
| 125 | 44 | 92 | 173 | 355 | 532 | 1,020 | 1,630 | 2,890 | 5,890 | 10,600 | 17,200 | 35,400 | 64,300 | 102,000 |
| 150 | 40 | 83 | 157 | 322 | 482 | 928 | 1,480 | 2,610 | 5,330 | 9,650 | 15,600 | 32,100 | 58,300 | 92,300 |
| 175 | 37 | 77 | 144 | 296 | 443 | 854 | 1,360 | 2,410 | 4,910 | 8,880 | 14,400 | 29,500 | 53,600 | 84,900 |
| 200 | 34 | 71 | 134 | 275 | 412 | 794 | 1,270 | 2,240 | 4,560 | 8,260 | 13,400 | 27,500 | 49,900 | 79,000 |
| 250 | 30 | 63 | 119 | 244 | 366 | 704 | 1,120 | 1,980 | 4,050 | 7,320 | 11,900 | 24,300 | 44,200 | 70,000 |
| 300 | 27 | 57 | 108 | 221 | 331 | 638 | 1,020 | 1,800 | 3,670 | 6,630 | 10,700 | 22,100 | 40,100 | 63,400 |
| 350 | 25 | 53 | 99 | 203 | 305 | 587 | 935 | 1,650 | 3,370 | 6,100 | 9,880 | 20,300 | 36,900 | 58,400 |
| 400 | 23 | 49 | 92 | 189 | 283 | 546 | 870 | 1,540 | 3,140 | 5,680 | 9,190 | 18,900 | 34,300 | 54,300 |
| 450 | 22 | 46 | 86 | 177 | 266 | 512 | 816 | 1,440 | 2,940 | 5,330 | 8,620 | 17,700 | 32,200 | 50,900 |
| 500 | 21 | 43 | 82 | 168 | 251 | 484 | 771 | 1,360 | 2,780 | 5,030 | 8,150 | 16,700 | 30,400 | 48,100 |
| 550 | 20 | 41 | 78 | 159 | 239 | 459 | 732 | 1,290 | 2,640 | 4,780 | 7,740 | 15,900 | 28,900 | 45,700 |
| 600 | 19 | 39 | 74 | 152 | 228 | 438 | 699 | 1,240 | 2,520 | 4,560 | 7,380 | 15,200 | 27,500 | 43,600 |
| 650 | 18 | 38 | 71 | 145 | 218 | 420 | 669 | 1,180 | 2,410 | 4,360 | 7,070 | 14,500 | 26,400 | 41,800 |
| 700 | 17 | 36 | 68 | 140 | 209 | 403 | 643 | 1,140 | 2,320 | 4,190 | 6,790 | 14,000 | 25,300 | 40,100 |
| 750 | 17 | 35 | 66 | 135 | 202 | 389 | 619 | 1,090 | 2,230 | 4,040 | 6,540 | 13,400 | 24,400 | 38,600 |
| 800 | 16 | 34 | 63 | 130 | 195 | 375 | 598 | 1,060 | 2,160 | 3,900 | 6,320 | 13,000 | 23,600 | 37,300 |
| 850 | 16 | 33 | 61 | 126 | 189 | 363 | 579 | 1,020 | 2,090 | 3,780 | 6,110 | 12,600 | 22,800 | 36,100 |
| 900 | 15 | 32 | 59 | 122 | 183 | 352 | 561 | 992 | 2,020 | 3,660 | 5,930 | 12,200 | 22,100 | 35,000 |
| 950 | 15 | 31 | 58 | 118 | 178 | 342 | 545 | 963 | 1,960 | 3,550 | 5,760 | 11,800 | 21,500 | 34,000 |
| 1,000 | 14 | 30 | 56 | 115 | 173 | 333 | 530 | 937 | 1,910 | 3,460 | 5,600 | 11,500 | 20,900 | 33,100 |
| 1,100 | 14 | 28 | 53 | 109 | 164 | 316 | 503 | 890 | 1,810 | 3,280 | 5,320 | 10,900 | 19,800 | 31,400 |
| 1,200 | 13 | 27 | 51 | 104 | 156 | 301 | 480 | 849 | 1,730 | 3,130 | 5,070 | 10,400 | 18,900 | 30,000 |
| 1,300 | 12 | 26 | 49 | 100 | 150 | 289 | 460 | 813 | 1,660 | 3,000 | 4,860 | 9,980 | 18,100 | 28,700 |
| 1,400 | 12 | 25 | 47 | 96 | 144 | 277 | 442 | 781 | 1,590 | 2,880 | 4,670 | 9,590 | 17,400 | 27,600 |
| 1,500 | 11 | 24 | 45 | 93 | 139 | 267 | 426 | 752 | 1,530 | 2,780 | 4,500 | 9,240 | 16,800 | 26,600 |
| 1,600 | 11 | 23 | 44 | 89 | 134 | 258 | 411 | 727 | 1,480 | 2,680 | 4,340 | 8,920 | 16,200 | 25,600 |
| 1,700 | 11 | 22 | 42 | 86 | 130 | 250 | 398 | 703 | 1,430 | 2,590 | 4,200 | 8,630 | 15,700 | 24,800 |
| 1,800 | 10 | 22 | 41 | 84 | 126 | 242 | 386 | 682 | 1,390 | 2,520 | 4,070 | 8,370 | 15,200 | 24,100 |
| 1,900 | 10 | 21 | 40 | 81 | 122 | 235 | 375 | 662 | 1,350 | 2,440 | 3,960 | 8,130 | 14,800 | 23,400 |
| 2,000 | NA | 20 | 39 | 79 | 119 | 229 | 364 | 644 | 1,310 | 2,380 | 3,850 | 7,910 | 14,400 | 22,700 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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

## TABLE 402.4(3) SCHEDULE 40 METALLIC PIPE

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | 2.0 psi |
| Pressure Drop | 1.0 psi |
| Specific Gravity | 0.60 |


