

## CHAPTER 12

### FUEL PIPING

#### 1201.0 Scope of Gas Piping.

- (A) Coverage of piping systems shall extend from the point of delivery to the connections with each gas utilization device. For other than undiluted liquefied petroleum gas systems, the point of delivery shall be considered the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted liquefied petroleum gas systems, the point of delivery shall be considered the outlet of the final pressure regulator, exclusive of the line gas regulators, in the system. [NFPA 54: 1.1.1.1(A)]
- (B) Piping systems requirements shall include design, materials, components, fabrications, assembly, installation, testing inspection, operation, and maintenance. [NFPA 54: 1.1.1.1(C)]
- (C) This code shall not apply to the following (reference standards for some of which appear in Appendix L [NFPA 54:1.1.1.2]):
- (1) Portable LP-Gas equipment of all types that is not connected to a fixed fuel piping system.
  - (2) Installation of farm equipment such as brooders, dehydrators, dryers, and irrigation equipment.
  - (3) Raw material (feedstock) applications, except for piping to special atmosphere generators.
  - (4) Oxygen-fuel gas cutting and welding systems.
  - (5) Industrial gas applications using gases such as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen.
  - (6) Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants.
  - (7) Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions.
  - (8) LP-Gas installations at utility gas plants.
  - (9) Liquefied natural gas (LNG) installations.

- (10) Fuel gas piping in power and atomic energy plants.
- (11) Proprietary items of equipment, apparatus, or instruments such as gas-generating sets, compressors, and calorimeters.
- (12) LP-Gas equipment for vaporization, gas mixing, and gas manufacturing.
- (13) LP-Gas piping for buildings under construction or renovations that are not to become part of the permanent building piping system—that is, temporary fixed piping for building heat.
- (14) Installation of LP-Gas systems for railroad switch heating.
- (15) Installation of LP-Gas and compressed natural gas systems on vehicles.
- (16) Gas piping, meters, gas-pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas.

#### 1202.0 General.

The regulations of this chapter shall govern the installation of all fuel gas piping in or in connection with any building or structure or within the property lines of any premises up to 5 psi, other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31.

**Exception:** Gas piping, meters, gas-pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas [NFPA 54: 1.1.1.2(16)]

#### 1203.0 Definitions.

For the purposes of this code, these definitions shall apply to this chapter. Certain terms, phrases, words, and their derivatives shall be interpreted as set forth in this section, provided, however, that whenever the words “gas meters” appear, they shall be construed to also mean valves and those devices required for the regulation of pressure and the measurement of natural gas being dispensed for any building, structure, or premises.

**1203.1 Appliance Fuel Connector** – An assembly of listed semi-rigid or flexible tubing and fittings to

carry fuel between a fuel-piping outlet and a fuel-burning appliance.

**1203.2 Fuel Gas** – Natural, manufactured, liquefied petroleum, or a mixture of these.

**1203.3 Gas Piping** – Any installation of pipe, valves, or fittings that is used to convey fuel gas, installed on any premises or in any building, but shall not include:

- (1) Any portion of the service piping.
- (2) Any approved piping connection six (6) feet (1,829 mm) or less in length between an existing gas outlet and a gas appliance in the same room with the outlet.

**1203.4 Gas-Piping System** – Any arrangement of gas piping supplied by one (1) meter, and each arrangement of gas piping serving a building, structure, or premises, whether individually metered or not.

**1203.5 Liquefied Petroleum Gas (LPG) Facilities** – Liquefied petroleum gas (LPG) facilities means tanks, containers, container valves, regulating equipment, meters, and/or appurtenances for the storage and supply of liquefied petroleum gas for any building, structure, or premises.

**1203.6 Provision for Location of Point of Delivery** - The location of the point of delivery shall be acceptable to the serving gas supplier. [NFPA 54:5.2]

**1203.7 Quick-Disconnect Device** – A hand-operated device that provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

**1203.8 Service Piping** – The piping and equipment between the street gas main and the gas piping system inlet that is installed by, and is under the control and maintenance of, the serving gas supplier.

**1203.9 Transition Gas Riser** – Any listed or approved section or sections of pipe and fittings used to convey fuel gas and installed in a gas piping system for the purpose of providing a transition from belowground to aboveground.

**1203.10 [For DSA-SS] Earthquake-actuated Gas Shutoff Valve.** *A valve for installation in a gas piping system and designed to automatically shut off the gas at the location of the valve in the event of a seismic disturbance.*

#### **1204.0 Inspection.**

**1204.1** Upon completion of the installation, alteration, or repair of any gas piping, and prior to the use thereof, the Authority Having Jurisdiction shall be notified that such gas piping is ready for inspection.

**1204.2** All excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. If any such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction.

**1204.3** The Authority Having Jurisdiction shall make the following inspections and either shall approve that portion of the work as completed or shall notify the permit holder wherein the same fails to comply with this code.

##### **1204.3.1 Rough Piping Inspection.**

This inspection shall be made after all gas piping authorized by the permit has been installed and before any such piping has been covered or concealed or any fixture or appliance has been attached thereto. This inspection shall include a determination that the gas-piping size, material, and installation meet the requirements of this code.

##### **1204.3.2 Final Piping Inspection.**

This inspection shall be made after all piping authorized by the permit has been installed and after all portions thereof that are to be covered or concealed are so concealed and before any fixtures, appliance, or shutoff valve has been attached thereto. This inspection shall be in accordance with Section 1214.1. Test gauges used in conducting tests shall comply with Section 319.0, Test Gauges.

**1204.4** In cases where the work authorized by the permit consists of a minor installation of additional piping to piping already connected to a gas meter, the foregoing inspections may be waived at the discretion of the Authority Having Jurisdiction. In this event, the Authority Having Jurisdiction shall make such inspection as deemed advisable in order to be assured that the work has been performed in accordance with the intent of this code.

#### **1205.0 Certificate of Inspection.**

**1205.1** If, upon final piping inspection, the installation is found to comply with the provisions of this code, a certificate of inspection may be issued by the Authority Having Jurisdiction.

**1205.2** A copy of the certificate of such final piping inspection shall be issued to the serving gas supplier supplying gas to the premises.

**1205.3** It shall be unlawful for any serving gas supplier, or person furnishing gas, to turn on or cause to be turned on, any fuel gas or any gas meter or meters, until such certificate of final inspection, as herein provided, has been issued.

**1206.0 Authority to Render Gas Service.**

**1206.1** It shall be unlawful for any person, firm, or corporation, excepting an authorized agent or employee of a person, firm, or corporation engaged in the business of furnishing or supplying gas and whose service pipes supply or connect with the particular premises, to turn on or reconnect gas service in or on any premises where and when gas service is, at the time, not being rendered.

**1206.2** It shall be unlawful to turn on or connect gas in or on any premises unless all outlets are properly and securely connected to gas appliances or capped or plugged with screw joint fittings.

**1207.0 Authority to Disconnect.**

**1207.1** The Authority Having Jurisdiction or the serving gas supplier is hereby authorized to disconnect any gas piping or appliance or both that shall be found not to conform to the requirements of this code or that may be found defective and in such condition as to endanger life or property.

**1207.2** Where such disconnection has been made, a notice shall be attached to such gas piping or appliance or both that shall state the same has been disconnected, together with the reasons thereof.

**1207.3** It shall be unlawful to remove or disconnect any gas piping or gas appliance without capping or plugging with a screw joint fitting the outlet from which said pipe or appliance was removed. All outlets to which gas appliances are not connected shall be left capped gastight on any piping system that has been installed, altered, or repaired.

**Exception:** When an approved listed quick-disconnect device is used.

**1208.0 Temporary Use of Gas.**

Where temporary use of gas is desired and the Authority Having Jurisdiction deems the use necessary, a permit may be issued for such use for a period of time not to exceed that designated by the Authority Having Jurisdiction, provided that such gas-piping system otherwise conforms to the requirements of this code regarding material, sizing, and safety.

**1209.0 Gas-Piping System Design, Materials, and Components.****1209.1 Piping Plan.**

**1209.1.1 Installation of Piping System.** Where required by the Authority Having Jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. This plan shall

show the proposed location of piping, the size of different branches, the various load demands, and the location of the point of delivery.

**1209.1.2 Addition to Existing System.** When additional gas utilization equipment is being connected to a gas-piping system, the existing piping shall be checked to determine whether it has adequate capacity (see Section 1209.4.3). If inadequate, the existing system shall be enlarged as required, or separate gas piping of adequate capacity shall be provided.

**1209.2 Provision for Location of Point of Delivery.**

The location of the point of delivery shall be acceptable to the serving gas supplier.

**1209.3 Interconnections Between Gas-Piping Systems.**

**1209.3.1 Interconnections Supplying Separate Users.** Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas-piping systems shall not be interconnected on the outlet side of the meters or service regulators.

**1209.3.2 Interconnections for Standby Fuels.**

Where a 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.

**1209.4 Sizing of Gas-Piping Systems.**

**1209.4.1 General Considerations.** Gas-piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of delivery and the gas utilization equipment.

**1209.4.2 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 gas utilization equipment served. Where the input rating is not indicated, the gas supplier, equipment manufacturer, or a qualified agency shall be contacted or the rating from Table 12-1 shall be used for estimating the volume of gas to be supplied. The total connected hourly load shall be used as the basis for piping sizing, assuming all equipment is operating at full capacity simultaneously.

**Exception:** Sizing shall be permitted to be based upon established load diversity factors.

**TABLE 12-1**  
**Approximate Gas Input for Typical Appliances**

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

For SI units: 1 Btu per hour = 0.293 W  
[NFPA 54: Table 5.4.2.1]

**1209.4.3 Sizing Methods.** Gas piping shall be sized in accordance with one of the following: [NFPA 54: 5.4.3]

- (1) Pipe sizing tables or sizing equations in this chapter.
- (2) Other approved engineering methods acceptable to the Authority Having Jurisdiction.
- (3) Sizing tables included in a listed piping system manufacturer's installation instructions.

**1209.4.4 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 gas utilization equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation. [NFPA 54: 5.4.4]

### 1209.5 Acceptable Piping Materials and Joining Methods.

#### 1209.5.1 General.

**1209.5.1.1 Materials.** Materials used for piping systems shall comply with the requirements of this chapter or shall be acceptable to the Authority Having Jurisdiction. [NFPA 54: 5.6.1.1]

**1209.5.1.2 Used Materials.** Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended. [NFPA 54: 5.6.1.2]

**1209.5.1.3 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 acceptable to the Authority Having Jurisdiction. [NFPA 54: 5.6.1.3]

#### 1209.5.2 Metallic Pipe.

**1209.5.2.1** Cast-iron pipe shall not be used. [NFPA 54: 5.6.2.1]

**1209.5.2.2** Steel and wrought-iron pipe shall be at least of standard weight (Schedule 40) and shall comply with one of the following standards: [NFPA 54: 5.6.2.2]

- (1) ANSI/ASME B36.10, *Welded and Seamless Wrought-Steel Pipe*
- (2) ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
- (3) ASTM A 106, *Standard Specification for*

*Seamless Carbon Steel Pipe for High-Temperature Service*

**1209.5.2.3** 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 scf of gas (0.7 mg/100 L). [NFPA 54: 5.6.2.3]

Threaded copper, brass, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54: 5.6.2.4]

**1209.5.2.4** Aluminum alloy pipe shall comply with ASTM B 241, *Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube* (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. [NFPA 54: 5.6.2.5] Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54: 5.6.2.6]

**1209.5.3 Metallic Tubing.** Seamless copper, aluminum alloy, or steel tubing shall not be used with gases corrosive to such material. [NFPA 54: 5.6.3]

**1209.5.3.1** Steel tubing shall comply with ASTM A 539, *Standard Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines*, or ASTM A 254, *Standard Specification for Copper Brazed Steel Tubing*. [NFPA 54: 5.6.3.1]

**1209.5.3.2** Copper and brass tubing shall not be used if the gas contains more than an average of 0.3 g of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or L of ASTM B 88, *Specification for Seamless Copper Water Tube*, or ASTM B 280, *Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service*. [NFPA 54: 5.6.3.2]

**1209.5.3.3** Aluminum alloy tubing shall comply with ASTM B 210, *Specification for Aluminum-Alloy Drawn Seamless Tubes*, or ASTM B 241, *Specification for Aluminum Alloy Seamless Pipe and Seamless Extruded Tube*. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by liquids such as water, detergent, or sewage. Aluminum alloy tubing shall not be

used in exterior locations or underground. [NFPA 54: 5.6.3.3]

**1209.5.3.4** Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation, and performance requirements of ANSI/IAS LC-1, *Standard for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*. [NFPA 54: 5.6.3.4]

**1209.5.4 Plastic Pipe, Tubing, and Fittings.**

Plastic pipe, tubing, and fittings shall be used outside underground only and shall conform with ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*. Pipe to be used shall be marked "gas" and "ASTM D 2513." [NFPA 54: 5.6.4.1]

Anodeless risers shall comply with the following: [NFPA 54: 5.6.4.3]

**1209.5.4.1** 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.

**1209.5.4.2** Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used by the manufacturer and shall be design-certified to meet the requirements of Category I of ASTM F 1973, *Factory Assembled Anodeless Riser and Transition Fitting on Polyethylene (PE) Fuel Gas Distribution Systems* and the code of Federal Regulations, Title 49, Part 192.281(e). The manufacturer shall provide the user with qualified installation instructions as prescribed by the code of Federal Regulations, Title 49, Part 192.283(b).

