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**Plumbing works — Code of practice —
Part 6: Fuel gas piping and firestop
protection**

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 644-6 was prepared by Technical Committee RSB/TC 17, *Urban planning*.

In the preparation of this standard, reference was made to the following standard:

IAPMO, *2024 Uniform plumbing code*

The assistance derived from the above source is hereby acknowledged with thanks.

DRS 644 consists of the following parts, under the general title *Plumbing works — Code of practice*:

- *Part 1: General*
- *Part 2: Plumbing fixtures and fixture fittings*
- *Part 3: Water supply and distribution*
- *Part 4: Sanitary and drainage system installation*
- *Part 5: Water heaters*
- *Part 6: Fuel gas piping and firestop protection*
- *Part 7: Healthcare facilities and medical gas and medical vacuum systems*
- *Part 8: Alternate water sources for non-potable applications and non-potable rainwater catchment systems*

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Committee membership

The following organizations were represented on the Technical Committee on *Urban planning* (RSB/TC 17) in the preparation of this standard.

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Ministry of Infrastructure (MININFRA)

Rwanda Housing Authority (RHA)

Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA)

Rwanda Plumbers Organization (RPO)

Rwanda Polytechnic – Kigali College

Rwanda Polytechnic – Musanze College

Rwanda Transport Development Agency (RTDA)

Rwanda Utility Regulatory Authority (RURA)

Rwanda Water Resources Board (RWB)

University of Rwanda – College of Science and Technology (UR-CST)

Water and Sanitation Corporation (WASAC)

Water for People

Rwanda Standards Board (RSB) – Secretariat

Plumbing works — Code of practice — Part 6: Fuel gas piping and firestop protection

1 Scope

1.1 This Draft Rwanda Standard provides recommendations and guidelines for fuel gas piping and firestop protection.

1.2 Coverage of piping systems extends from the point of delivery to the appliance connections.

1.3 Fuel gas piping systems do not apply to the following items:

- a) Portable LP-Gas appliances and equipment of all types that are not connected to a fixed fuel piping system.
- b) Installation of appliances such as brooders, dehydrators, dryers, and irrigation equipment used for agricultural purposes.
- c) Raw material (feedstock) applications except for piping to special atmosphere generators.
- d) Oxygen-fuel gas cutting and welding systems.
- e) Industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen.
- f) Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants.
- g) 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.
- h) LP-Gas installations at utility gas plants.
- i) Liquefied natural gas (LNG) installations.
- j) Fuel gas piping in electric utility power plants.
- k) Proprietary items of equipment, apparatus, or instruments such as gas-generating sets, compressors, and calorimeters.
- l) LP-Gas equipment for vaporization, gas mixing, and gas manufacturing.
- m) LP-Gas piping for buildings under construction or renovations that is not to become part of the permanent building piping system—that is, temporary fixed piping for building heat.
- n) Installation of LP-Gas systems for railroad switch heating.
- o) Installation of LP-Gas and compressed natural gas (CNG) systems on vehicles.
- p) Gas piping, meters, gas pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas.
- q) Building design and construction, except as specified herein.
- r) Fuel gas systems on recreational vehicles manufactured in accordance with national standards in place on fire and health safety criteria for recreational vehicles.
- s) Fuel gas systems using hydrogen as a fuel.
- t) Construction of appliances.

1.4 Firestop protection systems include piping penetrations of required fire-resistance-rated walls, partitions, floors, floor/ceiling assemblies, roof/ceiling assemblies, or shaft enclosures are to be protected in accordance with the requirements of the Rwanda building code.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A268, *Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service*

ASTM A269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM B88, *Standard Specification for Seamless Copper Water Tube*

ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*

ASTM B210, *Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes*

ASTM B241, *Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube*

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*

ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*

ASTM F1973, *Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems*

ASTM F2509, *Standard Specification for Field-assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene and Polyamide-11 (PA11) Gas Distribution Pipe and Tubing*

UL 467, *Grounding and Bonding Solutions Certification Testing*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in DRS 644-1 apply.

4 Symbols (and abbreviated terms)

Btu/h: British Thermal Unit per hour

CSST: Corrugated Stainless Steel Tubing

EHD: Equivalent Hydraulic Diameter

CSSTEHD: Corrugated Stainless Steel Tubing Equivalent Hydraulic Diameter

5 Fuel gas piping systems requirements

Requirements for piping systems shall include design, materials, components, fabrication, assembly, installation, testing, inspection, operation, and maintenance.

5.1 Gas piping system design

5.1.1 Piping plan

5.1.1.1 Where required by Competent Authority, a piping sketch or plan shall be prepared before proceeding with the installation. [NFPA 54:5.1.1]

5.1.1.2 The 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. [NFPA 54:5.1.1]

5.1.2 Installation of piping system

Where required by the Competent Authority, a piping sketch or plan shall be prepared before proceeding with the installation. The 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. [NFPA 54:5.1.1]

5.1.2.1 Addition to existing system

When additional appliances are being connected to a gas piping system, the existing piping shall be checked to determine whether it has adequate capacity. If the capacity of the system is determined to be inadequate for the additional appliances, the existing system shall be enlarged as required, or separate gas piping of adequate capacity shall be provided. [NFPA 54:5.1.2]

5.1.3 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 54:5.2.1]

5.1.3.1 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, equipment 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. [NFPA 54:5.2.2.1-5.2.2.2]

5.1.4 Sizing of gas piping systems

Gas piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54:5.3.1]

5.1.4.1 Maximum gas demand

The volumetric flow rate of gas to be provided shall be the sum of the maximum input of the appliances served. The volumetric flow rate of gas to be provided shall be adjusted for altitude where the installation is above 2000 feet (610 m). [NFPA 54:5.3.2.1 – 5.3.2.2] Where the input rating is not indicated, the gas supplier, appliance manufacturer, or a qualified agency shall be contacted, or the rating from Table 1 shall be used for estimating the volumetric flow rate of gas to be supplied.

The total connected hourly load shall be used as the basis for piping sizing, assuming all appliances are operating at full capacity simultaneously.