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square $\mathrm{inch}=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

| TABLE 402.4(6) SEMIRIGID COPPER TUBING |  |  |  |  | Gas |  |  | Natural |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Inlet Pressure |  |  | Less than 2 psi |  |
|  |  |  |  |  | Pressure Drop |  |  | 0.3 in. w.c. |  |
|  |  |  |  |  | Specific Gravity |  |  | 0.60 |  |
| TUBE SIZE (inch) |  |  |  |  |  |  |  |  |  |
| K \& L | $1 / 4$ | $3 / 8$ | 1/2 | 5/8 | 3/4 | 1 | $1^{1 / 4}$ | $1^{1 / 2}$ | 2 |
| Nominal ACR | $3 / 8$ | 1/2 | 5/8 | $3 / 4$ | 7/8 | $1^{1 / 8}$ | $13 / 8$ | - | - |
| Outside | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| Inside | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| Length (ft) Capacity in Cubic Feet of Gas Per Hour |  |  |  |  |  |  |  |  |  |
| 10 | 20 | 42 | 85 | 148 | 210 | 448 | 806 | 1,270 | 2,650 |
| 20 | 14 | 29 | 58 | 102 | 144 | 308 | 554 | 873 | 1,820 |
| 30 | 11 | 23 | 47 | 82 | 116 | 247 | 445 | 701 | 1,460 |
| 40 | 10 | 20 | 40 | 70 | 99 | 211 | 381 | 600 | 1,250 |
| 50 | NA | 17 | 35 | 62 | 88 | 187 | 337 | 532 | 1,110 |
| 60 | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1,000 |
| 70 | NA | 14 | 29 | 52 | 73 | 156 | 281 | 443 | 924 |
| 80 | NA | 13 | 27 | 48 | 68 | 145 | 262 | 413 | 859 |
| 90 | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 100 | NA | 12 | 24 | 43 | 60 | 129 | 232 | 366 | 761 |
| 125 | NA | 11 | 22 | 38 | 53 | 114 | 206 | 324 | 675 |
| 150 | NA | 10 | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 175 | NA | NA | 18 | 31 | 45 | 95 | 171 | 270 | 563 |
| 200 | NA | NA | 17 | 29 | 41 | 89 | 159 | 251 | 523 |
| 250 | NA | NA | 15 | 26 | 37 | 78 | 141 | 223 | 464 |
| 300 | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 350 | NA | NA | 12 | 22 | 31 | 65 | 118 | 186 | 387 |
| 400 | NA | NA | 11 | 20 | 28 | 61 | 110 | 173 | 360 |
| 450 | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 500 | NA | NA | 10 | 18 | 25 | 54 | 97 | 153 | 319 |
| 550 | NA | NA | NA | 17 | 24 | 51 | 92 | 145 | 303 |
| 600 | NA | NA | NA | 16 | 23 | 49 | 88 | 139 | 289 |
| 650 | NA | NA | NA | 15 | 22 | 47 | 84 | 133 | 277 |
| 700 | NA | NA | NA | 15 | 21 | 45 | 81 | 128 | 266 |
| 750 | NA | NA | NA | 14 | 20 | 43 | 78 | 123 | 256 |
| 800 | NA | NA | NA | 14 | 20 | 42 | 75 | 119 | 247 |
| 850 | NA | NA | NA | 13 | 19 | 40 | 73 | 115 | 239 |
| 900 | NA | NA | NA | 13 | 18 | 39 | 71 | 111 | 232 |
| 950 | NA | NA | NA | 13 | 18 | 38 | 69 | 108 | 225 |
| 1,000 | NA | NA | NA | 12 | 17 | 37 | 67 | 105 | 219 |
| 1,100 | NA | NA | NA | 12 | 16 | 35 | 63 | 100 | 208 |
| 1,200 | NA | NA | NA | 11 | 16 | 34 | 60 | 95 | 199 |
| 1,300 | NA | NA | NA | 11 | 15 | 32 | 58 | 91 | 190 |
| 1,400 | NA | NA | NA | 10 | 14 | 31 | 56 | 88 | 183 |
| 1,500 | NA | NA | NA | NA | 14 | 30 | 54 | 84 | 176 |
| 1,600 | NA | NA | NA | NA | 13 | 29 | 52 | 82 | 170 |
| 1,700 | NA | NA | NA | NA | 13 | 28 | 50 | 79 | 164 |
| 1,800 | NA | NA | NA | NA | 13 | 27 | 49 | 77 | 159 |
| 1,900 | NA | NA | NA | NA | 12 | 26 | 47 | 74 | 155 |
| 2,000 | NA | NA | NA | NA | 12 | 25 | 46 | 72 | 151 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. NA means a flow of less than 10 cfh .
3. All table entries have been rounded to three significant digits.

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


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. NA means a flow of less than 10 cfh .
3. All table entries have been rounded to three significant digits.

| TABLE 402.4(8) SEMIRIGID COPPER TUBING |  |  |  |  | Gas |  |  | Natural |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Inlet Pressure |  |  | Less than 2 psi |  |
|  |  |  |  |  | Pressure Drop |  |  | 1.0 in. w.c. |  |
|  |  |  |  |  | Specific Gravity |  |  | 0.60 |  |
| TUBE SIZE (inch) |  |  |  |  |  |  |  |  |  |
| K \& L | 1/4 | $3 / 8$ | 1/2 | 5/8 | 3/4 | 1 | $11 / 4$ | $1^{1 / 2}$ | 2 |
| Nominal ACR | $3 / 8$ | 1/2 | 5/8 | $3 / 4$ | 7/8 | $1^{1 / 8}$ | $13 / 8$ | - | - |
| Outside | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| Inside | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.24 | 1.481 | 1.959 |
| Length (ft) |  |  |  |  |  |  |  |  |  |
| 10 | 39 | 80 | 162 | 283 | 402 | 859 | 1,550 | 2,440 | 5,080 |
| 20 | 27 | 55 | 111 | 195 | 276 | 590 | 1,060 | 1,680 | 3,490 |
| 30 | 21 | 44 | 89 | 156 | 222 | 474 | 853 | 1,350 | 2,800 |
| 40 | 18 | 38 | 77 | 134 | 190 | 406 | 730 | 1,150 | 2,400 |
| 50 | 16 | 33 | 68 | 119 | 168 | 359 | 647 | 1,020 | 2,130 |
| 60 | 15 | 30 | 61 | 107 | 152 | 326 | 586 | 925 | 1,930 |
| 70 | 13 | 28 | 57 | 99 | 140 | 300 | 539 | 851 | 1,770 |
| 80 | 13 | 26 | 53 | 92 | 131 | 279 | 502 | 791 | 1,650 |
| 90 | 12 | 24 | 49 | 86 | 122 | 262 | 471 | 742 | 1,550 |
| 100 | 11 | 23 | 47 | 82 | 116 | 247 | 445 | 701 | 1,460 |
| 125 | NA | 20 | 41 | 72 | 103 | 219 | 394 | 622 | 1,290 |
| 150 | NA | 18 | 37 | 65 | 93 | 198 | 357 | 563 | 1,170 |
| 175 | NA | 17 | 34 | 60 | 85 | 183 | 329 | 518 | 1,080 |
| 200 | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1,000 |
| 250 | NA | 14 | 28 | 50 | 70 | 151 | 271 | 427 | 890 |
| 300 | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 350 | NA | 12 | 24 | 41 | 59 | 125 | 226 | 356 | 742 |
| 400 | NA | 11 | 22 | 39 | 55 | 117 | 210 | 331 | 690 |
| 450 | NA | 10 | 21 | 36 | 51 | 110 | 197 | 311 | 647 |
| 500 | NA | NA | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 550 | NA | NA | 19 | 32 | 46 | 98 | 177 | 279 | 581 |
| 600 | NA | NA | 18 | 31 | 44 | 94 | 169 | 266 | 554 |
| 650 | NA | NA | 17 | 30 | 42 | 90 | 162 | 255 | 531 |
| 700 | NA | NA | 16 | 28 | 40 | 86 | 155 | 245 | 510 |
| 750 | NA | NA | 16 | 27 | 39 | 83 | 150 | 236 | 491 |
| 800 | NA | NA | 15 | 26 | 38 | 80 | 144 | 228 | 474 |
| 850 | NA | NA | 15 | 26 | 36 | 78 | 140 | 220 | 459 |
| 900 | NA | NA | 14 | 25 | 35 | 75 | 135 | 214 | 445 |
| 950 | NA | NA | 14 | 24 | 34 | 73 | 132 | 207 | 432 |
| 1,000 | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 1,100 | NA | NA | 13 | 22 | 32 | 68 | 122 | 192 | 399 |
| 1,200 | NA | NA | 12 | 21 | 30 | 64 | 116 | 183 | 381 |
| 1,300 | NA | NA | 12 | 20 | 29 | 62 | 111 | 175 | 365 |
| 1,400 | NA | NA | 11 | 20 | 28 | 59 | 107 | 168 | 350 |
| 1,500 | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 1,600 | NA | NA | 10 | 18 | 26 | 55 | 99 | 156 | 326 |
| 1,700 | NA | NA | 10 | 18 | 25 | 53 | 96 | 151 | 315 |
| 1,800 | NA | NA | NA | 17 | 24 | 52 | 93 | 147 | 306 |
| 1,900 | NA | NA | NA | 17 | 24 | 50 | 90 | 143 | 297 |
| 2,000 | NA | NA | NA | 16 | 23 | 49 | 88 | 139 | 289 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. NA means a flow of less than 10 cfh .
3. All table entries have been rounded to three significant digits.