**1209.5.4.3** The use of plastic pipe, tubing, and fittings in undiluted liquefied petroleum gas-piping systems shall be in accordance with NFPA 58, *Liquefied Petroleum Gas Code*.

**1209.5.5 Workmanship and Defects.** Gas pipe or 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. [NFPA 54: 5.6.5]

**1209.5.6 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. [NFPA 54: 5.6.6]

#### 1209.5.7 Metallic Pipe Threads.

**(A) Specifications for Pipe Threads.** Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ANSI/ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*. [NFPA 54: 5.6.7.1]

**(B) 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. [NFPA 54: 5.6.7.2]

**(C) Number of Threads.** Field threading of metallic pipe shall be in accordance with Table 12-2. [NFPA 54: 5.6.7.3]

**(D) 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.

sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or to the weight of the pipe and its contents. [NFPA 54: 5.6.8]

**1209.5.8.1 Pipe Joints.** Pipe joints shall be threaded, flanged, brazed, or welded. Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54: 5.6.8.1]

**1209.5.8.2 Tubing Joints.** Tubing joints shall either be made with approved gas tubing fittings or be brazed with a material having a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54: 5.6.8.2]

**1209.5.8.3 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. [NFPA 54: 5.6.8.3]

**1209.5.8.4 Metallic Fittings (Including Valves, Strainers, Filters).** [NFPA 54: 5.6.8.4]

- (1) Threaded fittings in sizes larger than 4 in. (100 mm) shall not be used unless acceptable to the Authority Having Jurisdiction.
- (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.
  - (a) Flanges shall be permitted.
  - (b) Bushings shall not be used.
  - (c) Fittings shall not be used in systems containing flammable gas-air mixtures.
  - (d) Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.
  - (e) Fittings in sizes 6 inches (150 mm)

**TABLE 12-2**

**Specifications for Threading Metallic Pipe**

Iron Pipe Size (in.)	Approximate Length of Threaded Portion (in.)	Approximate No. of Threads to Be Cut
1/2	3/4	10
3/4	3/4	10
1	7/8	10
1-1/4	1	11
1-1/2	1	11
2	1	11
2-1/2	1-1/2	12
3	1-1/2	12
4	1-5/8	13

For SI units, 1 in. = 25.4 mm. [NFPA 54: 5.6.7.3]

#### 1209.5.8 Metallic Piping Joints and Fittings.

The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to

and larger shall not be used unless approved by the Authority Having Jurisdiction.

- (6) Aluminum Alloy Fittings. Threads shall not form the joint seal.
- (7) Zinc-Aluminum Alloy Fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.
- (8) Special Fittings. Fittings such as couplings; proprietary-type joints; saddle tees; gland-type compression fittings; and flared, flareless, or compression-type tubing fittings shall be (1) used within the fitting manufacturers' pressure-temperature recommendations; (2) used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction; (3) installed or braced to prevent separation of the joint by gas pressure or external physical damage; and (4) acceptable to the Authority Having Jurisdiction.

#### 1209.5.9 Plastic Piping, Joints, and Fittings.

Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers' instructions. The following shall be observed when making such joints: [NFPA 54: 5.6.9]

- (A) The joint shall be designed and installed so that the longitudinal pullout resistance of the joint will be at least equal to the tensile strength of the plastic piping material.
- (B) Heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gastight 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."
- (C) Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of

the pipe or tubing and shall extend at least to the outside end of the pipe or tubing and 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 forced fit in the plastic. Split tubular stiffeners shall not be used.

- (D) Plastic piping joints and fittings for use in liquefied petroleum gas-piping systems shall be in accordance with *Liquefied Petroleum Gas Code*, NFPA 58.

**1209.5.10 Flanges.** All flanges shall comply with ANSI/ASME B16.1, *Standard for Cast Iron Pipe Flanges and Flanged Fittings*; ANSI/ASME B16.20, *Standard for Ring-Joint Gaskets and Grooves for Steel Pipe Flanges*; or MSS SP-6, *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings*. The pressure-temperature ratings shall equal or exceed that required by the application. [NFPA 54: 5.6.10]

(A) **Flange Facings.** Standard facings shall be permitted for use under this code. Where 150-psi (1,090 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54: 5.6.10.1]

(B) **Lapped Flanges.** Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54: 5.6.10.2]

**1209.5.11 Flange Gaskets.** The 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 conducted without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing the material. [NFPA 54: 5.6.11]

- (1) Acceptable materials include the following: [NFPA 54: 5.6.11.1]
  - (a) Metal or metal-jacketed asbestos (plain or corrugated)
  - (b) Asbestos
  - (c) Aluminum "O" rings and spiral-wound metal gaskets
- (2) When a flanged joint is opened, the gasket shall be replaced. [NFPA 54: 5.6.11.2]
- (3) Full-face gaskets shall be used with all bronze and cast-iron flanges. [NFPA 54: 5.6.11.3]

**1209.6 Gas Meters.**

**1209.6.1 Capacity.** Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54: 5.7.1]

**1209.6.2 Location.**

(A) Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54: 5.7.2.1]

(B) Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway; under a fire escape; in public passages, halls, or coal bins; or where they will be subject to excessive corrosion or vibration. [NFPA 54: 5.7.2.2]

(C) Gas meters shall be located at least 3 feet (0.9 m) from sources of ignition. [NFPA 54: 5.7.2.3]

(D) Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature. Meters shall not be located in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54: 5.7.2.3]

**1209.6.3 Supports.** Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters. Where flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or by other means providing equivalent support. [NFPA 54: 5.7.3]

**1209.6.4 Meter Protection.** Meters shall be protected against overpressure, back-pressure, and vacuum where such conditions are anticipated. [NFPA 54: 5.7.4]

**1209.6.5 Identification.** Gas piping at multiple meter installations shall be marked by a metal tag or other permanent means attached by the installing agency, designating the building or the part of the building being supplied. [NFPA 54: 5.7.5]

**1209.7 Gas Pressure Regulators.**

**1209.7.1 Where Required.** A line gas pressure regulator or gas equipment pressure regulator, as applicable, shall be installed where the gas supply pressure is higher than that at which the branch supply line or gas utilization equipment is designed to operate or varies beyond design pressure limits. [NFPA 54: 5.8.1]

**1209.7.2 Listing.** The line gas pressure regulator

shall be listed in accordance with ANSI Z21.80. [NFPA 54: 5.8.2]

**1209.7.3 Location.** The gas pressure regulator shall be accessible for servicing. [NFPA 54: 5.8.3]

**1209.7.4 Regulator Protection.** Pressure regulators shall be protected against physical damage. [NFPA 54: 5.8.4]

**1209.7.5 Venting.****(A) Line Gas Pressure Regulators.**

[NFPA 54: 5.8.5.1]

- (1) An independent vent to the outside of the building, sized in accordance with the regulator manufacturer's instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard. Where there is more than one regulator at a location, each regulator shall have a separate vent to the outside or, if approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize back-pressure in the event of diaphragm failure. [See NFPA 54:5.9.7] for information on properly locating the vent.) Materials for vent piping shall be in accordance with Section 1209.5.

**Exception:** A regulator and vent-limiting means combination listed as complying with ANSI Z21.80, Standard for Line Pressure Regulators, shall be permitted to be used without a vent to the outdoors.

- (2) The vent shall be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage.
- (3) At locations where regulators might be submerged during floods, a special antiflood-type breather vent fitting shall be installed, or the vent line shall be extended above the height of the expected flood waters.
- (4) A regulator shall not be vented to the gas equipment flue or exhaust system.

**(B) Gas Appliance Pressure Regulators.**

*Venting of Gas Appliance Pressure Regulators. Venting of gas appliance pressure regulators shall comply with the following requirements: [NFPA 54:9.1.19]*



- (1) *Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the equipment, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent-limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure.*
- (2) *Vent-limiting means shall be employed on listed gas appliance pressure regulators only.*
- (3) *In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.*
- (4) *Under no circumstances shall a regulator be vented to the gas utilization equipment flue or exhaust system.*
- (5) *In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined.*
- (6) *Vent lines from a gas appliance pressure regulator and bleed lines from a diaphragm-type valve shall not be connected to a common manifold terminating in a combustion chamber. Vent lines shall not terminate in positive-pressure-type combustion chambers.*

**(C) Discharge of Vents [NFPA 54:5.9.7]**

- (1) *The discharge stacks, vents, or outlet parts of all pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged into the outside atmosphere.*
- (2) *Discharge stacks or vents shall be designed to prevent the entry of water, insects, or any 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.*

**1209.7.6 Bypass Piping.** Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative. [NFPA 54: 5.8.6]

**1209.7.7 Identification.** Line pressure regulators at multiple regulator installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied. [NFPA 54: 5.8.7]

**1209.8 Back-Pressure Protection.**

**1209.8.1 Where to Install.** Protective devices shall be installed as close to the utilization equipment as practical, where the design of utilization equipment connected is such that air, oxygen, or standby gases could be forced into the gas supply system. [NFPA 54: 5.10.1.1] Gas and air combustion mixers incorporating double diaphragm "zero" or "atmosphere" governors or regulators shall require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psi (34 kPa) or more. [NFPA 54: 5.10.1.2]

**1209.8.2 Protective Devices.** Protective devices shall include but not be limited to the following: [NFPA 54: 5.10.2]

- (1) Check valves
- (2) Three-way valves (of the type that completely closes one side before starting to open the other side)
- (3) Reverse flow indicators controlling positive shutoff valves
- (4) Normally closed air-actuated positive shutoff pressure regulators

**1209.9 Low-Pressure Protection.**

A protective device shall be installed between the meter and the gas utilization equipment if the operation of the equipment (i.e., gas compressors) is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54: 5.11]

**1209.10 Shutoff Valves.** Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed. [NFPA 54: 5.12]

**1209.11 Expansion and Flexibility.**

**1209.11.1 Design.** Piping systems shall be designed to have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or loads at joints, or undesirable forces or moments at points of connections to equipment and at anchorage or guide points. Formal calculations or model tests shall be required only where reasonable doubt exists as to the adequate flexibility of the system. [NFPA 54: 5.13.1]

Flexibility shall be provided by the use of bends, loops, offsets, or couplings of the slip

type. Provision shall be made to absorb thermal changes by the use of expansion joints of the bellows type, or by the use of "ball" or "swivel" joints. Expansion joints of the slip type shall not be used inside buildings or for thermal expansion. Where expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes. [NFPA 54: 5.13.1.1]

Pipe alignment guides shall be used with expansion joints according to the recommended practice of the joint manufacturer. [NFPA 54: 5.13.1.2]

**1209.11.2 Special Local Conditions.** Where local conditions include earthquake, tornado, unstable ground, or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54: 5.13.2]

**1210.0 Excess Flow Valve.** When automatic excess flow gas shutoff devices (valves) are used, they shall be listed and approved and shall be sized for the maximum flow anticipated for the main or branch of the fuel gas system in which the excess flow valve is installed.

## 1211.0 Gas Piping Installation.

### 1211.1 Piping Underground.

**1211.1.1 Clearances.** Underground gas piping shall be installed with sufficient clearance from any other underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance or shall be insulated from any source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54: 7.1.1]

#### 1211.1.2 Protection Against Damage.

**(A) Cover Requirements.** Underground piping systems shall be installed with a minimum of 18 inches (460 mm) of cover. Where external damage to the pipe is not likely to result, the minimum cover shall be 12 inches (300 mm). Where a minimum of 12 inches (300 mm) of cover cannot be provided, the pipe shall be installed in conduit or bridged (shielded). [NFPA 54: 7.1.2.1]

**(B) Trenches.** The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench. [NFPA 54: 7.1.2.2]

**(C) Backfilling.** Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom. [NFPA 54: 7.1.2.3]

**1211.1.3 Protection Against Corrosion.** Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders. 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. [NFPA 54: 7.1.3]

**1211.1.4 Protection Against Freezing.** Where the formation of hydrates or ice is known to occur, piping shall be protected against freezing. [NFPA 54: 7.1.4]

**1211.1.5 Piping Through Foundation Wall.** Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in a protective pipe. The space between the gas piping and the building shall be sealed to prevent entry of gas or water. [NFPA 54: 7.1.5]

**1211.1.6 Piping Underground Beneath Buildings.** Where the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in an approved conduit designed to withstand the superimposed loads. [NFPA 54: 7.1.6] The conduit shall extend into a normally usable and accessible 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 of a type that will retain the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend at least 4 inches (100 mm) outside the building, be vented above grade to the outside, and be installed so as to prevent the entrance of water and insects. [NFPA 54: 7.1.6.1]

#### 1211.1.7 Plastic Pipe.

**(A) Connection of Plastic Piping.** Plastic pipe shall be installed outside, underground only. [NFPA 54: 7.1.7.1]

**Exception No. 1:** Plastic pipe shall be permitted to terminate aboveground where an anodeless riser is used.

**Exception No. 2:** Plastic pipe shall be permitted to terminate with a wall head adapter aboveground in buildings,

including basements, where the plastic pipe is inserted in a piping material permitted for use in buildings.