Exception: Sizing shall be permitted to be based upon established load diversity factors. [NFPA 54:5.3.2.3]

Table 1 — Approximate gas input for typical appliances

[NFPA 54: TABLE A.5.3.2.1]

Appliance	Input (Btu/h approximate)
Space Heating Units	
Warm air furnace	-
Single family	100 000
Multifamily per unit	60 000
Hydronic boiler	-
Single family	100 000
Multifamily per unit	60 000
Space and water heating units	
Hydronic boiler	-
Single family	120 000
Multifamily per unit	75 000

Water heating appliances	
Water heater, automatic storage, 30 to 40 gallon tank	35 000
Water heater, automatic storage, 50-gallon tank	50 000
Water heater, automatic instantaneous	
Capacity at 2 gallons per min	142 800
Capacity at 4 gallons per min	285 000
Capacity at 6 gallons per min	428 400
Water heater, domestic, circulating or side-arm	35 000
Cooking appliances	
Range, freestanding, domestic	65 000
Built-in oven or broiler unit, domestic	25 000
Built-in top unit, domestic	40 000
Other appliances	
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: 1 000 British thermal units per hour = 0.293 kW	

5.1.4.2 Sizing methods

Gas piping shall be sized in accordance with one of the following:

- Pipe sizing tables or sizing equations in this chapter.
- Sizing tables included in a listed piping system manufacturer's installation instructions.
- Engineering methods. [NFPA 54:5.3.3]

5.1.4.3 Allowable pressure drop

The design pressure loss in a piping system from the point of delivery to the inlet connection of all appliances served shall be such that the supply pressure at each appliance inlet is greater than or equal to the minimum pressure required by the appliance. [NFPA 54:5.3.4]

5.1.5 Maximum operating pressure in buildings

The maximum operating pressure for any piping systems located inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met:

- a) The piping joints are welded or brazed.
- b) The piping is joined by fittings listed to ANSI LC 4/CSA 6.32 and installed according to the manufacturer's installation instructions.
- c) The piping joints are flanged and all pipe-to-flange connections are made by welding or brazing.
- d) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
- e) The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:
 - 1) Industrial processing or heating;
 - 2) Research;
 - 3) Warehousing;
 - 4) Boiler or mechanical rooms.
- f) The piping is a temporary installation for buildings under construction.
- g) The piping serves appliances or equipment used for agricultural purposes.
- h) The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58. [NFPA 54:5.4.4]

5.1.5.1 LP-Gas systems operating below -5 °F (-21 °C)

LP-Gas systems designed to operate below -5 °F (-21 °C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-Gas or to prevent LP-Gas vapor from condensing back into a liquid. [NFPA 54:5.4.5]

5.2 Acceptable piping materials and joining methods

5.2.1 Materials used for piping systems shall conform to the requirements of Section 5.2.1.

5.2.1.1 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 54:5.5.1.2]

5.2.1.1.1 Metallic pipe, metallic pipe shall be in accordance with 5.2.1.1.1.1 through 5.2.1.1.1.4.

5.2.1.1.1.1 Cast iron, cast-iron pipe shall not be used. [NFPA 54:5.5.2.1]

5.2.1.1.1.2 Steel, stainless steel, and wrought-iron pipe, steel, stainless steel, and wrought-iron pipe shall be at least schedule 40 and shall conform to the dimensional standards of ASME B36.10M and one of the following:

- a) ASTM A53;
- b) ASTM A106;
- c) ASTM A312. [NFPA 54:5.5.2.2]

5.2.1.1.1.3 Copper and copper alloy pipe, copper and copper alloy pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.5.2.3 – 5.5.2.4]

5.2.1.1.1.4 Aluminum alloy pipe, aluminum alloy pipe shall conform to ASTM B241 (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 54:5.5.2.5] Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.5.2.6]

5.2.1.1.2 Metallic tubing, tubing shall not be used with gases corrosive to the tubing material. [NFPA 54:5.5.3.1]

5.2.1.1.2.1 Steel tubing, steel tubing shall conform to ASTM A254. [NFPA 54:5.5.3.2]

5.2.1.1.2.2 Stainless steel, stainless steel tubing shall conform to one of the following:

- a) ASTM A268;
- b) ASTM A269. [NFPA 54:5.5.3.3]

5.2.1.1.2.3 Copper and copper alloy tubing, copper and copper alloy tubing 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). Copper tubing shall conform to standard Type K or Type L of ASTM B88 or ASTM B280. [NFPA 54:5.5.3.4]

5.2.1.1.2.4 Aluminum alloy tubing, aluminum alloy tubing shall conform to ASTM B210 or ASTM B241. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.5.3.5]

5.2.1.1.2.5 Corrugated stainless steel tubing, corrugated stainless steel tubing shall be listed in accordance with CSA/ANSI LC 1/CSA 6.26. [NFPA 54:5.5.3.6]

5.2.1.1.3 Plastic pipe, tubing and fittings, polyethylene plastic pipe, tubing, and fittings used to supply fuel gas shall conform to ASTM D2513. Pipe to be used shall be marked "gas" and "ASTM D2513." Polyamide pipe, tubing, and fittings shall be identified in and conform to ASTM F2945. Pipe to be used shall be marked "gas" and "ASTM F2945." Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) plastic pipe, tubing, and fittings shall not be used to supply fuel gas. [NFPA 54:5.5.4.1.1 – 5.5.4.1.3]

5.2.1.1.4 Regulator vent piping, plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC (Schedule 40 and 80). PVC vent piping shall not be installed indoors. [NFPA 54:5.5.4.2]

5.2.1.1.4 Anodeless risers, anodeless risers shall conform to 5.2.1.1.4.1 through 5.2.1.1.4.3 .

5.2.1.1.4.1 Factory-assembled anodeless risers, 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. [NFPA 54:5.5.4.3(1)]

5.2.1.1.4.2 Service head adapters and field-assembled anodeless risers, service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used and shall be design-certified to meet the requirements of Category I of ASTM D2513 and 49 CFR 192.281(e). The manufacturer shall provide the user qualified installation instructions as prescribed by 49 CFR 192.283(b). [NFPA 54:5.5.4.3(2)]

5.2.1.1.4.3 Undiluted Liquefied Petroleum Gas piping, the use of plastic pipe, tubing, and fittings in undiluted LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.5.4.3(3)]

5.2.1.1.5 Workmanship and defects, gas pipe, tubing, and fittings shall be clear and free from cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. [NFPA 54:5.5.5]

5.2.1.1.6 Metallic pipe threads, metallic pipe and fitting threads shall be taper pipe threads and shall conform to ASME B1.20.1. [NFPA 54:5.5.6.1]

5.2.1.1.6.1 Number of threads, field threading of metallic pipe shall be in accordance with Table 2. [NFPA 54:5.5.6.3].

Table 2 — Specifications for threading metallic pipe

[NFPA 54: TABLE 5.5.6.3]

Iron pipe size (inches)	Approximate length of threaded portion (inches)	Approximate number of threads to be cut
1/2	3/4	10
3/4	3/4	10