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | Less than 2.0 psi |
| Pressure Drop | 17.0 in w.c. |
| Specific Gravity | 0.60 | SEMIRIGID COPPER TUBING


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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

| TABLE 402.4(10) SEMIRIGID COPPER TUBING |  |  |  |  | Gas |  |  | Natural |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Inlet Pressure |  |  | 2.0 psi |  |  |
|  |  |  |  |  | Pressure Drop |  |  | 1.0 psi |  |  |
|  |  |  |  |  | Specific Gravity |  |  | 0.60 |  |  |
| TUBE SIZE (inch) |  |  |  |  |  |  |  |  |  |  |
| 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 | $13 / 8$ |  | - | - |
| Outside | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 |  | 1.625 | 2.125 |
| Inside | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 |  | 1.481 | 1.959 |
| Length (ft) Capacity in Cubic Feet of Gas Per Hour |  |  |  |  |  |  |  |  |  |  |
| 10 | 245 | 506 | 1,030 | 1,800 | 2,550 | 5,450 | 9,820 |  | 15,500 | 32,200 |
| 20 | 169 | 348 | 708 | 1,240 | 1,760 | 3,750 | 6,750 |  | 10,600 | 22,200 |
| 30 | 135 | 279 | 568 | 993 | 1,410 | 3,010 | 5,420 |  | 8,550 | 17,800 |
| 40 | 116 | 239 | 486 | 850 | 1,210 | 2,580 | 4,640 |  | 7,310 | 15,200 |
| 50 | 103 | 212 | 431 | 754 | 1,070 | 2,280 | 4,110 |  | 6,480 | 13,500 |
| 60 | 93 | 192 | 391 | 683 | 969 | 2,070 | 3,730 |  | 5,870 | 12,200 |
| 70 | 86 | 177 | 359 | 628 | 891 | 1,900 | 3,430 |  | 5,400 | 11,300 |
| 80 | 80 | 164 | 334 | 584 | 829 | 1,770 | 3,190 |  | 5,030 | 10,500 |
| 90 | 75 | 154 | 314 | 548 | 778 | 1,660 | 2,990 |  | 4,720 | 9,820 |
| 100 | 71 | 146 | 296 | 518 | 735 | 1,570 | 2,830 |  | 4,450 | 9,280 |
| 125 | 63 | 129 | 263 | 459 | 651 | 1,390 | 2,500 |  | 3,950 | 8,220 |
| 150 | 57 | 117 | 238 | 416 | 590 | 1,260 | 2,270 |  | 3,580 | 7,450 |
| 175 | 52 | 108 | 219 | 383 | 543 | 1,160 | 2,090 |  | 3,290 | 6,850 |
| 200 | 49 | 100 | 204 | 356 | 505 | 1,080 | 1,940 |  | 3,060 | 6,380 |
| 250 | 43 | 89 | 181 | 315 | 448 | 956 | 1,720 |  | 2,710 | 5,650 |
| 300 | 39 | 80 | 164 | 286 | 406 | 866 | 1,560 |  | 2,460 | 5,120 |
| 350 | 36 | 74 | 150 | 263 | 373 | 797 | 1,430 |  | 2,260 | 4,710 |
| 400 | 33 | 69 | 140 | 245 | 347 | 741 | 1,330 |  | 2,100 | 4,380 |
| 450 | 31 | 65 | 131 | 230 | 326 | 696 | 1,250 |  | 1,970 | 4,110 |
| 500 | 30 | 61 | 124 | 217 | 308 | 657 | 1,180 |  | 1,870 | 3,880 |
| 550 | 28 | 58 | 118 | 206 | 292 | 624 | 1,120 |  | 1,770 | 3,690 |
| 600 | 27 | 55 | 112 | 196 | 279 | 595 | 1,070 |  | 1,690 | 3,520 |
| 650 | 26 | 53 | 108 | 188 | 267 | 570 | 1,030 |  | 1,620 | 3,370 |
| 700 | 25 | 51 | 103 | 181 | 256 | 548 | 986 |  | 1,550 | 3,240 |
| 750 | 24 | 49 | 100 | 174 | 247 | 528 | 950 |  | 1,500 | 3,120 |
| 800 | 23 | 47 | 96 | 168 | 239 | 510 | 917 |  | 1,450 | 3,010 |
| 850 | 22 | 46 | 93 | 163 | 231 | 493 | 888 |  | 1,400 | 2,920 |
| 900 | 22 | 44 | 90 | 158 | 224 | 478 | 861 |  | 1,360 | 2,830 |
| 950 | 21 | 43 | 88 | 153 | 217 | 464 | 836 |  | 1,320 | 2,740 |
| 1,000 | 20 | 42 | 85 | 149 | 211 | 452 | 813 |  | 1,280 | 2,670 |
| 1,100 | 19 | 40 | 81 | 142 | 201 | 429 | 772 |  | 1,220 | 2,540 |
| 1,200 | 18 | 38 | 77 | 135 | 192 | 409 | 737 |  | 1,160 | 2,420 |
| 1,300 | 18 | 36 | 74 | 129 | 183 | 392 | 705 |  | 1,110 | 2,320 |
| 1,400 | 17 | 35 | 71 | 124 | 176 | 376 | 678 |  | 1,070 | 2,230 |
| 1,500 | 16 | 34 | 68 | 120 | 170 | 363 | 653 |  | 1,030 | 2,140 |
| 1,600 | 16 | 33 | 66 | 116 | 164 | 350 | 630 |  | 994 | 2,070 |
| 1,700 | 15 | 31 | 64 | 112 | 159 | 339 | 610 |  | 962 | 2,000 |
| 1,800 | 15 | 30 | 62 | 108 | 154 | 329 | 592 |  | 933 | 1,940 |
| 1,900 | 14 | 30 | 60 | 105 | 149 | 319 | 575 |  | 906 | 1,890 |
| 2,000 | 14 | 29 | 59 | 102 | 145 | 310 | 559 |  | 881 | 1,830 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. Where this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop not greater than 1 inch w.c.
3. All table entries have been rounded to three significant digits.