- (B) Connections made outside and underground between metallic and plastic piping shall be made only with ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings, Category I transition fittings*. [NFPA 54: 7.1.7.2]
- (C) An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the plastic pipe to facilitate locating. One end shall be brought aboveground at a building wall or riser. [NFPA 54: 7.1.7.3]

**1211.2 Installation of Piping.**

**1211.2.1** Piping installed aboveground shall be securely supported and located where it will be protected from physical damage (also see 1211.1.4). Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material approved for such applications. Where piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve shall be sealed at the wall to prevent the entry of water, insects, or rodents. [NFPA 54: 7.2.1]

**1211.2.2 Building Structure.**

- (1) The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. [NFPA 54: 7.2.2.1]
- (2) Approval shall be obtained before any beams or joists are cut or notched. [NFPA 54: 7.2.2.2] Permission shall be obtained from the Authority Having Jurisdiction.

**1211.2.3 Other than Dry Gas.** Drips, sloping, protection from freezing, and branch pipe connections, as provided for in Section 1211.1.4, 1211.6.1, and Section 1211.8, shall be provided when other than dry gas is distributed and climactic conditions make such provisions necessary. [NFPA 54: 7.2.3]

**1211.2.4 Gas Piping to be Sloped.** Piping for other than dry gas conditions shall be sloped not less than 1/4 inch in 15 feet (8 mm in 4572 mm) to prevent traps. [NFPA 54: 7.2.4]

**1211.2.4.1 Ceiling Locations.** Gas piping shall be permitted to be installed in accessible spaces between a fixed ceiling and a dropped ceiling, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.

**Exception:** Equipment shutoff valves required by this code shall be permitted to be installed in accessible spaces

containing vented gas utilization equipment.

**1211.2.5 Prohibited Locations.** Gas piping inside any building shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter, or elevator shaft. This provision shall not apply to ducts used to provide combustion and ventilation air in accordance with Section 507.0 or to above-ceiling spaces as covered in Section 1211.2.4.1.

**1211.2.6 Hangers, Supports, and Anchors.**

- (A) Piping shall be supported with pipe hooks, metal pipe straps, bands, brackets, or hangers suitable for the size of piping; be 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 ANSI/MSS SP-58, *Pipe Hangers and Supports - Materials, Design and Manufacture*. [NFPA 54: 7.2.6.1]
- (B) Spacings of supports in gas-piping installations shall not be greater than shown in Table 12-3. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instruction. [NFPA 54: 7.2.6.2]
- (C) 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. [NFPA 54: 7.2.6.3]

**TABLE 12-3  
Support of Piping**

Steel Pipe, Nominal Size of Pipe (in.)	Spacing of Supports (ft.)	Nominal Size of Tubing Smooth-wall (In. O.D.)	Spacing of Supports (ft.)
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1-1/4 or larger (horizontal)	10	7/8 or 1 (horizontal)	8
1-1/4 or larger (vertical)	every floor level	1 or larger (vertical)	every floor level

For SI units: 1 ft. = 0.305 m. [NFPA 54: Table 7.2.6.2]

**1211.2.7 Removal of Pipe.** Where piping containing gas is to be removed, the line shall be first disconnected from all sources of gas and then thoroughly purged with air, water, or inert gas before any cutting or welding is done. (See Section 1214.6.) [NFPA 54: 7.2.7]

### 1211.3 Concealed Piping in Buildings.

**1211.3.1 General.** Gas piping in concealed locations shall be installed in accordance with this section. [NFPA 54: 7.3.1]

**1211.3.2 Connections.** Where gas piping is to be concealed, unions, tubing fittings, right and left couplings, bushings, swing joints, and compression couplings made by combinations of fittings shall not be used. Connections shall be of the following type: [NFPA 54: 7.3.2]

- (1) Pipe fittings such as elbows, tees, and couplings.
- (2) Joining tubing by brazing (see Section 1209.5.8.2).
- (3) Fittings listed for use in concealed spaces that have been demonstrated to sustain, without leakage, any forces due to temperature expansion or contraction, vibration, or fatigue based on their geographic location, application, or operation.
- (4) Where necessary to insert fittings in gas pipe that has been installed in a concealed location, the pipe shall be reconnected by welding, flanges, or the use of a ground joint union with the nut center-punched to prevent loosening by vibration.

**1211.3.3 Piping in Partitions.** Concealed gas piping shall not be located in solid partitions. [NFPA 54: 7.3.3]

**1211.3.4 Tubing in Partitions.** This provision shall not apply to tubing that pierces walls, floors, or partitions or to tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length where both of the following requirements are met: [NFPA 54: 7.3.4]

- (1) A steel striker barrier not less than 0.0508 inches (1.3 mm) thick, or equivalent, is installed between the tubing and the finished wall and extends at least 4 inches (100 mm) beyond concealed penetrations of plates, fire stops, wall studs, and so on.
- (2) The tubing is installed in single runs and is not rigidly secured.

**1211.3.5 Piping in Floors.** In industrial occupancies, gas piping in solid floors such as concrete shall be laid in channels in the floor and covered to permit access to the piping with a minimum of damage to the building. Where

piping in floor channels could be exposed to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. [NFPA 54: 7.3.5.1]

**Exception:** In other than industrial occupancies and where approved by the Authority Having Jurisdiction, gas piping embedded in concrete floor slabs constructed with portland cement shall be surrounded with a minimum of 1-1/2 inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings, and risers shall be protected against corrosion in accordance with Section 1209.5.6. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. [NFPA 54: 7.3.5.2]

**1211.4 Piping in Vertical Chases.** (See Section 1202.0.) Where gas piping exceeding 5 psi (34 kPa) is located within vertical chases in accordance with Section 1211.5, the requirements of Sections 1211.5.1 through 1211.5.3 shall apply. [NFPA 54: 7.4]

**1211.5 Maximum Design Operating Pressure.** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met: [NFPA 54:5.5.1]

- (1) The piping system is welded.
- (2) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
- (3) The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:
  - (a) Industrial processing or heating
  - (b) Research
  - (c) Warehousing
  - (d) Boiler or mechanical equipment rooms
- (4) The piping is a temporary installation for buildings under construction.

**1211.5.1 Pressure Reduction.** (See Section 1202.0.) Where pressure reduction is required in branch connections for compliance with Section 1211.5, such reduction shall take place either inside the chase or immediately adjacent to the outside wall of the chase. Regulator venting and downstream overpressure protection shall comply with Section 1209.7.4 and NFPA Section 5.9. The regulator shall be accessible for service and repair and vented in accordance with one of the following: [NFPA 54: 7.4.1]

- (1) Where the fuel gas is lighter than air, regulators equipped with a vent-limiting

means shall be permitted to be vented into the chase. Regulators not equipped with a vent-limiting means shall be permitted to be vented either directly to the outdoors or to a point within the top 1 foot (0.3m) of the chase.

- (2) Where the fuel gas is heavier than air, the regulator vent shall be vented only directly to the outdoors.

**1211.5.2 Construction.** Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings. [NFPA 54: 7.4.2]

**1211.5.3 Ventilation.** A chase shall be ventilated to the outdoors and only at the top. The openings shall have a minimum free area (in square inches) equal to the product of one-half of the maximum pressure in the piping (in psi) times the largest nominal diameter of that piping (in inches), or the cross-sectional area of the chase, whichever is smaller. Where more than one fuel gas piping system is present, the free area for each system shall be calculated and the largest area used. [NFPA 54: 7.4.3]

**1211.6 Gas Pipe Turns.** Changes in direction of gas pipe shall be made by the use of fittings, or factory bends. [NFPA 54: 7.5]

**1211.6.1 Metallic Pipe.** Metallic pipe bends shall comply with the following: [NFPA 54: 7.5.1]

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

**1211.6.2 Plastic Pipe.** Plastic pipe bends shall comply with the following: [NFPA 54: 7.5.2]

- (1) The pipe shall not be damaged, and the internal diameter of the pipe shall not be effectively reduced.
- (2) Joints shall not be located in pipe bends.
- (3) The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.

- (4) Where the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

**1211.6.3 Elbows.** Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch of at least 1 inch (25 mm) for pipe sizes 2 inches and larger. [NFPA 54: 7.5.3]

### 1211.7 Drips and Sediment Traps.

**1211.7.1 Provide Drips Where Necessary.** For other than dry gas conditions, a drip shall be provided at any point in the line of pipe where condensate could collect. Where required by the Authority Having Jurisdiction or the serving gas supplier, a drip shall also be provided at the outlet of the meter. This drip shall be so installed as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before it will run back into the meter. [NFPA 54: 7.6.1]

**1211.7.2 Location of Drips.** All drips shall be installed only in such locations that they will be readily accessible to permit cleaning or emptying. A drip shall not be located where the condensate is likely to freeze. [NFPA 54: 7.6.2]

**1211.7.3 Sediment Traps. (See Section 1212.7.)**

### 1211.8 Outlets.

**1211.8.1 Location and Installation.**

- (1) The outlet fittings or piping shall be securely fastened in place. [NFPA 54: 7.7.1.1]
- (2) Outlets shall not be located behind doors. [NFPA 54: 7.7.1.2]
- (3) Outlets shall be located far enough from floors, walls, patios, slabs, and ceilings to permit the use of wrenches without straining, bending, or damaging the piping. [NFPA 54: 7.7.1.3]
- (4) The unthreaded portion of gas piping outlets shall extend not less than 1 in. (25 mm) through finished ceilings or indoor or outdoor walls. [NFPA 54: 7.7.1.4]
- (5) The unthreaded portion of gas-piping outlets shall extend not less than 2 inches (50 mm) above the surface of floors or outdoor patios or slabs. [NFPA 54: 7.7.1.5]
- (6) The provisions of Sections 1211.7.1 (4) and (5) shall not apply to listed quick-disconnect devices of the flush-mounted type or listed gas convenience outlets. Such devices shall be installed in accordance with the manufacturers' installation instructions. [NFPA 54: 7.7.1.6]

**1211.8.2 Cap All Outlets.**

- (A) Each outlet, including a valve, shall be closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. When equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be closed gastight. [NFPA 54: 7.7.2.1]

**Exception No. 1:** Laboratory equipment installed in accordance with 1212.2(A) shall be permitted.

**Exception No. 2:** The use of a listed quick-disconnect device with integral shutoff or listed gas convenience outlet shall be permitted.

- (B) Equipment shutoff valves installed in fireplaces shall be removed and the piping capped gastight where the fireplace is used for solid-fuel burning. [NFPA 54: 7.7.2.2]

**1211.9 Branch Pipe Connection.** When a branch outlet is placed on a main supply line before it is known what size pipe will be connected to it, the outlet shall be of the same size as the line that supplies it. [NFPA 54: 7.8]

**1211.10 Manual Gas Shutoff Valves.** (Also see Section 1212.4.)

**1211.10.1 Valves at Regulators.** An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator. [NFPA 54: 7.9.1]

**1211.10.2 Valves Controlling Multiple Systems.**

- (A) **Accessibility of Gas Valves.** Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them can be readily identified. [NFPA 54: 7.9.2.1]

- (B) **Shutoff Valves for Multiple House Lines.** In multiple-tenant buildings supplied through a master meter, or through one service regulator where a meter is not provided, or where meters or service regulators are not readily accessible from the equipment location, an individual

shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility.