1	$\frac{7}{8}$	10
$1\frac{1}{4}$	1	11
$1\frac{1}{2}$	1	11
2	1	11
$2\frac{1}{2}$	$1\frac{1}{2}$	12
3	$1\frac{1}{2}$	12
4	$1\frac{5}{8}$	13
For SI units: 1 inch = 25.4 mm		

5.2.1.1.6.2 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 54:5.5.6.2]

5.2.1.1.6.3 Thread joint sealing, threaded joints shall be made using a thread joint sealing material. [NFPA 54:5.5.6.4.1] Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used. [NFPA 54:5.5.6.4.2] Thread joint sealing materials shall be resistant to the chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.5.6.4.3]

5.2.1.1.7 Metallic piping joints and fittings, the type of piping joint used shall be suitable for the pressure and temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or the weight of the pipe and its contents. [NFPA 54:5.5.7]

5.2.1.1.7.1 Pipe joints, Schedule 40 and heavier pipe joints shall be threaded, flanged, brazed, welded, or assembled with press-connect fittings listed to ANSI LC 4/CSA 6.32. [NFPA 54:5.5.7.1]

5.2.1.1.7.2 Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1000 °F (538 °C). [NFPA 54:5.5.7.1]

5.2.1.1.7.3 Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7.1]

5.2.1.1.7.4 Copper tubing joints, copper tubing joints shall be assembled with approved gas tubing fittings, shall be brazed with a material having a melting point in excess of 1000 °F (538 °C), or shall be assembled with press-connect fittings listed to ANSI LC 4/CSA 6.32. Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.5.7]

5.2.1.1.7.5 Stainless steel tubing joints, stainless steel joints shall be welded, assembled with approved tubing fittings, brazed with a material having a melting point in excess of 1 000 °F (538 °C), or assembled with press-connect fittings listed to ANSI LC 4/CSA 6.32. Brazing alloys and fluxes shall be recommended by the manufacturer for use on stainless steel alloys. [NFPA 54:5.5.7.3]

5.2.1.1.7.6 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 54:5.5.7.4]

5.2.1.1.8 Metallic pipe fittings, metallic fittings shall conform to the following:

- a) Threaded fittings in sizes larger than 4 inches (100 mm) shall not be used.

- b) Fittings used with steel, stainless steel, or wrought-iron pipe shall be steel, stainless steel, copper alloy, malleable iron, or cast iron.
- c) Fittings used with copper or copper alloy pipe shall be copper or copper alloy.
- d) Fittings used with aluminum alloy pipe shall be aluminum alloy.
- e) Cast-iron fittings shall conform to the following:
 - 1) Flanges shall be permitted.
 - 2) Bushings shall not be used.
 - 3) Fittings shall not be used in systems containing flammable gas-air mixtures.
 - 4) Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Competent Authority.
 - 5) Fittings in sizes 6 inches (150 mm) and larger shall not be used unless approved by the Competent Authority.
- f) Aluminum alloy fitting threads shall not form the joint seal.
- g) Zinc-aluminum alloy fittings shall not be used in systems containing flammable gas-air mixtures.
- h) Special fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression-type tubing fittings shall be as follows:
 - 1) Used within the fitting manufacturer's pressure-temperature recommendations.
 - 2) Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction.
 - 3) Acceptable to the Competent Authority.
- i) When pipe fittings are drilled and tapped in the field, the operation shall be in accordance with the following:
 - 1) The operation shall be performed on systems having operating pressures of 5 psi (34 kPa) or less.
 - 2) The operation shall be performed by the gas supplier or their designated representative.
 - 3) The drilling and tapping operation shall be performed in accordance with written procedures prepared by the gas supplier.
 - 4) The fittings shall be located outdoors.

5) The tapped fitting assembly shall be inspected and proven to be free of leaks. [NFPA 54:5.5.7.5]

5.2.1.1.9 Plastic piping joints and fittings, plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers' instructions 5.2.1.1.9.1 through 5.2.1.1.9.4 shall be observed when making such joints. [NFPA 54:5.5.8]

5.2.1.1.9.1 Joint design, 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. [NFPA 54:5.5.8(1)]

5.2.1.1.9.2 Heat-fusion joint, 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. Polyethylene heat-fusion fittings shall be marked "ASTM D2513." Polyamide heat-fusion fittings shall be marked "ASTM F2945." [NFPA 54:5.5.8(2)]

5.2.1.1.9.3 Compression-type mechanical joints, where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.5.8(3)]

5.2.1.1.9.4 Liquefied Petroleum Gas Piping systems, plastic piping joints and fittings for use in LP-Gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.5.8(4)]

5.2.1.1.10 Flange specification, flanges shall conform to 5.2.1.1.10.1 through 5.2.1.1.10.7.

5.2.1.1.10.1 Cast iron flanges, cast iron flanges shall be in accordance with ASME B16.1. [NFPA 54:5.5.9.1.1]

5.2.1.1.10.2 Steel flanges, steel flanges shall be in accordance with the following:
 (1) ASME B16.5 or
 (2) ASME B16.47. [NFPA 54:5.5.9.1.2]

5.2.1.1.10.3 Non-ferrous flanges, non-ferrous flanges shall be in accordance with ASME B16.24. [NFPA 54:5.5.9.1.3]

5.2.1.1.10.4 Ductile iron flanges, ductile iron flanges shall be in accordance with ASME B16.42. [NFPA 54:5.5.9.1.4]

5.2.1.1.10.5 Dissimilar flange connections, raised-face flanges shall not be joined to flat-faced cast iron, ductile iron or nonferrous material flanges. [NFPA 54:5.5.9.2]

5.2.1.1.10.6 Flange facings, standard facings shall be permitted for use under this code of practice. Where 150 psi (1034 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.5.9.3]

5.2.1.1.10.7 Lapped flanges, lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54:5.5.9.4]

5.2.1.1.11 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 54:5.5.10]

5.2.1.1.11.1 Flange gasket materials, acceptable materials shall include the following:

- a) Metal (plain or corrugated);
- b) Composition;
- c) Aluminum "O" rings;
- d) Spiral-wound metal gaskets;
- e) Rubber-faced phenolic;
- f) Elastomeric. [NFPA 54:5.5.10.1]

5.2.1.1.11.2 Metallic flange gaskets, metallic flange gaskets shall be in accordance with ASME B16.20. [NFPA 54:5.5.10.2.1]

5.2.1.1.11.3 Non-metallic flange gaskets, non-metallic flange gaskets shall be in accordance with ASME B16.21. [NFPA 54:5.5.10.2.2]

5.2.1.1.11.4 Full-face flange gasket, full-face flange gaskets shall be used with all non-steel flanges. [NFPA 54:5.5.10.3]