## TABLE 402.4(12) SEMIRIGID COPPER TUBING

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | 5.0 psi |
| Pressure Drop | 3.5 psi |
| Specific Gravity | 0.60 |


| TUBE SIZE (inch) |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | K \& L | $1 / 4$ | $3 / 8$ | 1/2 | 5/8 | $3 / 4$ | 1 | $1^{1 / 4}$ | $1^{1 / 2}$ | 2 |
| Nominal | ACR | $3 / 8$ | 1/2 | 5/8 | $3 / 4$ | 7/8 | $11 / 8$ | $13 / 8$ | - | - |
| Outside |  | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| Inside |  | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |

Len
Capacity in Cubic Feet of Gas Per Hour

|  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| , 750 | 5,320 | 11,400 | 20,400 | 32,200 | 67,100 |
| 2,580 | 3,650 | 7,800 | 14,000 | 22,200 | 46,100 |
| 2,070 | 2,930 | 6,270 | 11,300 | 17,800 | 37,000 |


| 40 | 241 | 498 | 1,010 |
| :---: | :---: | :---: | :---: |
| 50 | 214 | 441 | 898 |
| 60 | 194 | 400 | 813 |
| 70 | 178 | 368 | 748 |
| 80 | 166 | 342 | 696 |
| 9 |  | 32 |  |


| 90 | 156 | 321 | 653 |  |
| :---: | :---: | :---: | :---: | :---: |
| 100 | 147 | 303 | 617 |  |
| 125 | 130 | 269 | 547 |  |
| 150 | 118 | 243 | 495 |  |
| 175 | 109 | 224 | 456 |  |
| 200 | 101 | 208 | 424 |  |
| 250 | 90 | 185 | 376 |  |
| 300 | 81 | 167 | 340 |  |
|  |  |  | 315 |  |


| 350 | 75 | 154 | 313 | 547 | 777 | 1,660 | 2,990 | 4,710 | 9,810 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 400 | 69 | 143 | 291 | 509 | 722 | 1,540 | 2,780 | 4,380 | 9,120 |
| 450 | 65 | 134 | 273 | 478 | 678 | 1,450 | 2,610 | 4,110 | 8,560 |
| 500 | 62 | 127 | 258 | 451 | 640 | 1,370 | 2,460 | 3,880 | 8,090 |
| 550 | 58 | 121 | 245 | 429 | 608 | 1,300 | 2,340 | 3,690 | 7,680 |
| 600 | 56 | 115 | 234 | 409 | 580 | 1,240 | 2,230 | 3,520 | 7,330 |
| 650 | 53 | 110 | 224 | 392 | 556 | 1,190 | 2,140 | 3,370 | 7,020 |
| 700 | 51 | 106 | 215 | 376 | 534 | 1,140 | 2,050 | 3,240 | 6,740 |
| 750 | 49 | 102 | 207 | 362 | 514 | 1,100 | 1,980 | 3,120 | 6,490 |
| 800 | 48 | 98 | 200 | 350 | 497 | 1,060 | 1,910 | 3,010 | 6,270 |
| 850 | 46 | 95 | 194 | 339 | 481 | 1,030 | 1,850 | 2,910 | 6,070 |
| 900 | 45 | 92 | 188 | 328 | 466 | 1,000 | 1,790 | 2,820 | 5,880 |
| 950 | 43 | 90 | 182 | 319 | 452 | 967 | 1,740 | 2,740 | 5,710 |
| 1,000 | 42 | 87 | 177 | 310 | 440 | 940 | 1,690 | 2,670 | 5,560 |
| 1,100 | 40 | 83 | 169 | 295 | 418 | 893 | 1,610 | 2,530 | 5,280 |
| 1,200 | 38 | 79 | 161 | 281 | 399 | 852 | 1,530 | 2,420 | 5,040 |
| 1,300 | 37 | 76 | 154 | 269 | 382 | 816 | 1,470 | 2,320 | 4,820 |
| 1,400 | 35 | 73 | 148 | 259 | 367 | 784 | 1,410 | 2,220 | 4,630 |
| 1,500 | 34 | 70 | 143 | 249 | 353 | 755 | 1,360 | 2,140 | 4,460 |
| 1,600 | 33 | 68 | 138 | 241 | 341 | 729 | 1,310 | 2,070 | 4,310 |
| 1,700 | 32 | 65 | 133 | 233 | 330 | 705 | 1,270 | 2,000 | 4,170 |
| 1,800 | 31 | 63 | 129 | 226 | 320 | 684 | 1,230 | 1,940 | 4,040 |
| 1,900 | 30 | 62 | 125 | 219 | 311 | 664 | 1,200 | 1,890 | 3,930 |
| 2,000 | 29 | 60 | 122 | 213 | 302 | 646 | 1,160 | 1,830 | 3,820 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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

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

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | Less than 2 psi |
| Pressure Drop | 0.5 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 | 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## 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: $L=1.3 n$, where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
2. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
3. All table entries have been rounded to three significant digits.

| TABLE 402.4(14) <br> 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 <br> 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
2. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
3. All table entries have been rounded to three significant digits.