In a common system serving a number of individual buildings, shutoff valves shall be installed at each building. [NFPA 54: 7.9.2.2]

**1211.10.3 Emergency Shutoff Valves.** An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted as required by the Authority Having Jurisdiction. [NFPA 54: 7.9.2.3]

**1211.11 Prohibited Devices.** No device shall be placed inside the gas piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas, except where proper allowance in the piping system design has been made for such a device and where approved by the Authority Having Jurisdiction. [NFPA 54: 7.10]

**1211.12 Systems Containing Gas-Air Mixtures Outside the Flammable Range.** Where gas-air mixing machines are employed to produce mixtures above or below the flammable range, they shall be provided with stops to prevent adjustment of the mixture to within or approaching the flammable range. [NFPA 54: 7.11]

**1211.13 Systems Containing Flammable Gas-Air Mixtures.**

**1211.13.1 Required Components.** A central premix system with a flammable mixture in the blower or compressor shall consist of the following components: [NFPA 54: 7.12.1]

- (1) Gas-mixing machine in the form of an automatic gas-air proportioning device combined with a downstream blower or compressor.
- (2) Flammable mixture piping, minimum Schedule 40 NPS.
- (3) Automatic firechecks.
- (4) Safety blowouts or backfire preventers for systems utilizing flammable mixture lines above 2-1/2 inch (65 mm) nominal pipe size or the equivalent.

**1211.13.2 Optional Components.**

The following components shall also be permitted to be utilized in any type of central premix system: [NFPA 54: 7.12.2]

- (1) Flow meters.
- (2) Flame arresters.

**1211.13.3 Additional Requirements.** Gas-mixing machines shall have nonsparking

blowers and shall be so constructed that a flashback will not rupture machine casings. [NFPA 54: 7.12.3]

**1211.13.4 Special Requirements for Mixing Blowers.** A mixing blower system shall be limited to applications with minimum practical lengths of mixture piping, limited to a maximum mixture pressure of 10 inch water column (2.49 kPa) and limited to gases containing no more than 10 percent hydrogen.

The blower shall be equipped with a gas-control valve at its air entrance so arranged that gas is admitted to the airstream, entering the blower in proper proportions for correct combustion by the type of burners employed, the said gas-control valve being of either the zero governor or mechanical ratio valve type that controls the gas and air adjustment simultaneously. No valves or other obstructions shall be installed between the blower discharge and the burner or burners. [NFPA 54: 7.12.4]

**1211.13.5 Installation of Gas-Mixing Machines.**

- (A) The machine shall be located in a large, well-ventilated area or in a small detached building or cutoff room provided with room construction and explosion vents in accordance with sound engineering principles. Such rooms or below-grade installations shall have adequate positive ventilation. [NFPA 54: 7.12.5.1]
- (B) Where gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be in accordance with *California Electrical Code*, for general service conditions, unless other hazards in the area prevail. Where gas-mixing machines are installed in small detached buildings or cutoff rooms, the electrical equipment and wiring shall be installed in accordance with *California Electrical Code*, for hazardous locations (Articles 500 and 501, Class I, Division 2). [NFPA 54: 7.12.5.2]
- (C) Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical. [NFPA 54: 7.12.5.3]
- (D) Controls for gas-mixing machines shall include interlocks and a safety shutoff valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, the controls

shall be interlocked so that the blower or compressor will stop operating following a gas supply failure. Where a system employs pressurized air, means shall be provided to shut off the gas supply in the event of air failure. [NFPA 54: 7.12.5.4]

- (E) Centrifugal gas-mixing machines in parallel shall be reviewed by the user and equipment manufacturer before installation, and means or plans for minimizing these effects of downstream pulsation and equipment overload shall be prepared and utilized as needed. [NFPA 54: 7.12.5.5]

**1211.13.6 Use of Automatic Firechecks, Safety Blowouts, or Backfire Preventers.**

Automatic firechecks and safety blowouts or backfire preventers shall be provided in piping systems distributing flammable air-gas mixtures from gas-mixing machines to protect the piping and the machines in the event of flashback, in accordance with the following: [NFPA 54: 7.12.6]

- (A) Approved automatic firechecks shall be installed upstream as close as practicable to the burner inlets following the firecheck manufacturers' instructions.
- (B) A separate manually operated gas valve shall be provided at each automatic firecheck for shutting off the flow of gas-air mixture through the firecheck after a flashback has occurred. The valve shall be located upstream as close as practical to the inlet of the automatic firecheck.

**CAUTION:**

These valves shall not be reopened after a flashback has occurred until the firecheck has cooled sufficiently to prevent reignition of the flammable mixture and has been reset properly.

- (C) A safety blowout or backfiring preventer shall be provided in the mixture line near the outlet of each gas-mixing machine where the size of the piping is larger than 2-1/2 inch (65 mm) NPS, or equivalent, to protect the mixing equipment in the event of an explosion passing through an automatic firecheck. The manufacturers' instructions shall be followed when installing these devices, particularly after a disc has burst.

The discharge from the safety blowout or backfire preventer shall be located or shielded so that particles from the ruptured disc cannot be directed toward personnel. Wherever there are interconnected installations of gas-mixing machines with safety blowouts or backfire preventers,

provision shall be made to keep the mixture from other machines from reaching any ruptured disc opening. Check valves shall not be used for this purpose.

- (D) Large-capacity premix systems provided with explosion heads (rupture disc) to relieve excessive pressure in pipelines shall be located at and vented to a safe outdoor location. Provisions shall be provided for automatically shutting off the supply of gas-air mixture in the event of rupture.

#### 1211.14 Electrical Bonding and Grounding.

- (A) Each aboveground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded when it is connected to gas utilization equipment that is connected to the equipment grounding conductor of the circuit supplying that equipment. [NFPA 54: 7.13.1]
- (B) Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54: 7.13.2]

**1211.15 Electrical Circuits.** Electrical circuits shall not utilize gas piping or components as conductors. [NFPA 54: 7.14]

**Exception:** Low-voltage (50 V or less) control circuits, ignition circuits, and electronic flame detection device circuits shall be permitted to make use of piping or components as a part of an electric circuit.

#### 1211.16 Electrical Connections.

- (A) All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of *California Electrical Code*. (See Section 1211.13.)
- (B) Any essential safety control depending on electric current as the operating medium shall be of a type that will shut off (fail safe) the flow of gas in the event of current failure. [NFPA 54: 7.15.2]

#### 1211.17 Pipe Sizing Methods.

**1211.17.1** Where the pipe size is to be determined using any of the methods in Sections 1211.17.1.1 through 1211.17.1.3, the diameter of each pipe segment shall be obtained from the pipe-sizing tables in Section 1211.17.2 or from the sizing equations in Section 1211.17.3. [NFPA 54: 6.1]

**1211.17.1.1 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. [NFPA 54: 6.1.1]

**1211.17.1.2 Branch Length Method.** Pipe shall be sized as follows: [NFPA 54: 6.1.2]

- (A) 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.
- (B) 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.

**1211.17.1.3 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. [NFPA 54: 6.1.3]

**1211.17.2 Tables for Sizing Gas-Piping Systems.** Tables 12-7 through 12-41 shall be used to size gas piping in conjunction with one of the methods described in Sections 1211.17.1.1 through 1211.17.1.3. [NFPA 54: 6.2]

**1211.17.3 Sizing Equations.** The inside diameter of smooth-wall pipe or tubing shall be determined by the sizing equations 12-1 or 12-2, using the equivalent pipe length determined by Sections 1211.17.1.1 through 1211.17.1.3. [NFPA 54: 6.4]

**Equation 12-1 Low-Pressure Gas Formula (Less than 1.5 psi [10.3 kPa]):** [NFPA 54: 6.4.1]

$$D = \frac{Q^{0.381}}{19.17 \left( \frac{\Delta H}{Cr \times L} \right)^{0.206}}$$

where:

D = inside diameter of pipe, inches

Q = input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30-inch (759 mm) mercury column

P<sub>1</sub> = upstream pressure, psia (P<sub>1</sub> + 14.7)

P<sub>2</sub> = downstream pressure, psia (P<sub>2</sub> + 14.7)

L = equivalent length of pipe, feet

ΔH = pressure drop, inches water column (27.7 in. H<sub>2</sub>O = 1 psi)



**Equation 12-2 High-Pressure Gas Formula (1.5 psi [10.3 kPa] and above):** [NFPA 54: 6.4.2]

$$D = \frac{Q^{0.381}}{18.93 \left[ \frac{(P_1^2 - P_2^2) \cdot Y}{Cr \times L} \right]^{0.206}}$$

where:

D = inside diameter of pipe, inches

Q = input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30 inch (759 mm) mercury column

P<sub>1</sub> = upstream pressure, psia (P<sub>1</sub> + 14.7)

P<sub>2</sub> = downstream pressure, psia (P<sub>2</sub> + 14.7)

L = equivalent length of pipe, feet.

ΔH = pressure drop, inches water column (27.7 in. H<sub>2</sub>O = 1 psi)

**TABLE 12-4**

**Cr and Y for Natural Gas and Undiluted Propane at Standard Conditions** [NFPA 54: Table 6.4.2]

Formula Factors Gas	Cr	Y
Natural Gas	0.6094	0.9992
Undiluted Propane	1.2462	0.9910

For SI units, 1 ft.<sup>3</sup> = 0.028 m<sup>3</sup>; 1 ft. = 0.305 m; 1 in. water column = 0.249 kPa; 1 psi = 6.894 kPa; 1,000 Btu/h = 0.293 kW.

**1211.18 [For DSA-SS] Earthquake-actuated Gas Shutoff Valves.** Earthquake-actuated gas shutoff valves, certified by the State Architect as conforming to California Referenced Standard 12-16-1, shall be provided for buildings when such installation is required by local ordinance. Earthquake-actuated gas shutoff valves which have not been certified by the State Architect shall be prohibited in buildings open to the public under mandatory installation by local ordinance.

**1212.0 Equipment Connections to Building Piping.**

**1212.1 Connecting Gas Equipment.** Gas utilization equipment shall be connected to the building piping in compliance with Sections 1212.4 and 1212.5 by one of the following: [NFPA 54: 9.6.1]

- (1) Rigid metallic pipe and fittings.
- (2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

- (3) Listed flexible gas connectors in compliance with ANSI Z21.24, *Standard for Connectors for Gas Appliances*. The connector shall be used in accordance with the terms of their listing that are completely in the same room as the equipment.
- (4) CSST where installed in accordance with the manufacturer's instructions.
- (5) Listed nonmetallic gas hose connectors in accordance with 1212.2.
- (6) Gas-fired food service (commercial cooking) equipment listed for use with casters or otherwise subject to movement for cleaning, and other large and heavy gas utilization equipment that can be moved, shall be connected in accordance with the connector manufacturer's installation instructions using a listed appliance connector complying with ANSI Z21.69, *Standard for Connectors for Movable Gas Appliances*. [NFPA 54: 9.6.1.1]
- (7) In 1212.1(2), (3), and (5), the connector or tubing shall be installed so as to be protected against physical and thermal damage. Aluminum alloy tubing and connectors shall be coated to protect against external corrosion where they are in contact with masonry, plaster, or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents, or sewage.

**1212.2 Use of Nonmetallic Gas Hose Connectors.** Listed nonmetallic gas hose connectors shall be used in accordance with the terms of their listing and as follows: [NFPA 54: 9.6.2]

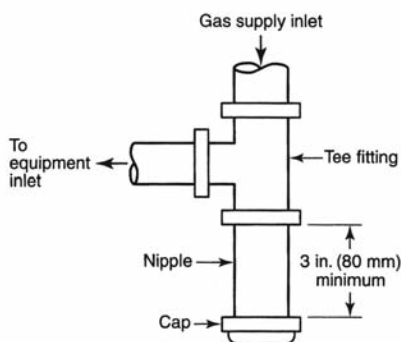
- (A) **Indoor.** Indoor gas hose connectors shall be used only to connect laboratory, shop, and ironing equipment requiring mobility during operation. An equipment shutoff valve shall be installed where the connector is attached to the building piping. The connector shall be of minimum length and shall not exceed 6 feet (1829 mm). The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors.
- (B) **Outdoor.** Outdoor gas hose connectors are permitted to connect portable outdoor gas-fired equipment. An equipment shutoff valve, a listed quick-disconnect device, or a listed gas convenience outlet shall be installed where the connector is attached to the supply piping and in such a manner to prevent the accumulation of water or foreign matter. This connection shall be made only in the outdoor area where the equipment is to be used. The connector length shall not exceed 15 feet (4572 mm).