5.2.1.1.11.5 Separated flanges, when a flanged joint is separated, the gasket shall be replaced. [NFPA 54:5.5.10.4]

5.2.1.1.12 Gas meters, gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.6.1]

5.2.1.1.12.1 Location, gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.6.2.1]

5.2.1.1.12.2 Protection from damage, 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 where they will be subject to excessive corrosion or vibration. [NFPA 54:5.6.2.2]

5.2.1.1.12.3 Extreme temperatures, gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature or in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54:5.6.2.3]

5.2.1.1.12.4 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 54:5.6.3]

5.2.1.1.12.5 Meter protection, meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54:5.6.4]

5.2.1.1.12.6 Identification, gas piping at multiple meter installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied and attached by the installing agency. [NFPA 54:5.6.5]

5.2.1.1.13 Gas pressure regulators, a line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served. [NFPA 54:5.6.5]

5.2.1.1.13.1 Listing, line pressure regulators shall be listed in accordance with CSA/ANSI Z21.80/CSA 6.22 where the outlet pressure is set to 2 psi (14 kPa) or less. [NFPA 54:5.7.2]

5.2.1.1.13.2 Location, the gas pressure regulator shall be accessible for servicing. [NFPA 54:5.7.3]

5.2.1.1.13.3 Regulator protection, pressure regulators shall be protected against physical damage. [NFPA 54:5.7.4]

5.2.1.1.13.4 Regulator vents, regulator vents shall be in accordance with Clause 5.2.1.1.26. [NFPA 54:5.7.5]

5.2.1.1.13.5 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 54:5.7.6]

5.2.1.1.14 Overpressure protection required, where the serving gas supplier delivers gas at a pressure greater than 2 psi (14 kPa) for piping systems serving appliances designed to operate at a gas pressure of 14 inches water column (3.5 kPa) or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 inches water column (3.5 kPa) shall be equipped with overpressure protection devices as required by the appliance manufacturer's installation instructions. [NFPA 54:5.8.1]

5.2.1.1.14.1 Overpressure protection devices, overpressure protection devices shall be one of the following:

- a) Pressure relief valve.
- b) Monitor regulator.
- c) Series regulator installed upstream from the line regulator and set to continuously limit the pressure on the inlet of the line regulator to the maximum values specified in 5.2.1.1.21 or less.
- d) Automatic shutoff device installed in series with the line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum values specified in 5.2.1.1.21 or less. This device shall be designed so that it will remain closed until manually reset. [NFPA 54:5.8.3.1]

5.2.1.1.14.2 Separate devices, the devices in 5.2.1.1.14.1 shall be installed either as an integral part of the service or line pressure regulator or as separate units. Where separate overpressure protection devices are installed, they shall conform to 5.2.1.1.14.1 through 5.2.1.1.20. [NFPA 54:5.8.3.2]

5.2.1.1.15 Construction and installation, all overpressure protection devices shall meet the following requirements:

- a) Be constructed of materials so that the operation of the device is not impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.
- b) Be designed and installed so they can be operated to determine whether the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they operate and be examined for leakage when in the closed position. [NFPA 54:5.8.4]

5.2.1.1.16 External control piping, external control piping shall be designed and installed so that damage to the control piping of one device does not render both the regulator and the overpressure protective device inoperative. [NFPA 54:5.8.5]

5.2.1.1.17 Setting, each pressure limiting or pressure relieving device shall be set so that the gas pressure supplied to the connected appliance(s) does not exceed the limits specified in 5.2.1.1.21 and 5.2.1.1.21.1. [NFPA 54:5.8.6]

5.2.1.1.18 Unauthorized operation, where unauthorized operation of any shutoff valve could render a pressure relieving valve or pressure limiting device inoperative, one of the following shall be accomplished:

- (1) The valve shall be locked in the open position. Instruct authorized personnel in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.
- (2) Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and arrange the isolating valves or three-way valve so that only one relief valve can be rendered inoperative at a time. [NFPA 54:5.8.7]

5.2.1.1.19 Discharge of vents, the discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or 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. [NFPA 54:5.8.8.1 – 5.8.8.2]

5.2.1.1.20 Size of fittings, pipe, and openings, the fittings, pipe, and openings located between the system to be protected and the pressure relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity. [NFPA 54:5.8.9]

5.2.1.1.21 Pressure limitation requirements, where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches water column (3.5 kPa) or less are required to be equipped with overpressure protection by 5.2.1.1.21.1, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance to 2 psi (14 kPa) or less upon a failure of the line pressure regulator. [NFPA 54:5.8.2.1]

5.2.1.1.21.1 Overpressure protection required, where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 inches water column (3.5 kPa) are required to be equipped with overpressure protection by 5.2.1.1.21.1, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance as required by the appliance manufacturer's installation instructions. [NFPA 54:5.8.2.2]

5.2.1.1.21.2 Overpressure protection devices, each overpressure protection device installed to meet the requirements of this section shall be capable of limiting the pressure to its connected appliance(s) as required by this section independently of any other pressure control equipment in the piping system. [NFPA 54:5.8.2.3]

5.2.1.1.21.3 Detection of failure, each gas piping system for which an overpressure protection device is required by this section shall be designed and installed so that a failure of the primary pressure control device(s) is detectable. [NFPA 54:5.8.2.4]

5.2.1.1.21.4 Flow capacity, if a pressure relief valve is used to meet the requirements of this section, it shall have a flow capacity such that the pressure in the protected system is maintained at or below the limits specified in Section 5.7.10 under the following conditions:

- 1) The line pressure regulator for which the relief valve is providing overpressure protection has failed wide open.
- 2) The gas pressure at the inlet of the line pressure regulator for which the relief valve is providing overpressure protection is not less than the regulator's normal operating inlet pressure. [NFPA 54:5.8.2.5]

5.2.1.1.22 Backpressure protection, protective devices shall be installed as close to the equipment as practical where the design of equipment connected is such that air, oxygen, or standby gases could be forced into the gas supply system. 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 54:5.9.1.1 – 5.9.1.2]

5.2.1.1.22.1 Protective devices, protective devices shall include but not be limited to the following:

- a) Check valves.
- b) Three-way valves (of the type that completely closes one side before starting to open the other side).
- c) Reverse flow indicators controlling positive shutoff valves.
- d) Normally closed air-actuated positive shutoff pressure regulators. [NFPA 54:5.9.2]

5.2.1.1.23 Low-pressure protection, a protective device shall be installed between the meter and the appliance or equipment if the operation of the appliance or equipment is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such protective devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54:5.10]

5.2.1.1.24 Shutoff valves, shutoff valves shall be selected in accordance with Table 3. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed and labeled. Where used outdoors, such use shall be in accordance with the manufacturer's recommendation. [NFPA 54:5.11]

5.2.1.1.25 Expansion and flexibility, piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54:5.13.1]

5.2.1.1.25.1 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]

5.2.1.1.26 Pressure regulator and pressure control venting, the venting of the atmospheric side of diaphragms in line pressure regulators, gas appliance regulators, and gas pressure limit controls shall be in accordance with all of the following:

- a) An independent vent pipe to the outdoors, sized in accordance with the device manufacturer's instructions, shall be provided where the location of a device is such that a discharge of fuel gas will cause a hazard. For devices other than appliance regulators, vents are not required to be independent where the vents are connected to a common manifold designed in accordance with engineering methods to minimize backpressure in the event of diaphragm failure and such design is approved.