TABLE 402.4(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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
2. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
3. All table entries have been rounded to three significant digits.


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds $3 / 4 \mathrm{psi}$, 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
4. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
5. All table entries have been rounded to three significant digits.

TABLE 402.4(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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds $3 / 4 \mathrm{psi}$, 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
4. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
5. All table entries have been rounded to three significant digits.

TABLE 402.4(18) POLYETHYLENE PLASTIC PIPE

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


| PIPE SIZE (in.) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal OD | 1/2 | $3 / 4$ | 1 | $1^{1 / 4}$ | 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 Feet of Gas per Hour |  |  |  |  |  |
| 10 | 153 | 305 | 551 | 955 | 1,440 | 2,590 |
| 20 | 105 | 210 | 379 | 656 | 991 | 1,780 |
| 30 | 84 | 169 | 304 | 527 | 796 | 1,430 |
| 40 | 72 | 144 | 260 | $451$ | 681 | 1,220 |
| 50 | 64 | 128 | 231 | 400 | 604 | 1,080 |
| 60 | 58 | 116 | 209 | 362 | 547 | 983 |
| 70 | 53 | 107 | 192 | 333 | 503 | 904 |
| 80 | 50 | 99 | 179 | 310 | 468 | 841 |
| 90 | 46 | 93 | 168 | 291 | 439 | 789 |
| 100 | 44 | 88 | 159 | 275 | 415 | 745 |
| $125$ | 39 | $78$ | $141$ | $243$ | 368 | 661 |
| 150 | 35 | 71 | 127 | 221 | 333 | 598 |
| $175$ | $32$ | $65$ | $117$ | 203 | 306 | 551 |
| 200 | 30 | 60 | 109 | 189 | 285 | 512 |
| 250 | 27 | 54 | $97$ | $167$ | 253 | 454 |
| 300 | 24 | 48 | 88 | 152 | 229 | 411 |
| 350 | 22 | 45 | 81 | 139 | 211 | 378 |
| $400$ | $21$ | $42$ | $75$ | $130$ | 196 | 352 |
| 450 | 19 | 39 | 70 | 122 | 184 | 330 |
| 500 | 18 | 37 | 66 | 115 | 174 | 312 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
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 Feet 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

| TABLE 402.4(20) POLYETHYLENE PLASTIC PIPE |  |  |  | Gas |  | Natural |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Inlet Pressure 2 |  | 2.0 psi |
|  |  |  |  | Pressure Drop 1. |  | 1.0 psi |
|  |  |  |  | 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 Feet of Gas per Hour |  |  |  |  |  |
| 10 | 1,860 | 3,720 | 6,710 | 11,600 | 17,600 | 31,600 |
| 20 | 1,280 | 2,560 | 4,610 | 7,990 | 12,100 | 21,700 |
| 30 | 1,030 | 2,050 | 3,710 | 6,420 | 9,690 | 17,400 |
| 40 | 878 | 1,760 | 3,170 | 5,490 | 8,300 | 14,900 |
| 50 | 778 | 1,560 | 2,810 | 4,870 | 7,350 | 13,200 |
| 60 | 705 | 1,410 | 2,550 | 4,410 | 6,660 | 12,000 |
| 70 | 649 | 1,300 | 2,340 | 4,060 | 6,130 | 11,000 |
| 80 | 603 | 1,210 | 2,180 | 3,780 | 5,700 | 10,200 |
| 90 | 566 | 1,130 | 2,050 | 3,540 | 5,350 | 9,610 |
| 100 | 535 | 1,070 | 1,930 | 3,350 | 5,050 | 9,080 |
| 125 | 474 | 949 | 1,710 | 2,970 | 4,480 | 8,050 |
| 150 | 429 | 860 | 1,550 | 2,690 | 4,060 | 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 | 2,790 | 5,010 |
| 350 | 272 | 544 | 981 | 1,700 | 2,570 | 4,610 |
| 400 | 253 | 506 | 913 | 1,580 | 2,390 | 4,290 |
| 450 | 237 | 475 | 856 | 1,480 | 2,240 | 4,020 |
| 500 | 224 | 448 | 809 | 1,400 | 2,120 | 3,800 |
| 550 | 213 | 426 | 768 | 1,330 | 2,010 | 3,610 |
| 600 | 203 | 406 | 733 | 1,270 | 1,920 | 3,440 |
| 650 | 194 | 389 | 702 | 1,220 | 1,840 | 3,300 |
| 700 | 187 | 374 | 674 | 1,170 | 1,760 | 3,170 |
| 750 | 180 | 360 | 649 | 1,130 | 1,700 | 3,050 |
| 800 | 174 | 348 | 627 | 1,090 | 1,640 | 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 | 1,450 | 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 | 1,260 | 2,270 |
| 1,400 | 128 | 257 | 463 | 803 | 1,210 | 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 | 1,090 | 1,960 |
| 1,800 | 112 | 224 | 404 | 701 | 1,060 | 1,900 |
| 1,900 | 109 | 218 | 393 | 680 | 1,030 | 1,850 |
| 2,000 | 106 | 212 | 382 | 662 | 1,000 | 1,800 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square $\mathrm{inch}=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

TABLE 402.4(21)
POLYETHYLENE PLASTIC TUBING

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | Less than 2.0 psi |
| Pressure Drop | 0.3 in. w.c. |
| Specific Gravity | 0.60 |


|  | PLASTIC TUBING SIZE (CTS) (in.) |  |
| :---: | :---: | :---: |
| Nominal OD | $1 / 2$ | $3 / 4$ |
| Designation | SDR 7.00 | SDR 11.00 |
| Actual ID | 0.445 | 0.927 |


| Length (ft) | Capacity in Cubic Feet of Gas per Hour |  |
| :---: | :---: | :---: |
| 10 | 54 | 372 |
| 20 | 37 | 256 |


| 20 | 37 | 256 |
| :---: | :---: | :---: |
| 30 | 30 | 205 |
| 40 | 26 | 176 |


| 40 | 26 | 176 |
| :---: | :---: | :---: |
| 50 | 23 | 156 |
| 60 | 21 | 141 |


| 70 | 19 | 130 |
| :---: | :---: | :---: |
| 80 | 18 | 121 |
| 90 | 17 | 113 |
| 100 | 16 | 107 |
| 125 | 14 | 95 |
| 150 | 13 | 86 |
| 175 | 12 | 79 |
| 200 | 11 | 74 |
| 225 | 10 | 69 |
| 250 | NA | 65 |
| 275 | NA | 62 |
| 300 | NA | 59 |
| 350 | NA | 54 |
| 400 | NA | 51 |
| 450 | NA | 47 |
| 500 | NA | 45 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$,
1 pound per square inch $=6.895 \mathrm{kPa}$, 1 -inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}$,
1 cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Notes:

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

TABLE 402.4(22)
POLYETHYLENE PLASTIC TUBING

| Gas | Natural |
| ---: | :--- |
| Inlet Pressure | Less than 2.0 psi |
| Pressure Drop | 0.5 in. w.c. |
| Specific Gravity | 0.60 |


|  | PLASTIC TUBING SIZE (CTS) (in.) |  |
| :---: | :---: | :---: |
| Nominal OD | $1 / 2$ | $3 / 4$ |
| Designation | SDR 7.00 | SDR 11.00 |
| Actual ID | 0.445 | 0.927 |
| Length (ft) | Capacity in Cubic Feet of Gas per Hour |  |
| 10 | 72 | 490 |
| 20 | 49 | 337 |
| 30 | 39 | 271 |
| 40 | 34 | 232 |
| 50 | 30 | 205 |
| 60 | 27 | 186 |
| 70 | 25 | 171 |
| 80 | 23 | 159 |
| 90 | 22 | 149 |
| 100 | 21 | 141 |
| 125 | 18 | 125 |
| 150 | 17 | 113 |
| 175 | 15 | 104 |
| 200 | 14 | 97 |
| 225 | 13 | 91 |
| 250 | 12 | 86 |
| 275 | 11 | 82 |
| 300 | 11 | 78 |
| 350 | 10 | 72 |
| 400 | NA | 67 |
| 450 | NA | 63 |
| 500 | NA | 59 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$,
1 pound per square inch $=6.895 \mathrm{kPa}$, 1 -inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}$,
1 cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

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 |


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

|  | TABLE 402.4(25) SCHEDULE 40 METALLIC PIP |  |  |  |  |  | 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 | $11 / 4$ | $1^{1 / 2}$ | 2 | $2^{1 / 2}$ | 3 | 4 |
| Actual ID | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| Length (ft) | Capacity in Thousands of Btu per Hour |  |  |  |  |  |  |  |  |
| 10 | 2,680 | 5,590 | 10,500 | 21,600 | 32,400 | 62,400 | 99,500 | 176,000 | 359,000 |
| 20 | 1,840 | 3,850 | 7,240 | 14,900 | 22,300 | 42,900 | 68,400 | 121,000 | 247,000 |
| 30 | 1,480 | 3,090 | 5,820 | 11,900 | 17,900 | 34,500 | 54,900 | 97,100 | 198,000 |
| 40 | 1,260 | 2,640 | 4,980 | 10,200 | 15,300 | 29,500 | 47,000 | 83,100 | 170,000 |
| 50 | 1,120 | 2,340 | 4,410 | 9,060 | 13,600 | 26,100 | 41,700 | 73,700 | 150,000 |
| 60 | 1,010 | 2,120 | 4,000 | 8,210 | 12,300 | 23,700 | 37,700 | 66,700 | 136,000 |
| 70 | 934 | 1,950 | 3,680 | 7,550 | 11,300 | 21,800 | 34,700 | 61,400 | 125,000 |
| 80 | 869 | 1,820 | 3,420 | 7,020 | 10,500 | 20,300 | 32,300 | 57,100 | 116,000 |
| 90 | 815 | 1,700 | 3,210 | 6,590 | 9,880 | 19,000 | 30,300 | 53,600 | 109,000 |
| 100 | 770 | 1,610 | 3,030 | 6,230 | 9,330 | 18,000 | 28,600 | 50,600 | 103,000 |
| 125 | 682 | 1,430 | 2,690 | 5,520 | 8,270 | 15,900 | 25,400 | 44,900 | 91,500 |
| 150 | 618 | 1,290 | 2,440 | 5,000 | 7,490 | 14,400 | 23,000 | 40,700 | 82,900 |
| 175 | 569 | 1,190 | 2,240 | 4,600 | 6,890 | 13,300 | 21,200 | 37,400 | 76,300 |
| 200 | 529 | 1,110 | 2,080 | 4,280 | 6,410 | 12,300 | 19,700 | 34,800 | 71,000 |
| 250 | 469 | 981 | 1,850 | 3,790 | 5,680 | 10,900 | 17,400 | 30,800 | 62,900 |
| 300 | 425 | 889 | 1,670 | 3,440 | 5,150 | 9,920 | 15,800 | 27,900 | 57,000 |
| 350 | 391 | 817 | 1,540 | 3,160 | 4,740 | 9,120 | 14,500 | 25,700 | 52,400 |
| 400 | 364 | 760 | 1,430 | 2,940 | 4,410 | 8,490 | 13,500 | 23,900 | 48,800 |
| 450 | 341 | 714 | 1,340 | 2,760 | 4,130 | 7,960 | 12,700 | 22,400 | 45,800 |
| 500 | 322 | 674 | 1,270 | 2,610 | 3,910 | 7,520 | 12,000 | 21,200 | 43,200 |
| 550 | 306 | 640 | 1,210 | 2,480 | 3,710 | 7,140 | 11,400 | 20,100 | 41,100 |
| 600 | 292 | 611 | 1,150 | 2,360 | 3,540 | 6,820 | 10,900 | 19,200 | 39,200 |
| 650 | 280 | 585 | 1,100 | 2,260 | 3,390 | 6,530 | 10,400 | 18,400 | 37,500 |
| 700 | 269 | 562 | 1,060 | 2,170 | 3,260 | 6,270 | 9,990 | 17,700 | 36,000 |
| 750 | 259 | 541 | 1,020 | 2,090 | 3,140 | 6,040 | 9,630 | 17,000 | 34,700 |
| 800 | 250 | 523 | 985 | 2,020 | 3,030 | 5,830 | 9,300 | 16,400 | 33,500 |
| 850 | 242 | 506 | 953 | 1,960 | 2,930 | 5,640 | 9,000 | 15,900 | 32,400 |
| 900 | 235 | 490 | 924 | 1,900 | 2,840 | 5,470 | 8,720 | 15,400 | 31,500 |
| 950 | 228 | 476 | 897 | 1,840 | 2,760 | 5,310 | 8,470 | 15,000 | 30,500 |
| 1,000 | 222 | 463 | 873 | 1,790 | 2,680 | 5,170 | 8,240 | 14,600 | 29,700 |
| 1,100 | 210 | 440 | 829 | 1,700 | 2,550 | 4,910 | 7,830 | 13,800 | 28,200 |
| 1,200 | 201 | 420 | 791 | 1,620 | 2,430 | 4,680 | 7,470 | 13,200 | 26,900 |
| 1,300 | 192 | 402 | 757 | 1,550 | 2,330 | 4,490 | 7,150 | 12,600 | 25,800 |
| 1,400 | 185 | 386 | 727 | 1,490 | 2,240 | 4,310 | 6,870 | 12,100 | 24,800 |
| 1,500 | 178 | 372 | 701 | 1,440 | 2,160 | 4,150 | 6,620 | 11,700 | 23,900 |
| 1,600 | 172 | 359 | 677 | 1,390 | 2,080 | 4,010 | 6,390 | 11,300 | 23,000 |
| 1,700 | 166 | 348 | 655 | 1,340 | 2,010 | 3,880 | 6,180 | 10,900 | 22,300 |
| 1,800 | 161 | 337 | 635 | 1,300 | 1,950 | 3,760 | 6,000 | 10,600 | 21,600 |
| 1,900 | 157 | 327 | 617 | 1,270 | 1,900 | 3,650 | 5,820 | 10,300 | 21,000 |
| 2,000 | 152 | 318 | 600 | 1,230 | 1,840 | 3,550 | 5,660 | 10,000 | 20,400 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