### 1212.3 Connection of Portable and Mobile Industrial Gas Equipment.

- (A) Where portable industrial gas utilization equipment, or equipment requiring mobility or subject to vibration, is connected to the building gas piping system by the use of a flexible hose, the hose shall be suitable and safe for the conditions under which it can be used. [NFPA 54: 9.6.3.1]
- (B) Where industrial gas utilization equipment requiring mobility is connected to the rigid piping by the use of swivel joints or couplings, the swivel joints or couplings shall be suitable for the service required, and only the minimum number required shall be installed. [NFPA 54: 9.6.3.2]
- (C) Where industrial gas utilization equipment subject to vibration is connected to the building piping system by the use of all-metal flexible connectors, the connectors shall be suitable for the service required. [NFPA 54: 9.6.3.3]
- (D) Where flexible connections are used, they shall be of the minimum practical length and shall not extend from one room to another or pass through any walls, partitions, ceilings, or floors. Flexible connections shall not be used in any concealed location. They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections. [NFPA 54: 9.6.3.4]

### 1212.4 Equipment Shutoff Valves and Connections.

Gas utilization equipment connected to a piping system shall have an accessible, approved manual shutoff valve with a nondisplaceable valve member, or a listed gas convenience outlet [NFPA 54: 9.6.4], installed within 6 feet (1.8 m) of the equipment it serves. Where a connector is used, the valve shall be installed upstream of the connector. A union or



**Figure 12-1 Method of Installing a Tee Fitting Sediment Trap.**

flanged connection shall be provided downstream from this valve to permit removal of controls. Shutoff valves serving decorative gas appliances shall be permitted to be installed in fireplaces if listed for such use. [NFPA 54: 9.6.4.1]

**1212.5 Quick-Disconnect Devices.** Quick-disconnect devices used to connect equipment to the building piping shall be listed. [NFPA 54: 9.6.5.1] Where they are installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54: 9.6.5.2]

**1212.6 Support of Chimneys.** All portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturers' instructions.

**1212.7 Sediment Trap.** Where a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap shall be installed as close to the inlet of the equipment as practical at the time of equipment installation. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet, as illustrated in Figure 12-1, or other device recognized as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative vented appliances for installation in vented fireplaces, gas fireplaces, and outdoor grills shall not be required to be so equipped. [NFPA 54: 9.6.7]

**1212.8 Installation of Piping.** Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the gas utilization equipment. [NFPA 54: 9.6.8]

### 1213.0 Liquefied Petroleum Gas Facilities and Piping.

Liquefied petroleum gas facilities shall comply with NFPA 58, *Liquefied Petroleum Gas Code*.

### 1214.0 Pressure Testing and Inspection.

#### 1214.1 General.

**1214.1.1** 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. [NFPA 54: 8.1.1.1]

**1214.1.2** Inspection shall consist of visual examination during or after manufacture, fabrication, assembly, or pressure tests, as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic-particle, radiographic, and ultrasonic, shall not be required unless specifically listed herein or in the engineering design. [NFPA 54: 8.1.1.2]

**1214.1.3** Where repairs or additions are made following 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 leak-detecting methods approved by the Authority Having Jurisdiction. [NFPA 54: 8.1.1.3]

**1214.1.4** Where new branches are installed from the point of delivery 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 approved leak-detecting methods. [NFPA 54: 8.1.1.4]

**1214.1.5** A piping system shall 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 pressure. [NFPA 54: 8.1.1.5]

**1214.1.6** 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. [NFPA 54: 8.1.1.6]

**1214.1.7 Test Medium.** The test medium shall be air, nitrogen, carbon dioxide, or an inert gas. OXYGEN SHALL NEVER BE USED. [NFPA 54: 8.1.2]

#### **1214.2 Test Preparation.**

**1214.2.1** Pipe joints, including welds, shall be left exposed for examination during the test. [NFPA 54: 8.1.3.1]

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

**1214.2.2** Expansion joints shall be provided with temporary restraints, if required for the additional thrust load under test. [NFPA 54: 8.1.3.2]

**1214.2.3** 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. [NFPA 54: 8.1.3.3]

**1214.2.4** Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures of less

than the test pressure, such appliances, equipment, or equipment components shall be isolated from the piping system by disconnecting them and capping the outlets. [NFPA 54: 8.1.3.4]

**1214.2.5** Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures equal to or greater than the test pressure, such appliances and equipment shall be isolated from the piping system by closing the individual appliance equipment shutoff valves. [NFPA 54: 8.1.3.5]

**1214.2.6** 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. [NFPA 54: 8.1.3.6]

#### **1214.3 Test Pressure.**

**1214.3.1** 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 due to 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. [NFPA 54: 8.1.4.1]

**1214.3.2** The test pressure to be used shall be no less than 1-1/2 times the proposed maximum working pressure, but not less than 3 psi (20 kPa), irrespective of design pressure. [NFPA 54: 8.1.4.2]

**1214.3.3** Test duration shall be not less than 1/2 hour for each 500 cubic feet (14 m<sup>3</sup>) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet (0.28 m<sup>3</sup>) or a system in a single-family dwelling, the test duration shall be a minimum of 10 minutes. The duration of the test shall not be required to exceed 24 hours. [NFPA 54: 8.1.4.3]

#### **1214.4 Detection of Leaks and Defects.**

**1214.4.1** 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. [NFPA 54: 8.1.5.1]

**1214.4.2** 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 provide a source of ignition shall not be used. [NFPA 54: 8.1.5.2]

**1214.4.3** Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. [See Section 1214.1.3.] [NFPA 54: 8.1.5.3]

**1214.5 System and Equipment Leakage Test.**

**1214.5.1 Test Gases.** Leak checks using fuel gas shall be permitted in piping systems that have been pressure-tested in accordance with Section 1214.0. [NFPA 54: 8.2.1]

**1214.5.2 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 all valves at unused outlets are closed and plugged or capped. [NFPA 54: 8.2.2]

**1214.5.3 Test for Leakage.** Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be checked for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made. [NFPA 54: 8.2.3]

**1214.5.4 Placing Equipment in Operation.**

Gas utilization equipment shall not be placed in operation until after the piping system has been tested in accordance with Section 1214.5.3 and purged in accordance with Section 1214.6.2. [NFPA 54: 8.2.4]

**1214.6 Purging.**

**1214.6.1 Removal From Service.** When 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 12-5. [NFPA 54: 8.3.1]

**TABLE 12-5**  
**Length of Piping Requiring Purging with Inert Gas for Servicing or Modification**  
[NFPA 54: Table 8.3.1]

Nominal Pipe Size (in.)	Length of Piping Requiring Purging (ft.)
2	> 50
3	> 30
4	> 15
6	> 10
8 or larger	Any length

For SI units: 1 ft = 0.305 m.

**1214.6.2 Placing in Operation.** When 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 12-6 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 12-6, the air in the piping shall first be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas. [NFPA 54: 8.3.2]

**TABLE 12-6**  
**Length of Piping Requiring Purging with Inert Gas Before Placing in Operation**  
[NFPA 54: Table 8.3.2]

Nominal Pipe Size (in.)	Length of Piping Requiring Purging (ft.)
3	>30
4	>15
6	>10
8 or larger	Any length

For SI units: 1 ft. = 0.305 m.

**1214.6.3 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. [NFPA 54: 8.3.3]

**1214.6.4 Placing Equipment in Operation.** After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary. [NFPA 54: 8.3.4]

**1215.0 Interconnections Between Gas Piping Systems [NFPA 54: 5.3]**

**1215.1 Interconnections Supplying Separate Users.** Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas-piping systems shall not be interconnected on the outlet side of the meters or service regulators. [NFPA 54: 5.3.1]

**1215.2 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. [NFPA 54: 5.3.2.1] 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. [NFPA 54:5.3.2.2]

**1216.0 Required Gas Supply.**

**1216.1** The following regulations, as set forth in this section and in Section 1217.0, Required Gas Piping Size, shall be the standard for the installation of gas piping. All natural gas regulations and tables are based on the use of gas having a specific gravity of sixty hundredths (0.60), supplied at six (6) to eight (8) inches (152–203 mm) water column pressure at the outlet of the meter. For undiluted liquefied petroleum gas, gas piping may be sized for 2,500 Btu per cubic foot (25.9 Watt-hours/L) at eleven (11) inches (279 mm) water column and specific gravity of one and fifty-two hundredths (1.52).

**Note:** Where gas of a different specific gravity is to be delivered, the serving gas supplier should be contacted for specific gravity conversion factors to use in sizing piping systems from the pipe sizing tables in this chapter.

**1216.2** The hourly volume of gas required at each piping outlet shall be taken as not less than the maximum hourly rating as specified by the manufacturer of the appliance or appliances to be connected to each such outlet.

**1216.3** Where the gas appliances to be installed have not been definitely specified, Table 12-1 may be used as a reference to estimate requirements of typical appliances.

To obtain the cubic feet per hour (L/sec.) of gas required, divide input of appliances by the average Btu (Watt-hour) heating value per cubic foot (L) of the gas. The average Btu (Watt-hour) per cubic foot (L) of the gas in the area of the installation may be obtained from the serving gas supplier.

**1216.4** The size of the supply piping outlet for any gas appliance shall not be less than one-half (1/2) inch (15 mm).

The minimum size of any piping outlet for a mobile home shall be three-quarter (3/4) inch (20 mm).

**1217.0 Required Gas Piping Size.**

**1217.1** Where the maximum demand does not exceed two hundred fifty (250) cubic feet per hour (2

L/sec.) and the maximum length of piping between the meter and the most distant outlet is not over two hundred fifty (250) feet (76,200 mm), the size of each section and each outlet of any system of gas piping shall be determined by means of Table 12-7 for steel pipe, or Table 12-15 for copper tubing systems, or Table 12-19 for CSST systems. Other Systems within the range of Table 12-7 or 12-15 or Table 12-19 may be sized from that table or by means of the methods set forth in Section 1217.3.

**1217.2** To determine the size of each section of pipe in any system within the range of Table 12-7, proceed as follows:

- (1) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
- (2) In Table 12-7 select the length in feet column and row showing that distance, or the next longer distance if the table does not give the exact length.
- (3) Starting at the most remote outlet, find in the row just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure in the row.
- (4) At the top of this column will be found the correct size of pipe.
- (5) Using this same row, proceed in a similar manner for each section of pipe serving this outlet. For each section of pipe, determine the total gas demand supplied by that section. Where gas piping sections serve both heating and cooling equipment and the installation prevents both units from operating simultaneously, only the larger of the two demand loads needs be used in sizing these sections.
- (6) Size each section of branch piping not previously sized by measuring the distance from the gas meter location to the most remote outlet in that branch and follow the procedures of steps 2, 3, 4, and 5 above.

**Note:**

Size branch piping in the order of their distance from the meter location, beginning with the most distant outlet not previously sized.

**1217.3** For conditions other than those covered by Section 1217.1, such as longer runs or greater gas demands, the size of each gas piping system shall be determined by standard engineering methods acceptable to the Authority Having Jurisdiction, and each such system shall be so designed that the total

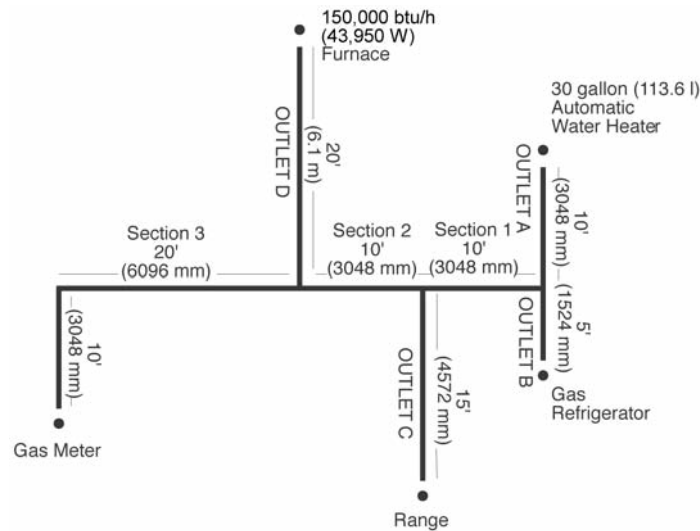
pressure drop between the meter or other point of supply and any outlet when full demand is being supplied to all outlets, will at no time exceed five-tenths (0.5) inches (12.7 mm) water column pressure.

**1217.4** Where the gas pressure may be higher than fourteen (14) inches (356 mm) or lower than six (6) inches (152 mm) of water column, or when diversity demand factors are used, the design, pipe, sizing, materials, location, and use of such systems first shall be approved by the Authority Having Jurisdiction. Piping systems designed for pressures higher than the serving gas supplier's standard

delivery pressure shall have prior verification from the gas supplier of the availability of the design pressure. Systems using undiluted liquefied petroleum gas may be sized using Table 12-11 for steel pipe and Table 12-23 for CSST for eleven (11) inches (279 mm) of water column and in accordance with the provisions of Sections 1217.1 and 1217.2. For copper tubing systems using undiluted liquefied petroleum gas, the capacity of the tubing shall be determined by multiplying the values of Table 12-15 by the appropriate factor from Table 12-16.

**Figure 12-2 Example Illustrating Use of Tables 12-1 and 12-7**

Problem: Determine the required pipe size of each section and outlet of the piping system shown in Figure 12-2. Gas to be used has a specific gravity of sixty hundredths (0.60) and eleven hundred (1,100) Btu per cubic foot (11.4 Watt-hour/L), delivered at eight (8) inch (203 mm) water column pressure.