Exceptions:

- (1) A regulator and vent limiting means combination listed as conforming to CSA/ANSI Z21.80/CSA 6.22, shall not be required to be vented to the outdoors.
 - (2) A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.
- b) Materials for vent piping shall be in accordance with 5.2 through 5.2.1.1.11.5.
 - c) The vent terminus shall be designed to prevent the entry of water, insects, and other foreign matter that could cause blockage.
 - d) Vent piping shall be installed to minimize static loads and bending moments placed on the regulators and gas pressure control devices.
 - e) Vents shall terminate not less than 3 feet (914 mm) from a possible source of ignition.
 - f) At locations where a vent termination could be submerged during floods or snow accumulations, an antiflood-type breather vent fitting shall be installed, or the vent terminal shall be located above the height of the expected flood waters or snow.

Vent piping from pressure regulators and gas pressure controls shall not be connected to a common manifold that serves a bleed line from a diaphragm-type gas valve. [NFPA 54:5.14]

Table 3 — Manual gas valve standards

[NFPA 54: TABLE 5.11]

Shutoff valve application	Test method
Appliance shutoff valve up to ½ psi	CSA/ANSI Z21.15/CSA 9.1
	ASME B16.44
	ASME B16.33 marked 125 G
	ANSI LC 4/CSA 6.32
Valve up to ½ psi	ASME B16.44
	ASME B16.33 marked 125 G
	ANSI LC 4/CSA 6.32

Valve up to 2 psi	ASME B16.44 labelled 2 G
	ASME B16.33 marked 125 G
	ANSI LC 4/CSA 6.32 with ASME B16.44 labelled 2G or labelled 5G
	ANSI LC 4/CSA 6.32 with ASME B16.33 marked 125 G
Valve up to 5 psi	ASME B16.44 labelled 5 G
	ASME B16.33
	ANSI LC 4/CSA 6.32 with ASME B16.44 marked 5G
	ANSI LC 4/CSA 6.32 with ASME B16.33 marked 125G
Valve up to 125 psi	ASME B16.33 marked 125 G
	ANSI LC 4/CSA 6.32 with ASME B16.33 marked 125G
For SI Units: 1 pound-force per square inch = 6.8947 kPa	

5.3 Inspection

5.3.1 Inspection notification

Upon completion of the installation, alteration, or repair of gas piping, and prior to the use thereof, the competent authority shall be notified that such gas piping is ready for inspection.

5.3.2 Excavation

Excavations required for the installation of underground piping shall be kept open until the piping has been inspected and approved. Where such piping is covered or concealed before such approval, it shall be exposed upon the direction of the competent authority.

5.3.3 Types of inspection

The Competent Authority 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 be in accordance with this code of practice.

5.3.3.1 Rough piping inspection

This inspection shall be made after gas piping authorized by the permit has been installed and before such piping has been covered or concealed or 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 of practice.

5.3.3.2 Final piping inspection

This inspection shall be made after piping authorized by the permit has been installed, and after portions, thereof that are to be covered or concealed are so concealed, and before fixture, appliance, or shutoff valve has been attached thereto. This inspection shall conform to Section 5.12.1. Test gauges used in conducting tests shall be in accordance with 5.3.4.

5.3.4 Inspection waived

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 preceding inspections shall be permitted to be waived at the discretion of the Competent Authority. In this event, the Competent Authority shall make such inspection as deemed advisable to be assured that the work has been performed in accordance with the intent of this code of practice.

5.3.5 Certificate of inspection

5.3.5.1 Issuance

Whereupon final piping inspection, the installation is found to be in accordance with the provisions of this code of practice, a certificate of inspection shall be permitted to be issued by the Competent Authority.

5.3.5.2 Gas supplier

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

5.3.5.3 Unlawful

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

5.3.5.4 Authority to render gas service

5.3.5.4.1 Authorized personnel

It shall be unlawful for a 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 a premises where and when gas service is, at the time, not being rendered.

5.3.5.4.2 Outlets

It shall be unlawful to turn on or connect gas in or on the premises unless outlets are securely connected to gas appliances or capped or plugged with screw joint fittings.

5.3.5.5 Authority to disconnect**5.3.5.5.1 Disconnection**

The Competent Authority or the serving gas supplier is hereby authorized to disconnect gas piping or appliance or both that shall be found not to be in accordance with the requirements of this code of practice or that are found defective and in such condition as to endanger life or property.

5.3.5.5.2 Notice

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.

5.3.5.5.3 Capped outlets

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

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

5.3.5.6 Temporary use of gas**5.3.5.6.1 General**

Where temporary use of gas is desired, and the Competent Authority deems the use necessary, a permit shall be permitted to be issued for such use for a period not to exceed that designated by the Competent Authority, provided that such gas piping system otherwise is in accordance with the requirements of this code of practice regarding material, sizing, and safety.