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 |


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

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


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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

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


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

For SI: 1 inch $=25.4 \mathrm{~mm}, 1 \mathrm{foot}=304.8 \mathrm{~mm}, 1$ pound per square $\mathrm{inch}=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## 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 $10,000 \mathrm{Btu} / \mathrm{hr}$.


For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

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

TABLE 402.4(30) 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 |


| 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
2. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
3. All table entries have been rounded to three significant digits.

| TABLE 402.4(31) <br> CORRUGATED STAINLESS STEEL TUBING (CSST) |  |  |  |  |  |  |  |  |  | Gas | Undiluted Propane |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  | Inlet Pressure |  |  | 2.0 psi |  |  |
|  |  |  |  |  |  |  |  | Pressure Drop |  |  | 1.0 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 | 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds $1 / 2$ psi (based on 13 in. w.c. outlet pressure), DO NOT USE THIS TABLE. Consult with the regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
2. CAUTION: Capacities shown in the table might exceed maximum capacity for a selected regulator. Consult with the regulator or tubing manufacturer for guidance.
3. Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
4. EHD—Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
5. All table entries have been rounded to three significant digits.

TABLE 402.4(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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.

## Notes:

1. Table does not include effect of pressure drop across line regulator. Where regulator loss exceeds1 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: $L=1.3 n$ where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings and/or bends.
4. EHD-Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
5. All table entries have been rounded to three significant digits.

| TABLE 402.4(33) POLYETHYLENE PLASTIC PIPE |  |  |  | Gas |  | Undiluted Propane |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Inlet Pressure 1 |  | 11.0 in. w.c. |
|  |  |  |  | Pressure Drop |  | 0.5 in. w.c. |
|  |  |  |  | Specific Gravity |  | 1.50 |
| 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 Thousands 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 | 978 | 1,760 |
| 100 | 98 | 196 | 353 | 612 | 924 | 1,660 |
| 125 | 87 | 173 | 313 | 542 | 819 | 1,470 |
| 150 | 78 | 157 | 284 | 491 | 742 | 1,330 |
| 175 | 72 | 145 | 261 | 452 | 683 | 1,230 |
| 200 | 67 | 135 | 243 | 420 | 635 | 1,140 |
| 250 | 60 | 119 | 215 | 373 | 563 | 1,010 |
| 300 | 54 | 108 | 195 | 338 | 510 | 916 |
| 350 | 50 | 99 | 179 | 311 | 469 | 843 |
| 400 | 46 | 92 | 167 | 289 | 436 | 784 |
| 450 | 43 | 87 | 157 | 271 | 409 | 736 |
| 500 | 41 | 82 | 148 | 256 | 387 | 695 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$, 1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

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.) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal OD | 1/2 | 3/4 | 1 | $1^{1 / 4}$ | $1^{1 / 2}$ | 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 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 | 201 | 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 $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}, 1$ pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283 \mathrm{~m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
Note: All table entries have been rounded to three significant digits.

TABLE 402.4(35)

| POLYETHYLENE PLASTIC TUBING |  |
| ---: | :--- |
| Gas | Undiluted Propane |
| Inlet Pressure | 11.0 in. w.c. |
| Pressure Drop | 0.5 in. w.c. |
| Specific Gravity | 1.50 |



| Nominal OD | $1 / 2$ | $3 / 4$ |
| :---: | :---: | :---: |
| Designation | SDR 7.00 | SDR 11.00 |
| Actual ID | 0.445 | 0.927 |


| Length (ft) | Capacity in Cubic Feet of Gas per Hour |  |
| :---: | :---: | :---: |
| 10 | 121 | 828 |
| 20 | 83 | 569 |


| 20 | 83 | 569 |
| :---: | :---: | :---: |
| 30 | 67 | 457 |
| 40 | 57 | 391 |


| 50 | 51 | 347 |
| :--- | :--- | :--- |
| 60 | 46 | 314 |


| 70 | 42 | 289 |
| :---: | :---: | :---: |
| 80 | 39 | 269 |
| 90 | 37 | 252 |
| 100 | 35 | 238 |
| 125 | 31 | 211 |
| 150 | 28 | 191 |
| 175 | 26 | 176 |
| 200 | 24 | 164 |
| 225 | 22 | 154 |
| 250 | 21 | 145 |
| 275 | 20 | 138 |
| 300 | 19 | 132 |
| 350 | 18 | 121 |
| 400 | 16 | 113 |
| 450 | 15 | 106 |
| 500 | 15 | 100 |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$,
1 pound per square inch $=6.895 \mathrm{kPa}, 1$-inch water column $=0.2488 \mathrm{kPa}$,
1 British thermal unit per hour $=0.2931 \mathrm{~W}, 1$ cubic foot per hour $=0.0283$ $\mathrm{m}^{3} / \mathrm{h}, 1$ degree $=0.01745 \mathrm{rad}$.
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. Alumi-num-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 I 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 |
| :---: | :---: | :---: |
| $1 / 2$ | $3 / 4$ | 10 |
| $3 / 4$ | $3 / 4$ | 10 |
| 1 | 7/8 | 10 |
| $11 / 4$ | 1 | 11 |
| $11 / 2$ | 1 | 11 |
| 2 | 1 | 11 |
| $21 / 2$ | $11 / 2$ | 12 |
| 3 | $11 / 2$ | 12 |
| 4 | $15 / 8$ | 13 |