Solution:

- (1) Maximum gas demand of outlet A —  
32 cubic feet per hour (0.21 L/sec.) (from Table 12-1).  
Maximum gas demand of outlet B —  
3 cubic feet per hour (0.02 L/sec.) (from Table 12-1).  
Maximum gas demand of outlet C —  
59 cubic feet per hour (0.46 L/sec.) (from Table 12-1).  
Maximum gas demand of outlet D —  
136 cubic feet per hour (1.1 L/sec.) (150,000 Btu/hour [43,950 W])  
divided by 1,100 Btu per cubic foot (11.4 Watt-hour/L)
- (2) The length of pipe from the gas meter to the most remote outlet (outlet A) is 60 feet (18,288 mm).
- (3) Using the length in feet column row marked 60 feet (18,288 mm) in Table 12-7:
  - Outlet A, supplying 32 cubic feet per hour (0.21 L/sec.), requires one-half (1/2) inch (15 mm) pipe. Section 1, supplying outlets A and B, or 35 cubic feet per hour (0.24 L/sec.) requires one-half (1/2) inch (15 mm) pipe.
  - Section 2, supplying outlets A, B, and C, or 94 cubic feet per hour (0.7 L/sec.) requires three-quarter (3/4) inch (20 mm) pipe.
  - Section 3, supplying outlets A, B, C, and D, or 230 cubic feet per hour (1.8 L/sec.), requires one and one quarter (1-1/4) inch (32 mm) pipe.
- (4) Using the column marked 60 feet (18288 mm) in Table 12-7 (no column for actual length of 55 feet [16,764 mm]):
  - Outlet B supplying 3 cubic feet per hour (0.02 L/sec.), requires one-half (1/2) inch (15 mm) pipe.
  - Outlet C, supplying 59 cubic feet per hour (0.46 L/sec.), requires one-half (1/2) inch (15 mm) pipe.
- (5) Using the column marked 60 feet (15,240 mm) in Table 12-7:
  - Outlet D, supplying 136 cubic feet per hour (1.1 L/sec.), requires (1) inch (25 mm) pipe.

**Table 12-7  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(a)]**

													Gas: Natural	
													Inlet Pressure: Less than 2 psi	
													Pressure Drop: 0.3 in. w.c.	
													Specific Gravity: 0.60	
Pipe Size (in.)														
Nominal:	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	131	273	514	1,060	1,580	3,050	4,860	8,580	17,500	31,700	51,300	105,000	191,000	303,000
20	90	188	353	726	1,090	2,090	3,340	5,900	12,000	21,800	35,300	72,400	132,000	208,000
30	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
40	62	129	243	499	747	1,440	2,290	4,050	8,270	15,000	24,200	49,800	90,400	143,000
50	55	114	215	442	662	1,280	2,030	3,590	7,330	13,300	21,500	44,100	80,100	127,000
60	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	72,600	115,000
70	46	95	179	368	552	1,060	1,690	3,000	6,110	11,100	17,900	36,800	66,800	106,000
80	42	89	167	343	514	989	1,580	2,790	5,680	10,300	16,700	34,200	62,100	98,400
90	40	83	157	322	482	928	1,480	2,610	5,330	9,650	15,600	32,100	58,300	92,300
100	38	79	148	304	455	877	1,400	2,470	5,040	9,110	14,800	30,300	55,100	87,200
125	33	70	131	269	403	777	1,240	2,190	4,460	8,080	13,100	26,900	48,800	77,300
150	30	63	119	244	366	704	1,120	1,980	4,050	7,320	11,900	24,300	44,200	70,000
175	28	58	109	224	336	648	1,030	1,820	3,720	6,730	10,900	22,400	40,700	64,400
200	26	54	102	209	313	602	960	1,700	3,460	6,260	10,100	20,800	37,900	59,900
250	23	48	90	185	277	534	851	1,500	3,070	5,550	8,990	18,500	33,500	53,100
300	21	43	82	168	251	484	771	1,360	2,780	5,030	8,150	16,700	30,400	48,100
350	19	40	75	154	231	445	709	1,250	2,560	4,630	7,490	15,400	28,000	44,300
400	18	37	70	143	215	414	660	1,170	2,380	4,310	6,970	14,300	26,000	41,200
450	17	35	66	135	202	389	619	1,090	2,230	4,040	6,540	13,400	24,400	38,600
500	16	33	62	127	191	367	585	1,030	2,110	3,820	6,180	12,700	23,100	36,500
550	15	31	59	121	181	349	556	982	2,000	3,620	5,870	12,100	21,900	34,700
600	14	30	56	115	173	333	530	937	1,910	3,460	5,600	11,500	20,900	33,100
650	14	29	54	110	165	318	508	897	1,830	3,310	5,360	11,000	20,000	31,700
700	13	27	52	106	159	306	488	862	1,760	3,180	5,150	10,600	19,200	30,400
750	13	26	50	102	153	295	470	830	1,690	3,060	4,960	10,200	18,500	29,300
800	12	26	48	99	148	285	454	802	1,640	2,960	4,790	9,840	17,900	28,300
850	12	25	46	95	143	275	439	776	1,580	2,860	4,640	9,530	17,300	27,400
900	11	24	45	93	139	267	426	752	1,530	2,780	4,500	9,240	16,800	26,600
950	11	23	44	90	135	259	413	731	1,490	2,700	4,370	8,970	16,300	25,800
1,000	11	23	43	87	131	252	402	711	1,450	2,620	4,250	8,720	15,800	25,100
1,100	10	21	40	83	124	240	382	675	1,380	2,490	4,030	8,290	15,100	23,800
1,200	NA	20	39	79	119	229	364	644	1,310	2,380	3,850	7,910	14,400	22,700
1,300	NA	20	37	76	114	219	349	617	1,260	2,280	3,680	7,570	13,700	21,800
1,400	NA	19	35	73	109	210	335	592	1,210	2,190	3,540	7,270	13,200	20,900
1,500	NA	18	34	70	105	203	323	571	1,160	2,110	3,410	7,010	12,700	20,100
1,600	NA	18	33	68	102	196	312	551	1,120	2,030	3,290	6,770	12,300	19,500
1,700	NA	17	32	66	98	189	302	533	1,090	1,970	3,190	6,550	11,900	18,800
1,800	NA	16	31	64	95	184	293	517	1,050	1,910	3,090	6,350	11,500	18,300
1,900	NA	16	30	62	93	178	284	502	1,020	1,850	3,000	6,170	11,200	17,700
2,000	NA	16	29	60	90	173	276	488	1,000	1,800	2,920	6,000	10,900	17,200

NA means a flow of less than 10 cfh.  
Note: All table entries are rounded to 3 significant digits.

**Table 12-8  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(b)]**

														Gas:	Natural
														Inlet Pressure:	Less than 2 psi
														Pressure Drop:	0.5 in. w.c.
														Specific Gravity:	0.60
Pipe Size (in.)															
Nominal:	½	¾	1	1¼	1½	2	2½	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	

NA means a flow of less than 10 cfh.  
Note: All table entries are rounded to 3 significant digits.



**Table 12-9  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(c)]**

										Gas: Natural										
										Inlet Pressure: 2.0 psi										
										Pressure Drop: 1.0 psi										
										Specific Gravity: 0.60										
										Pipe Size (in.)										
Nominal:	½	¾	1	1¼	1½	2	2½	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											

Note: All table entries are rounded to 3 significant digits.

**Table 12-10  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(d)]**

		Gas: Natural							
		Inlet Pressure: 3.0 psi							
		Pressure Drop: 2.0 psi							
		Specific Gravity: 0.60							
Pipe Size (in.)									
Nominal:	½	¾	1	1¼	1½	2	2½	3	4
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas per Hour								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	73,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,800	20,800	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,800
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
250	412	862	1,620	3,330	5,000	9,620	15,300	27,100	55,300
300	374	781	1,470	3,020	4,530	8,720	13,900	24,600	50,100
350	344	719	1,350	2,780	4,170	8,020	12,800	22,600	46,100
400	320	669	1,260	2,590	3,870	7,460	11,900	21,000	42,900
450	300	627	1,180	2,430	3,640	7,000	11,200	19,700	40,200
500	283	593	1,120	2,290	3,430	6,610	10,500	18,600	38,000
550	269	563	1,060	2,180	3,260	6,280	10,000	17,700	36,100
600	257	537	1,010	2,080	3,110	5,990	9,550	16,900	34,400
650	246	514	969	1,990	2,980	5,740	9,150	16,200	33,000
700	236	494	931	1,910	2,860	5,510	8,790	15,500	31,700
750	228	476	897	1,840	2,760	5,310	8,470	15,000	30,500
800	220	460	866	1,780	2,660	5,130	8,180	14,500	29,500
850	213	445	838	1,720	2,580	4,960	7,910	14,000	28,500
900	206	431	812	1,670	2,500	4,810	7,670	13,600	27,700
950	200	419	789	1,620	2,430	4,670	7,450	13,200	26,900
1,000	195	407	767	1,580	2,360	4,550	7,240	12,800	26,100
1,100	185	387	729	1,500	2,240	4,320	6,890	12,200	24,800
1,200	177	369	695	1,430	2,140	4,120	6,570	11,600	23,700
1,300	169	353	666	1,370	2,050	3,940	6,290	11,100	22,700
1,400	162	340	640	1,310	1,970	3,790	6,040	10,700	21,800
1,500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000
1,600	151	316	595	1,220	1,830	3,530	5,620	10,000	20,300
1,700	146	306	576	1,180	1,770	3,410	5,440	9,610	19,600
1,800	142	296	558	1,150	1,720	3,310	5,270	9,320	19,000
1,900	138	288	542	1,110	1,670	3,210	5,120	9,050	18,400
2,000	134	280	527	1,080	1,620	3,120	4,980	8,800	18,000

Note: All table entries are rounded to 3 significant digits.

**Table 12-11  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(e)]**

										Gas: Natural										
										Inlet Pressure: 5.0 psi										
										Pressure Drop: 3.5 psi										
										Specific Gravity: 0.60										
										Pipe Size (in.)										
Nominal:	½	¾	1	1¼	1½	2	2½	3	4											
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026											
Length (ft)	Capacity in Cubic Feet of Gas per Hour																			
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000											
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000											
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000											
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000											
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000											
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000											
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000											
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000											
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000											
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000											
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000											
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900											
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600											
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700											
250	558	1,170	2,200	4,510	6,760	13,000	20,800	36,700	74,900											
300	506	1,060	1,990	4,090	6,130	11,800	18,800	33,300	67,800											
350	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400											
400	433	905	1,710	3,500	5,250	10,100	16,100	28,500	58,100											
450	406	849	1,600	3,290	4,920	9,480	15,100	26,700	54,500											
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500											
550	364	762	1,440	2,950	4,420	8,500	13,600	24,000	48,900											
600	348	727	1,370	2,810	4,210	8,110	12,900	22,900	46,600											
650	333	696	1,310	2,690	4,030	7,770	12,400	21,900	44,600											
700	320	669	1,260	2,590	3,880	7,460	11,900	21,000	42,900											
750	308	644	1,210	2,490	3,730	7,190	11,500	20,300	41,300											
800	298	622	1,170	2,410	3,610	6,940	11,100	19,600	39,900											
850	288	602	1,130	2,330	3,490	6,720	10,700	18,900	38,600											
900	279	584	1,100	2,260	3,380	6,520	10,400	18,400	37,400											
950	271	567	1,070	2,190	3,290	6,330	10,100	17,800	36,400											
1,000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400											
1,100	250	524	987	2,030	3,030	5,840	9,320	16,500	33,600											
1,200	239	500	941	1,930	2,900	5,580	8,890	15,700	32,000											
1,300	229	478	901	1,850	2,770	5,340	8,510	15,000	30,700											
1,400	220	460	866	1,780	2,660	5,130	8,180	14,500	29,500											
1,500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400											
1,600	205	428	806	1,650	2,480	4,770	7,610	13,400	27,400											
1,700	198	414	780	1,600	2,400	4,620	7,360	13,000	26,500											
1,800	192	401	756	1,550	2,330	4,480	7,140	12,600	25,700											
1,900	186	390	734	1,510	2,260	4,350	6,930	12,300	25,000											
2,000	181	379	714	1,470	2,200	4,230	6,740	11,900	24,300											

Note: All table entries are rounded to 3 significant digits.

**Table 12-12  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(f)]**

		Gas: Natural								
		Inlet Pressure: Less than 2 psi								
		Pressure Drop: 0.3 in. w.c.								
		Specific Gravity: 0.60								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	¾	1	1¼	1½	2	
	ACR:	⅜	½	¾	1	1¼	1½	2	2½	
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>a</sup>		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	

NA means a flow of less than 10 cfh.