5.3.5.7 Excess flow valve**5.3.5.7.1 General**

Where automatic excess flow valves are installed, they shall be listed in accordance with ANSI Z21.93/CSA 6.30 and shall be sized and installed in accordance with the manufacturers' instructions. [NFPA 54:5.12]

5.4 Gas piping installation**5.4.1 Piping underground**

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. 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 54:7.1.1.1 – 7.1.1.2]

5.4.1.1 Cover requirements

Underground piping systems shall be installed with a minimum of 12 inches (305 mm) of cover. The minimum cover shall be increased to 18 inches (457 mm) if external damage to the pipe or tubing from external forces is likely to result. Where a minimum of 12 inches (305 mm) of cover cannot be provided, the piping shall be installed in conduit. [NFPA 54:7.1.2.1 – 7.1.2.1(B)]

5.4.1.2 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]

5.4.1.2.1 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]

5.4.1.3 Protection against corrosion

Steel pipe and steel tubing installed underground shall be installed in accordance with 5.4.1.3.1 through Section 5.4.1.3.9. [NFPA 54:7.1.3]

5.4.1.3.1 Zinc coating

Zinc coating (galvanizing) shall not be deemed adequate protection for underground gas piping. [NFPA 54:7.1.3.1]

5.4.1.3.2 Underground piping

Underground piping shall conform to one or more of the following unless approved technical justification is provided to demonstrate that protection is unnecessary:

- (1) The piping shall be made of corrosion-resistant material that is suitable for the environment in which it will be installed.
- (2) Pipe shall have a factory-applied, electrically insulating coating. Fittings and joints between sections of coated pipe shall be coated in accordance with the coating manufacturer's instructions.
- (3) The piping shall have a cathodic protection system installed, and the system shall be maintained in accordance with Clause 5.9.1.3.3 or Clause 5.9.1.3.6. [NFPA 54:7.1.3.2]

5.4.1.3.3 Cathodic protection

Cathodic protection systems shall be monitored by testing and the results shall be documented. The test results shall demonstrate one of the following:

- (1) A pipe-to-soil voltage of -0.85 volts or more negative is produced, with reference to a saturated copper-copper sulfate half cell.
- (2) A pipe-to-soil voltage of -0.78 volts or more negative is produced, with reference to a saturated KCl calomel half cell.
- (3) A pipe-to-soil voltage of -0.80 volts or more negative is produced, with reference to a silver-silver chloride half cell.
- (4) Compliance with a method specified in relevant applicable standards. {NFPA 54:7.1.3.3}

5.4.1.3.4 Sacrificial anodes

Sacrificial anodes shall be tested in accordance with the following:

- (1) Upon installation of the cathodic protection system, except where prohibited by climatic conditions, in which case the testing shall be performed not later than 180 days after the installation of the system.
- (2) 12 to 18 months after the initial test.
- (3) Upon successful verification testing in accordance with 5.4.1.3.4(1) and 5.4.1.3.4(2), periodic follow-up testing shall be performed at intervals not to exceed 36 months. [NFPA 54:7.1.3.4]

5.4.1.3.5 System failing tests

Systems failing a test shall be repaired not more than 180 days after the date of the failed testing. The testing schedule shall be restarted as required in 5.4.1.3.4(1) and 5.4.1.3.4(2), and the results shall conform to 5.4.1.3.3. [NFPA 54:7.1.3.5]

5.4.1.3.6 Impressed current cathodic protection

Impressed current cathodic protection systems shall be inspected and tested in accordance with the following schedule:

- (1) The impressed current rectifier voltage output shall be checked at intervals not exceeding two months.
- (2) The pipe-to-soil voltage shall be tested at least annually. [NFPA 54:7.1.3.6]

5.4.1.3.7 Documentation

Documentation of the results of the two most recent tests shall be retained. [NFPA 54:7.1.3.7]

5.4.1.3.8 Dissimilar metals

Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. [NFPA 54:7.1.3.8]

5.4.1.3.9 Steel risers

Steel risers, other than anodeless risers, connected to plastic piping shall be cathodically protected by means of a welded anode. [NFPA 54:7.1.3.9]

5.4.1.4 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]

5.4.1.5 Piping through foundation wall

Piping through a foundation wall shall conform to all of the following:

- (1) Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in a protective sleeve or protected by an approved device or method.
- (2) The spaces between the gas piping and the sleeve and between the sleeve and the wall shall be sealed to prevent entry of gas and water.

- (3) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.1.5]

5.4.1.6 Piping underground beneath buildings

Where gas piping is installed underground beneath buildings, the piping shall be either of the following:

- (1) Encased in an approved conduit designed to withstand the imposed loads and installed in accordance with 5.4.1.6.1 or 5.4.1.6.2.
- (2) A piping/encasement system listed for installation beneath buildings. [NFPA 54:7.1.6]

5.4.1.6.1 Conduit with one end terminating outdoors

The conduit shall extend into an 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 retains 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 (102 mm) outside the building, be vented outdoors above finished ground level, and be installed so as to prevent the entrance of water and insects. [NFPA 54:7.1.6.1]

5.4.1.6.2 Conduit with both ends terminating indoors

Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. [NFPA 54:7.1.6.2]

5.4.1.7 Connections of plastic piping

Plastic piping shall be installed outdoors, underground only.

Exceptions:

- (1) Plastic piping shall be permitted to terminate aboveground where an anodeless riser is used.
- (2) Plastic piping shall be permitted to terminate with a wall head adapter aboveground in buildings, including basements, where the plastic piping is inserted in a piping material permitted for use in buildings. [NFPA 54:7.1.7.1]

5.4.1.7.1 Connections between metallic and plastic piping

Connections made between metallic and plastic piping shall be made with fittings conforming to one of the following:

- (1) ASTM D2513, Category I transition fittings
- (2) ASTM F1973
- (3) ASTM F2509 [NFPA 54:7.1.7.2]

5.4.1.7.2 Tracer wire

An electrically continuous corrosion-resistant tracer shall be buried with the plastic pipe to facilitate locating. The tracer shall be one of the following:

- (1) A product specifically designed for that purpose.
- (2) Insulated copper conductor not less than 14 AWG.

Where tracer wire is used, access shall be provided from aboveground, or one end of the tracer wire or tape shall be brought aboveground at a building wall or riser. [NFPA 54:7.1.7.3 – 7.1.7.3.2]

5.4.2 CSST piping systems

CSST piping systems shall be installed in accordance with this code of practice and the manufacturer's installation instructions. [NFPA 54:7.1.8]

5.4.3 Installation of aboveground piping

Piping installed aboveground shall conform to all of the following:

- (1) Piping shall be securely supported and located where it will be protected from physical damage.
- (2) Where passing through an exterior wall, the piping shall also be protected from corrosion by coating or wrapping with an inert material approved for such applications.
- (3) The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents.
- (4) Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed.
- (5) Piping installed outdoors shall be elevated not less than 3½ inches (89 mm) above the ground.
- (6) Sealing materials shall be compatible with the piping and sleeve. [NFPA 54:7.2.1]

5.4.3.1 Protective coating

Where piping is in contact with a material or an atmosphere corrosive to the piping system, the piping and fittings shall be coated with a corrosion-resistant material. Any such coating used on piping or components shall not be considered as adding strength to the system. [NFPA 54:7.2.2]

5.4.3.2 Building structure

The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. Approval shall be obtained before any beams or joists are cut or notched. [NFPA 54:7.2.3.1 – 7.2.3.2]

5.4.3.3 Gas piping to be sloped

Piping for other than dry gas conditions shall be sloped not less than ¼ inch in 15 feet (6.4 mm in 4.6 m) to prevent traps. [NFPA 54:7.2.4]

5.4.3.3.1 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: Appliance or equipment shutoff valves required by this code of practice shall be permitted to be installed in accessible spaces containing vented appliances.