For SI: 1 inch $=25.4 \mathrm{~mm}$.
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 $1,000^{\circ} \mathrm{F}\left(538^{\circ} \mathrm{C}\right)$. 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 $1,000^{\circ} \mathrm{F}\left(538^{\circ} \mathrm{C}\right)$. Brazing alloys shall not contain more than 0.05 percent phosphorus.
403.10.3 Flared joints. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints.
403.10.4 Metallic fittings. Metallic fittings shall comply with the following:

1. Threaded fittings in sizes larger than 4 inches (102 mm ) shall not be used except where approved.
2. Fittings used with steel or wrought-iron pipe shall be steel, brass, bronze, malleable iron or cast iron.
3. Fittings used with copper or brass pipe shall be copper, brass or bronze.
4. Fittings used with aluminum-alloy pipe shall be of aluminum alloy.
5. Cast-iron fittings:
5.1. Flanges shall be permitted.
5.2. Bushings shall not be used.
5.3. Fittings shall not be used in systems containing flammable gas-air mixtures.
5.4. Fittings in sizes 4 inches ( 102 mm ) and larger shall not be used indoors except where approved.
5.5. Fittings in sizes 6 inches ( 152 mm ) and larger shall not be used except where approved.
6. Aluminum-alloy fittings. Threads shall not form the joint seal.
7. Zinc aluminum-alloy fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.
8. Special fittings. Fittings such as couplings, propri-etary-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:
9. 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.
10. 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."
11. 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.
12. 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 nearest edge of the member, the pipe shall be protected by shield plates. Shield plates shall be a minimum of $1 / 16$-inch-thick (1.6 mm ) steel, shall cover the area of the pipe where the member is notched or bored and shall extend a minimum of 4 inches (102 mm ) above sole plates, below top plates and to each side of a stud, joist or rafter.
404.6 Piping in solid floors. Piping in solid floors shall be laid in channels in the floor and covered in a manner that will allow access to the piping with a minimum amount of damage to the building. Where such piping is subject to exposure to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. As an alternative to installation in channels, the piping shall be installed in a 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 $(51 \mathrm{~mm})$ 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 $3 \frac{1}{2}$ inches ( 152 mm ) above ground and where installed across roof surfaces, shall be elevated not less than $31 / 2$ 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 $\mathrm{mm})$ 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 $100 \mathrm{psig}(689 \mathrm{kPa})$ 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) <br> 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:
6. The pipe shall not be damaged and the internal diameter of the pipe shall not be effectively reduced.
7. Joints shall not be located in pipe bends.
8. The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.
9. 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 $(51 \mathrm{~mm})$ 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 leakdetecting 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 $1 \frac{1}{2}$ 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 $\left(14 \mathrm{~m}^{3}\right)$ of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet $\left(0.28 \mathrm{~m}^{3}\right)$ 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 <br> (inches) | LENGTH OF PIPING <br> REQUIRING PURGING |
| :---: | :---: |
| $2^{1 / 2}$ | $>50$ feet |
| 3 | $>30$ feet |
| 4 | $>15$ feet |
| 6 | $>10$ feet |
| 8 or larger | Any length |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$.
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 <br> (inches) | LENGTH OF PIPING <br> REQUIRING PURGING |
| :---: | :---: |
| 3 | $>30$ feet |
| 4 | $>15$ feet |
| 6 | $>10$ feet |
| 8 or larger | Any length |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$.
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

| VALVE STANDARDS | APPLIANCE SHUTOFF VALVE APPLICATION UP TO $1 \frac{1}{2}$ psig PRESSURE | OTHER VALVE APPLICATIONS |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UP TO $1 / 2$ psig PRESSURE | UP TO 2 psig PRESSURE | UP TO 5 psig PRESSURE | UP TO 125 psig PRESSURE |
| ANSI Z21.15 | X | - | - | - | - |
| CSA Requirement 3-88 | X | X | $\mathrm{X}^{\text {a }}$ | $\mathrm{X}^{\text {b }}$ | - |
| ASME B16.44 | X | X | $\mathrm{X}^{\text {a }}$ | $\mathrm{X}^{\text {b }}$ | - |
| ASME B16.33 | X | X | X | X | X |

For SI: 1 pound per square inch gauge $=6.895 \mathrm{kPa}$.
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 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.
7. 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 consid-
ered 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 ( 30480 mm ) of, but not less than 20 feet $(6096 \mathrm{~mm})$ 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 $/ \mathrm{min}$ ) 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:
4. Beneath power lines.
5. 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 $(7620 \mathrm{~mm})$ from the nearest rail of any railroad track.
4. Less than 50 feet ( 15240 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 ( 15240 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 ( 22860 mm ) of, but not less than 25 feet $(7620 \mathrm{~mm})$ 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 stor-

 age 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
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 CYLINDER 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 <br> 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 $=304.8 \mathrm{~mm}$

## 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.

| TABLE 415.1 |  |  |  |
| :--- | :---: | :---: | :---: |
| SUPPORT OF PIPING |  |  |  |
| STEEL PIPE, <br> NOMINAL SIZE <br> OF PIPE <br> (inches) SPACING OF <br> SUPPORTS <br> (feet) NOMINAL SIZE <br> OF TUBING <br> (SMOOTH-WALL) <br> (inch O.D.) SPACING OF <br> SUPPORTS <br> (feet) <br> $1 / 2$ 6 $1 / 2$ 4 <br> $3 / 4$ or 1 8 $5 / 8$ or $3 / 4$ 6 <br> $1 / 1 / 4$ or larger <br> (horizontal) 10 $7 / 8$ or 1 <br> (Horizontal) 8 <br> $1 / 4$ or larger <br> (vertical) Every floor <br> level 1 or Larger <br> (vertical) Every floor <br> level |  |  |  |

For SI: 1 inch $=25.4 \mathrm{~mm}, 1$ foot $=304.8 \mathrm{~mm}$.

## 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 downstream 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 $60 \mathrm{psi}(414 \mathrm{kPa})$ or less; and (3) the service or line pressure regulator has all of the following design features or characteristics:
3. Pipe connections to the service or line regulator do not exceed 2 inches ( 51 mm ) nominal diameter.
4. The regulator is self-contained with no external static or control piping.
5. 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.
6. 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.
7. 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:
8. Spring-loaded relief device.
9. 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.
10. A monitoring regulator installed in series with the service or line pressure regulator.
11. 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.
12. 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.
13. 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 pres-sure-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:
14. 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.
15. 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.