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**Table 12-13  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(g)]**

		Gas: Natural								
		Inlet Pressure: Less than 2 psi								
		Pressure Drop: 0.5 in. w.c.								
		Specific Gravity: 0.60								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	¾	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	7⁄8	1½	1¾	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>a</sup>		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	

NA means a flow of less than 10 cfh.

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**Table 12-14  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(h)]**

		Gas:	Natural								
		Inlet Pressure:	Less than 2 psi								
		Pressure Drop:	1.0 in. w.c.								
		Specific Gravity:	0.60								
SPECIAL USE: Tube Sizing Between House Line Regulator and the Appliance.											
Tube Size (in.)											
Nominal:	K & L:	¼	⅜	½	¾	¾	1	1¼	1½	2	
	ACR:	⅜	½	⅝	¾	¾	1½	1¾	—	—	
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	
Inside: <sup>a</sup>		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	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		

NA means a flow of less than 10 cfh.

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**Table 12-15  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(i)]**

		Gas: Natural								
		Inlet Pressure: Less than 2.0 psi								
		Pressure Drop: 17.0 in. w.c.								
		Specific Gravity: 0.60								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	¾	1½	1¾	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>*</sup>		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	

Note: All table entries are rounded to 3 significant digits.

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

**Table 12-16  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(j)]**

		Gas: Natural								
		Inlet Pressure: 2.0 psi								
		Pressure Drop: 1.0 psi								
		Specific Gravity: 0.60								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	¾	¾	1	1¼	1½	2
	ACR:	⅜	½	¾	¾	¾	1½	1¾	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>a</sup>		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	

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.



**Table 12-17**  
**Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(k)]**

		Gas: Natural								
		Inlet Pressure: 2.0 psi								
		Pressure Drop: 1.5 psi								
		Specific Gravity: 0.60								
<b>SPECIAL USE: Pipe Sizing Between Point of Delivery and the House Line Regulator. Total Load Supplied by a Single House Line Regulator Not Exceeding 150 Cubic Feet per Hour.<sup>†</sup></b>										
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅝	1⅞	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>§</sup>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10	303	625	1,270	2,220	3,150	6,740	12,100	19,100	39,800	
20	208	430	874	1,530	2,170	4,630	8,330	13,100	27,400	
30	167	345	702	1,230	1,740	3,720	6,690	10,600	22,000	
40	143	295	601	1,050	1,490	3,180	5,730	9,030	18,800	
50	127	262	532	931	1,320	2,820	5,080	8,000	16,700	
60	115	237	482	843	1,200	2,560	4,600	7,250	15,100	
70	106	218	444	776	1,100	2,350	4,230	6,670	13,900	
80	98	203	413	722	1,020	2,190	3,940	6,210	12,900	
90	92	190	387	677	961	2,050	3,690	5,820	12,100	
100	87	180	366	640	907	1,940	3,490	5,500	11,500	
125	77	159	324	567	804	1,720	3,090	4,880	10,200	
150	70	144	294	514	729	1,560	2,800	4,420	9,200	
175	64	133	270	472	670	1,430	2,580	4,060	8,460	
200	60	124	252	440	624	1,330	2,400	3,780	7,870	
250	53	110	223	390	553	1,180	2,130	3,350	6,980	
300	48	99	202	353	501	1,070	1,930	3,040	6,320	
350	44	91	186	325	461	984	1,770	2,790	5,820	
400	41	85	173	302	429	916	1,650	2,600	5,410	
450	39	80	162	283	402	859	1,550	2,440	5,080	
500	36	75	153	268	380	811	1,460	2,300	4,800	
550	35	72	146	254	361	771	1,390	2,190	4,560	
600	33	68	139	243	344	735	1,320	2,090	4,350	
650	32	65	133	232	330	704	1,270	2,000	4,160	
700	30	63	128	223	317	676	1,220	1,920	4,000	
750	29	60	123	215	305	652	1,170	1,850	3,850	
800	28	58	119	208	295	629	1,130	1,790	3,720	
850	27	57	115	201	285	609	1,100	1,730	3,600	
900	27	55	111	195	276	590	1,060	1,680	3,490	
950	26	53	108	189	268	573	1,030	1,630	3,390	
1,000	25	52	105	184	261	558	1,000	1,580	3,300	
1,100	24	49	100	175	248	530	954	1,500	3,130	
1,200	23	47	95	167	237	505	910	1,430	2,990	
1,300	22	45	91	160	227	484	871	1,370	2,860	
1,400	21	43	88	153	218	465	837	1,320	2,750	
1,500	20	42	85	148	210	448	806	1,270	2,650	
1,600	19	40	82	143	202	432	779	1,230	2,560	
1,700	19	39	79	138	196	419	753	1,190	2,470	
1,800	18	38	77	134	190	406	731	1,150	2,400	
1,900	18	37	74	130	184	394	709	1,120	2,330	
2,000	17	36	72	126	179	383	690	1,090	2,270	

Note: All table entries are rounded to 3 significant digits.

<sup>§</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

<sup>†</sup>When this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 in. w.c.

**Table 12-18  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(l)]**

		Gas: Natural								
		Inlet Pressure: 5.0 psi								
		Pressure Drop: 3.5 psi								
		Specific Gravity: 0.60								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1½	1¾	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>a</sup>		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	511	1,050	2,140	3,750	5,320	11,400	20,400	32,200	67,100	
20	351	724	1,470	2,580	3,650	7,800	14,000	22,200	46,100	
30	282	582	1,180	2,070	2,930	6,270	11,300	17,800	37,000	
40	241	498	1,010	1,770	2,510	5,360	9,660	15,200	31,700	
50	214	441	898	1,570	2,230	4,750	8,560	13,500	28,100	
60	194	400	813	1,420	2,020	4,310	7,750	12,200	25,500	
70	178	368	748	1,310	1,860	3,960	7,130	11,200	23,400	
80	166	342	696	1,220	1,730	3,690	6,640	10,500	21,800	
90	156	321	653	1,140	1,620	3,460	6,230	9,820	20,400	
100	147	303	617	1,080	1,530	3,270	5,880	9,270	19,300	
125	130	269	547	955	1,360	2,900	5,210	8,220	17,100	
150	118	243	495	866	1,230	2,620	4,720	7,450	15,500	
175	109	224	456	796	1,130	2,410	4,350	6,850	14,300	
200	101	208	424	741	1,050	2,250	4,040	6,370	13,300	
250	90	185	376	657	932	1,990	3,580	5,650	11,800	
300	81	167	340	595	844	1,800	3,250	5,120	10,700	
350	75	154	313	547	777	1,660	2,990	4,710	9,810	
400	69	143	291	509	722	1,540	2,780	4,380	9,120	
450	65	134	273	478	678	1,450	2,610	4,110	8,560	
500	62	127	258	451	640	1,370	2,460	3,880	8,090	
550	58	121	245	429	608	1,300	2,340	3,690	7,680	
600	56	115	234	409	580	1,240	2,230	3,520	7,330	
650	53	110	224	392	556	1,190	2,140	3,370	7,020	
700	51	106	215	376	534	1,140	2,050	3,240	6,740	
750	49	102	207	362	514	1,100	1,980	3,120	6,490	
800	48	98	200	350	497	1,060	1,910	3,010	6,270	
850	46	95	194	339	481	1,030	1,850	2,910	6,070	
900	45	92	188	328	466	1,000	1,790	2,820	5,880	
950	43	90	182	319	452	967	1,740	2,740	5,710	
1,000	42	87	177	310	440	940	1,690	2,670	5,560	
1,100	40	83	169	295	418	893	1,610	2,530	5,280	
1,200	38	79	161	281	399	852	1,530	2,420	5,040	
1,300	37	76	154	269	382	816	1,470	2,320	4,820	
1,400	35	73	148	259	367	784	1,410	2,220	4,630	
1,500	34	70	143	249	353	755	1,360	2,140	4,460	
1,600	33	68	138	241	341	729	1,310	2,070	4,310	
1,700	32	65	133	233	330	705	1,270	2,000	4,170	
1,800	31	63	129	226	320	684	1,230	1,940	4,040	
1,900	30	62	125	219	311	664	1,200	1,890	3,930	
2,000	29	60	122	213	302	646	1,160	1,830	3,820	

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**Table 12-19  
Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(m)]**

														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															

\*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.

Notes:

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

(2) All table entries are rounded to 3 significant digits.

**Table 12-20  
Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(n)]**

														Gas: Natural														
														Inlet Pressure: Less than 2 psi														
														Pressure Drop: 3.0 in. w.c.														
														Specific Gravity: 0.60														
														Tube Size (EHD)*														
Flow Designation:	13	15	18	19	23	25	30	31	37	46	48	60	62															
Length (ft)	Capacity in Cubic Feet of Gas per Hour																											
5	120	160	277	327	529	649	1,180	1,370	2,140	4,430	5,010	8,800	10,100															
10	83	112	197	231	380	462	828	958	1,530	3,200	3,560	6,270	7,160															
15	67	90	161	189	313	379	673	778	1,250	2,540	2,910	5,140	5,850															
20	57	78	140	164	273	329	580	672	1,090	2,200	2,530	4,460	5,070															
25	51	69	125	147	245	295	518	599	978	1,960	2,270	4,000	4,540															
30	46	63	115	134	225	270	471	546	895	1,790	2,070	3,660	4,140															
40	39	54	100	116	196	234	407	471	778	1,550	1,800	3,180	3,590															
50	35	48	89	104	176	210	363	421	698	1,380	1,610	2,850	3,210															
60	32	44	82	95	161	192	330	383	639	1,260	1,470	2,600	2,930															
70	29	41	76	88	150	178	306	355	593	1,170	1,360	2,420	2,720															
80	27	38	71	82	141	167	285	331	555	1,090	1,280	2,260	2,540															
90	26	36	67	77	133	157	268	311	524	1,030	1,200	2,140	2,400															
100	24	34	63	73	126	149	254	295	498	974	1,140	2,030	2,280															
150	19	27	52	60	104	122	206	240	409	793	936	1,660	1,860															
200	17	23	45	52	91	106	178	207	355	686	812	1,440	1,610															
250	15	21	40	46	82	95	159	184	319	613	728	1,290	1,440															
300	13	19	37	42	75	87	144	168	234	559	665	1,180	1,320															

\*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.

Notes:

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

(2) All table entries are rounded to 3 significant digits.

**Table 12-21**  
**Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(o)]**

													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	

\*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.

Notes:

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

(2) All table entries are rounded to 3 significant digits.

**Table 12-22**  
**Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(p)]**

													Gas:	Natural
													Inlet Pressure:	2.0 psi
													Pressure Drop:	1.0 psi
													Specific Gravity:	0.60
Tube Size (EHD)*														
Flow Designation:	13	15	18	19	23	25	30	31	37	46	48	60	62	
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	270	353	587	700	1,100	1,370	2,590	2,990	4,510	9,600	10,700	18,600	21,600	
25	166	220	374	444	709	876	1,620	1,870	2,890	6,040	6,780	11,900	13,700	
30	151	200	342	405	650	801	1,480	1,700	2,640	5,510	6,200	10,900	12,500	
40	129	172	297	351	567	696	1,270	1,470	2,300	4,760	5,380	9,440	10,900	
50	115	154	266	314	510	624	1,140	1,310	2,060	4,260	4,820	8,470	9,720	
75	93	124	218	257	420	512	922	1,070	1,690	3,470	3,950	6,940	7,940	
80	89	120	211	249	407	496	892	1,030	1,640	3,360	3,820	6,730	7,690	
100	79	107	189	222	366	445	795	920	1,470	3,000	3,420	6,030	6,880	
150	64	87	155	182	302	364	646	748	1,210	2,440	2,800	4,940	5,620	
200	55	75	135	157	263	317	557	645	1,050	2,110	2,430	4,290	4,870	
250	49	67	121	141	236	284	497	576	941	1,890	2,180	3,850	4,360	
300	44	61	110	129	217	260	453	525	862	1,720	1,990	3,520	3,980	
400	38	52	96	111	189	225	390	453	749	1,490	1,730	3,060	3,450	
500	34	46	86	100	170	202	348	404	552	1,330	1,550	2,740	3,090	

\*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.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 3/4 psi, do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

(2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

(4) All table entries are rounded to 3 significant digits.

**Table 12-23  
Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(q)]**

														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								

\*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.

Notes:

- (1) Table does not include effect of pressure drop across line regulator. Where regulator loss exceeds 1 psi, do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drop across regulator may vary with the flow rate.
- (2) CAUTION: Capacities shown in table may exceed maximum capacity of selected regulator. Consult with tubing manufacturer for guidance.
- (3) Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- (4) All table entries are rounded to 3 significant digits.