5.4.3.4 Prohibited locations

Gas piping inside any building shall not be installed in or through a clothes chute, chimney or gas vent, dumbwaiter, elevator shaft, or air duct, other than combustion air ducts. [NFPA 54:7.2.5]

Exception: Ducts used to provide ventilation air in accordance with 5.4.3.3.1.

5.4.3.5 Hangers, supports and anchors

Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58. [NFPA 54:7.2.6.1]

5.4.3.5.1 Spacing

Spacing of supports in gas piping installations shall not be greater than shown in Table 4. Spacing of supports of CSST shall be in accordance with the CSST manufacturer's instructions. [NFPA 54:7.2.6.2]

Table 4 — Support of piping

[NFPA 54: TABLE 7.2.6.2]

STEEL PIPE, NOMINAL SIZE OF PIPE (inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING SMOOTH WALL (inches O.D.)	SPACING OF SUPPORTS (feet)
½	6	½	4
¾ or 1	8	⅝ or ¾	6
1 ¼ or larger (horizontal)	10	⅞ or 1 (horizontal)	8
1 ¼ or larger (vertical)	Every floor level	1 or larger (vertical)	Every floor level
For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm			

5.4.3.5.2 Expansion and contraction

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 system shall be designed and installed so they are not disengaged by movement of the supported piping. [NFPA 54:7.2.6.3]

5.4.3.5.3 Piping on roofs

Gas piping installed on the roof surfaces shall be supported in accordance with Table 4. Gas piping shall be elevated not less than 3½ inches (89 mm) above the roof surface. [NFPA 54:7.2.6.4.1, 7.2.6.4.2]

5.4.4 Concealed piping in buildings

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

5.4.4.1 Connections

Where gas piping is to be concealed, connections shall be of the following type:

- (1) Pipe fittings such as elbows, tees, couplings, and right/left nipple/couplings.
- (2) Joining tubing by brazing (see Section XXXX).
- (3) Press-connect fittings listed to ANSI LC 4/CSA 6.32.

- (4) CSST fittings listed to CSA/ANSI LC 1/CSA 6.26.
- (5) Where necessary to insert fittings into a gas pipe system installed in a concealed location, the pipe shall be reconnected by welding, flanges, or the use of a right/left nipple/coupling.

5.4.4.2 Piping in partitions

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

5.4.4.3 Tubing in partitions

This provision shall not apply to tubing that pierces walls, floors, or partitions. Tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length shall meet the following requirements:

- (1) A steel striker barrier not less than 0.0508 of an inch (1.3 mm) thick, or equivalent, is installed between the tubing and the finished wall and extends at least 4 inches (102 mm) beyond concealed penetrations of plates, firestops, wall studs, and so on.
- (2) The tubing is installed in single runs and is not rigidly secured. [NFPA 54:7.3.4]

5.4.4.4 Industrial occupancies

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]

5.4.4.5 Other occupancies

In other than industrial occupancies and where approved by the Competent Authority, gas piping embedded in concrete floor slabs constructed with portland cement shall be surrounded with a minimum of 1½ 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 5.4.3.1. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate. [NFPA 54:7.3.5.2]

5.4.5 Piping in vertical chases

Where gas piping exceeding 5 psi (34 kPa) is located within vertical chases in accordance with Section 5.7.4(4), the requirements specified in 5.4.5.1 through 5.4.5.3 shall apply. [NFPA 54:7.4]

5.4.5.1 Pressure reduction

Where pressure reduction is required in branch connections for conformity to XXXX, 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 conform to Clause XXXX and Clause XXXX through Clause XXXX. The regulator shall be accessible for service and repair and vented in accordance with one of the following:

- (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 (305 mm) of the chase.
- (2) Where the fuel gas is heavier than air, the regulator vent shall be vented only directly to the outdoors. [NFPA 54:7.4.1]

5.4.5.2 Chase construction

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

5.4.5.3 Ventilation

A chase shall be ventilated to the outdoors and only at the top. The opening(s) shall have a minimum free area [in square inches (square meters)] equal to the product of one-half of the maximum pressure in the piping [in pounds per square inch (kilopascals)] times the largest nominal diameter of that piping [in inches (millimeters)], 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]

5.4.6 Gas pipe turns

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

5.4.6.1 Metallic pipe

Metallic pipe bends shall conform to the following:

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

- (5) The inside radius of a bend shall be not less than 6 times the outside diameter of the pipe. [NFPA 54:7.5.1]

5.4.6.2 Plastic pipe

Plastic pipe bends shall conform to the following:

- (1) The pipe shall not be damaged, and the internal diameter of the pipe shall not be effectively reduced.
- (2) Joints shall not be located in pipe bends.
- (3) The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.
- (4) Where the piping manufacturer specifies the use of special bending tools or procedures, such tools or procedures shall be used. [NFPA 54:7.5.2]

5.4.6.3 Elbows

Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch of at least 1 inch (25.4 mm) for pipe sizes 2 inches (50 mm) and larger. [NFPA 54:7.5.3]

5.4.7 Drips and sediment traps

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 Competent Authority or the serving gas supplier, a drip shall also be provided at the outlet of the meter. This drip shall be installed so as to constitute a trap wherein an accumulation of condensate shuts off the flow of gas before it runs back into the meter. [NFPA 54:7.6.1]

5.4.7.1 Location of drips

All drips shall be installed only in such locations that they are 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]

5.4.7.2 Sediment traps

The installation of sediment traps shall be in accordance with Clause XXXX. [NFPA 54:7.6.3]

5.4.8 Outlets

Outlets shall be located and installed in accordance with the following requirements:

- (1) The outlet fittings or piping shall be securely fastened in place.
- (2) Outlets shall not be located behind doors.
- (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.
- (4) The unthreaded portion of gas piping outlets shall extend not less than 1 inch (25.4 mm) through finished ceilings or indoor or outdoor walls.
- (5) The unthreaded portion of gas piping outlets shall extend not less than 2 inches (51 mm) above the surface of floors or outdoor patios or slabs.
- (6) The provisions of 5.4.8(4) and 5.4.8(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 manufacturer's installation instructions. [NFPA 54:7.7.1.1 – 7.7.1.6]

5.4.8.1 Cap outlets

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 appliance or equipment is connected thereto. When an appliance or equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be capped or plugged gastight.