**Table 12-24  
Polyethylene Plastic Pipe [NFPA 54: Table 6.2(r)]**

							Gas:	Natural
							Inlet Pressure:	Less than 2 psi
							Pressure Drop:	0.3 in. w.c.
							Specific Gravity:	0.60
							Pipe Size (in.)	
Nominal OD:	½	¾	1	1¼	1½	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		

Note: All table entries are rounded to 3 significant digits.

**Table 12-25  
Polyethylene Plastic Pipe [NFPA 54: Table 6.2(s)]**

		Gas: Natural				
		Inlet Pressure: Less than 2 psi				
		Pressure Drop: 0.5 in. w.c.				
		Specific Gravity: 0.60				
		Pipe Size (in.)				
Nominal OD:	½	¾	1	1¼	1½	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

Note: All table entries are rounded to 3 significant digits.

**Table 12-26  
Polyethylene Plastic Pipe [NFPA 54: Table 6.2(t)]**

		Gas: Natural				
		Inlet Pressure: 2.0 psi				
		Pressure Drop: 1.0 psi				
		Specific Gravity: 0.60				
		Pipe Size (in.)				
Nominal OD:	½	¾	1	1¼	1½	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

Note: All table entries are rounded to 3 significant digits.

**Table 12-27  
Polyethylene Plastic Tubing [NFPA 54: Table 6.2(u)]**

	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:	½	¾
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
30	30	205
40	26	176
50	23	156
60	21	141
70	19	130
80	18	121
90	17	113
100	16	107
125	14	95
150	13	86
175	12	79
200	11	74
225	10	69
250	NA	65
275	NA	62
300	NA	59
350	NA	54
400	NA	51
450	NA	47
500	NA	45

\*CTS = Copper tube size.  
NA means a flow of less than 10 cfh.  
Note: All table entries are rounded to 3 significant digits.

**Table 12-28  
Polyethylene Plastic Tubing [NFPA 54: Table 6.2(v)]**

	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:	½	¾
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

\*CTS = Copper tube size.  
NA means a flow of less than 10 cfh.  
Note: All table entries are rounded to 3 significant digits.



**Table 12-29  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(a)]**

		Gas: Undiluted Propane							
		Inlet Pressure: 10.0 psi							
		Pressure Drop: 1.0 psi							
		Specific Gravity: 1.50							
SPECIAL USE: Pipe Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)									
Pipe Size (in.)									
Nominal Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	3,320	6,950	13,100	26,900	40,300	77,600	124,000	219,000	446,000
20	2,280	4,780	9,000	18,500	27,700	53,300	85,000	150,000	306,000
30	1,830	3,840	7,220	14,800	22,200	42,800	68,200	121,000	246,000
40	1,570	3,280	6,180	12,700	19,000	36,600	58,400	103,000	211,000
50	1,390	2,910	5,480	11,300	16,900	32,500	51,700	91,500	187,000
60	1,260	2,640	4,970	10,200	15,300	29,400	46,900	82,900	169,000
70	1,160	2,430	4,570	9,380	14,100	27,100	43,100	76,300	156,000
80	1,080	2,260	4,250	8,730	13,100	25,200	40,100	70,900	145,000
90	1,010	2,120	3,990	8,190	12,300	23,600	37,700	66,600	136,000
100	956	2,000	3,770	7,730	11,600	22,300	35,600	62,900	128,000
125	848	1,770	3,340	6,850	10,300	19,800	31,500	55,700	114,000
150	768	1,610	3,020	6,210	9,300	17,900	28,600	50,500	103,000
175	706	1,480	2,780	5,710	8,560	16,500	26,300	46,500	94,700
200	657	1,370	2,590	5,320	7,960	15,300	24,400	43,200	88,100
250	582	1,220	2,290	4,710	7,060	13,600	21,700	38,300	78,100
300	528	1,100	2,080	4,270	6,400	12,300	19,600	34,700	70,800
350	486	1,020	1,910	3,930	5,880	11,300	18,100	31,900	65,100
400	452	945	1,780	3,650	5,470	10,500	16,800	29,700	60,600
450	424	886	1,670	3,430	5,140	9,890	15,800	27,900	56,800
500	400	837	1,580	3,240	4,850	9,340	14,900	26,300	53,700
550	380	795	1,500	3,070	4,610	8,870	14,100	25,000	51,000
600	363	759	1,430	2,930	4,400	8,460	13,500	23,900	48,600
650	347	726	1,370	2,810	4,210	8,110	12,900	22,800	46,600
700	334	698	1,310	2,700	4,040	7,790	12,400	21,900	44,800
750	321	672	1,270	2,600	3,900	7,500	12,000	21,100	43,100
800	310	649	1,220	2,510	3,760	7,240	11,500	20,400	41,600
850	300	628	1,180	2,430	3,640	7,010	11,200	19,800	40,300
900	291	609	1,150	2,360	3,530	6,800	10,800	19,200	39,100
950	283	592	1,110	2,290	3,430	6,600	10,500	18,600	37,900
1,000	275	575	1,080	2,230	3,330	6,420	10,200	18,100	36,900
1,100	261	546	1,030	2,110	3,170	6,100	9,720	17,200	35,000
1,200	249	521	982	2,020	3,020	5,820	9,270	16,400	33,400
1,300	239	499	940	1,930	2,890	5,570	8,880	15,700	32,000
1,400	229	480	903	1,850	2,780	5,350	8,530	15,100	30,800
1,500	221	462	870	1,790	2,680	5,160	8,220	14,500	29,600
1,600	213	446	840	1,730	2,590	4,980	7,940	14,000	28,600
1,700	206	432	813	1,670	2,500	4,820	7,680	13,600	27,700
1,800	200	419	789	1,620	2,430	4,670	7,450	13,200	26,900
1,900	194	407	766	1,570	2,360	4,540	7,230	12,800	26,100
2,000	189	395	745	1,530	2,290	4,410	7,030	12,400	25,400

Note: All table entries are rounded to 3 significant digits.

**Table 12-30  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(b)]**

		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 Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	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

Note: All table entries are rounded to 3 significant digits.

**Table 12-31  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(c)]**

		Gas: Undiluted Propane							
		Inlet Pressure: 2.0 psi							
		Pressure Drop: 1.0 psi							
		Specific Gravity: 1.50							
Pipe Size (in.)									
Nominal:	½	¾	1	1¼	1½	2	2½	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

Note: All table entries are rounded to 3 significant digits.

**Table 12-32  
Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(d)]**

		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 Single or Second Stage (Low Pressure Regulator) and Appliance									
Pipe Size (in.)									
Nominal Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	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

Note: All table entries are rounded to 3 significant digits.

**Table 12-33  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(e)]**

		Gas: Undiluted Propane								
		Inlet Pressure: 10.0 psi								
		Pressure Drop: 1.0 psi								
		Specific Gravity: 1.50								
SPECIAL USE: Tube Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)										
Tube Size (in.)										
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
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	

Note: All table entries are rounded to 3 significant digits.

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

**Table 12-34  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(f)]**

		Gas: Undiluted Propane								
		Inlet Pressure: 11.0 in. w.c.								
		Pressure Drop: 0.5 in. w.c.								
		Specific Gravity: 1.50								
SPECIAL USE: Tube Sizing Between Single or Second Stage (Low Pressure Regulator) and Appliance										
Tube Size (in.)										
Nominal:	K & L:	¼	⅜	½	¾	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1½	1¾	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside: <sup>a</sup>		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	

NA means a flow of less than 10,000 Btu/hr.

Note: All table entries are rounded to 3 significant digits.

<sup>a</sup>Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**Table 12-35  
Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(g)]**

		Gas: Undiluted Propane								
		Inlet Pressure: 2.0 psi								
		Pressure Drop: 1.0 psi								
		Specific Gravity: 1.50								
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1½	1¾	—	—
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	413	852	1,730	3,030	4,300	9,170	16,500	26,000	54,200	
20	284	585	1,190	2,080	2,950	6,310	11,400	17,900	37,300	
30	228	470	956	1,670	2,370	5,060	9,120	14,400	29,900	
40	195	402	818	1,430	2,030	4,330	7,800	12,300	25,600	
50	173	356	725	1,270	1,800	3,840	6,920	10,900	22,700	
60	157	323	657	1,150	1,630	3,480	6,270	9,880	20,600	
70	144	297	605	1,060	1,500	3,200	5,760	9,090	18,900	
80	134	276	562	983	1,390	2,980	5,360	8,450	17,600	
90	126	259	528	922	1,310	2,790	5,030	7,930	16,500	
100	119	245	498	871	1,240	2,640	4,750	7,490	15,600	
125	105	217	442	772	1,100	2,340	4,210	6,640	13,800	
150	95	197	400	700	992	2,120	3,820	6,020	12,500	
175	88	181	368	644	913	1,950	3,510	5,540	11,500	
200	82	168	343	599	849	1,810	3,270	5,150	10,700	
250	72	149	304	531	753	1,610	2,900	4,560	9,510	
300	66	135	275	481	682	1,460	2,620	4,140	8,610	
350	60	124	253	442	628	1,340	2,410	3,800	7,920	
400	56	116	235	411	584	1,250	2,250	3,540	7,370	
450	53	109	221	386	548	1,170	2,110	3,320	6,920	
500	50	103	209	365	517	1,110	1,990	3,140	6,530	
550	47	97	198	346	491	1,050	1,890	2,980	6,210	
600	45	93	189	330	469	1,000	1,800	2,840	5,920	
650	43	89	181	316	449	959	1,730	2,720	5,670	
700	41	86	174	304	431	921	1,660	2,620	5,450	
750	40	82	168	293	415	888	1,600	2,520	5,250	
800	39	80	162	283	401	857	1,540	2,430	5,070	
850	37	77	157	274	388	829	1,490	2,350	4,900	
900	36	75	152	265	376	804	1,450	2,280	4,750	
950	35	72	147	258	366	781	1,410	2,220	4,620	
1,000	34	71	143	251	356	760	1,370	2,160	4,490	
1,100	32	67	136	238	338	721	1,300	2,050	4,270	
1,200	31	64	130	227	322	688	1,240	1,950	4,070	
1,300	30	61	124	217	309	659	1,190	1,870	3,900	
1,400	28	59	120	209	296	633	1,140	1,800	3,740	
1,500	27	57	115	201	286	610	1,100	1,730	3,610	
1,600	26	55	111	194	276	589	1,060	1,670	3,480	
1,700	26	53	108	188	267	570	1,030	1,620	3,370	
1,800	25	51	104	182	259	553	1,000	1,570	3,270	
1,900	24	50	101	177	251	537	966	1,520	3,170	
2,000	23	48	99	172	244	522	940	1,480	3,090	

Note: All table entries are rounded to 3 significant digits.

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

**Table 12-36  
Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(h)]**

													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	

\*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.

Notes:

- (1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- (2) All table entries are rounded to 3 significant digits.

**Table 12-37  
Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(i)]**

													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	

\*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.

Notes:

- (1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 1/2 psi (based on 13 in. w.c. outlet pressure), do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
- (2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
- (3) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- (4) All table entries are rounded to 3 significant digits.



**Table 12-38**  
**Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(j)]**

		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	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

\*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.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds ½ psi (based on 13 in. w.c. outlet pressure), do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

(2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.

(4) All table entries are rounded to 3 significant digits.

**Table 12-39**  
**Polyethylene Plastic Pipe [NFPA 54: Table 6.3(k)]**

		Gas: Undiluted Propane					
		Inlet Pressure: 11.0 in. w.c.					
		Pressure Drop: 0.5 in. w.c.					
		Specific Gravity: 1.50					
		Pipe Size (in.)					
Nominal OD:		½	¾	1	1¼	1½	2
Designation:	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	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	

Note: All table entries are rounded to 3 significant digits.

**Table 12-40  
Polyethylene Plastic Pipe [NFPA 54: Table 6.3(I)]**

						Gas:	Undiluted Propane
						Inlet Pressure:	2.0 psi
						Pressure Drop:	1.0 psi
						Specific Gravity:	1.50
Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	2	
Designation:	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	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	

Note: All table entries are rounded to 3 significant digits.

**Table 12-41  
Polyethylene Plastic Tubing [NFPA 54: Table 6.3(m)]**

	<b>Gas: Undiluted Propane</b>	
	<b>Inlet Pressure:</b>	<b>11.0 in. w.c.</b>
	<b>Pressure Drop:</b>	<b>0.5 in. w.c.</b>
	<b>Specific Gravity:</b>	<b>1.50</b>
	<b>Plastic Tubing Size (CTS) (in.)</b>	
<b>Nominal OD:</b>	$\frac{1}{2}$	$\frac{3}{4}$
<b>Designation:</b>	<b>SDR 7.00</b>	<b>SDR 11.00</b>
<b>Actual ID:</b>	<b>0.445</b>	<b>0.927</b>
<b>Length (ft)</b>	<b>Capacity in Thousands of Btu per Hour</b>	
10	121	828
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113
450	15	106
500	15	100

Note: All table entries are rounded to 3 significant digits.