Exceptions:

- (1) Laboratory appliances installed in accordance with Clause XXXX shall be permitted.
- (2) The use of a listed quick-disconnect device with integral shutoff or listed gas convenience outlet shall be permitted. [NFPA 54:7.7.2.1]

5.4.8.2 Appliance shutoff valves

Appliance 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]

5.4.9 Manual gas shutoff valves

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 54:7.8.2]

5.4.9.1 Accessibility of gas valves

System shutoff valves shall be readily accessible for operation and installed so as to be protected from physical damage. System shutoff valves 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 54:7.8.1.1 – 7.8.1.2]

5.4.9.2 Shutoff valves for multiple house lines

In multiple-tenant buildings supplied through a master meter, through one service regulator where a meter is not provided, or where meters or service regulators are not readily accessible from the appliance or 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 54:7.8.3.1]

5.4.9.3 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 Competent Authority. [NFPA 54:7.8.3.2]

5.4.9.4 Shutoff valve for laboratories

Each laboratory space containing two or more gas outlets installed on tables, benches, or in hoods in educational, research, commercial and industrial occupancies shall have a single shutoff valve through which all such gas outlets are supplied. The shutoff valve shall be accessible, located within the laboratory or adjacent to the laboratory's egress door, and identified. [NFPA 54:7.8.3.3]

5.4.9.5 System shutoff valves

Where a system shutoff valve is installed, the valve shall conform to 5.2.1.1.24. [NFPA 54:7.8.4]

5.4.10 Prohibited devices

Devices shall not be placed within the interior of gas piping or fittings where such devices reduce the cross-sectional area or otherwise obstruct the free flow of gas, except where allowance in the piping system design has been made for such devices. [NFPA 54:7.9]

5.4.11 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 54:7.10]

5.4.12 Systems containing flammable gas-air mixtures

Systems containing flammable gas-air mixtures shall be in accordance with 5.4.12.1 through 5.4.12.6.

5.4.12.1 Required components

A central premix system with a flammable mixture in the blower or compressor shall consist of the following components:

- (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.
- (3) Automatic firecheck(s).
- (4) Safety blowout(s) or backfire preventers for systems utilizing flammable mixture lines above 2½ inches (65 mm) nominal pipe size (NPS) or the equivalent. [NFPA 54:7.11.1]

5.4.12.2 Optional Components

The following components shall also be permitted to be utilized in any type of central premix system:

- (1) Flowmeter(s)
- (2) Flame arrester(s) [NFPA 54:7.11.2]

5.4.12.3 Additional requirements

Gas-mixing machines shall have nonsparking blowers and shall be constructed so that a flashback does not rupture machine casings. [NFPA 54:7.11.3]

5.4.12.4 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 inches water column (2.5 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 arranged so 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 54:7.11.4]

5.4.12.5 Installation of gas-mixing machines

Installation of gas-mixing machines shall conform to 5.4.12.5.1 through 5.4.12.5.5.

5.4.12.5.1 Location

The gas-mixing machine shall be located in a well-ventilated area or in a detached building or cutoff room provided with room construction and explosion vents in accordance with engineering methods. Such rooms or below-grade installations shall have adequate positive ventilation. [NFPA 54:7.11.5.1]

5.4.12.5.2 Electrical requirements

Where gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be in accordance with NFPA 70 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 NFPA 70 for hazardous locations (Articles 500 and 501, Class I, Division 2). [NFPA 54:7.11.5.2]

5.4.12.5.3 Air Intakes

Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical. [NFPA 54:7.11.5.3]

5.4.12.5.4 Controls

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 stops 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 54:7.11.5.4]

5.4.12.5.5 Installation in parallel

Centrifugal gas-mixing machines in parallel shall be reviewed by the user and equipment manufacturer before installation, and means or plans for minimizing the effects of downstream pulsation and equipment overload shall be prepared and utilized as needed. [NFPA 54:7.11.5.5]

5.4.12.6 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:

- (1) Approved automatic firechecks shall be installed upstream as close as practical to the burner inlets following the firecheck manufacturers' instructions.
- (2) A separate manually operated gas valve shall be provided at each automatic firecheck for shutting off the flow of the 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 re-ignition of the flammable mixture and has been reset properly.

- (3) 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 2½ inches (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.
- (4) Large-capacity premix systems provided with explosion heads (rupture discs) 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 the gas-air mixture in the event of rupture. [NFPA 54:7.11.6]

5.5 Electrical bonding and grounding

5.5.1 Pipe and tubing other than CSST

Each aboveground portion of a gas piping system, other than CSST, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than CSST, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54:7.12.1]

5.5.2 Bonding of CSST gas piping

CSST gas piping systems, and gas piping systems containing one or more segments of CSST, shall be electrically continuous and bonded to the electrical service grounding electrode system or, where provided, lightning protection grounding electrode system. [NFPA 54:7.12.2]

5.5.2.1 Bonding jumper connection

The bonding jumper shall connect to a metallic pipe, pipe fitting, or CSST fitting. [NFPA 54:7.12.2.1]

5.5.2.2 Bonding jumper size

The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent. [NFPA 54:7.12.2.2]

5.5.2.3 Bonding jumper length

The length of the jumper between the connection to the gas piping system and the grounding electrode system shall not exceed 75 feet (22 860 mm). Any additional grounding electrodes installed to meet this requirement shall be bonded to the electrical service grounding electrode system or, where provided, lightning protection grounding electrode system. [NFPA 54:7.12.2.3]

5.5.2.4 Bonding connections

Bonding connections shall be in accordance with NFPA 70. [NFPA 54:7.12.2.4]

5.5.2.5 Devices Used for Bonding. Devices used for the bonding connection shall be listed for the application in accordance with UL 467. [NFPA 54:7.12.2.5]

5.5.3 Arc-resistant jacketed CSST

CSST listed with an arc resistant jacket or coating system in accordance with CSA/ANSI LC 1/CSA 6.26 shall be electrically continuous and bonded to an effective ground fault current path. Where any CSST component of a piping system does not have an arc-resistant jacket or coating system, the bonding requirements of 5.5.2 shall apply. Arc-resistant jacketed CSST shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54:7.12.3]

5.5.4 Prohibited use

Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54:7.12.4.1]

5.5.5 Lightning protection system

Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780. [NFPA 54:7.12.5]

5.5.6 Electrical circuits

Electrical circuits shall not utilize gas piping or components as conductors.

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. [NFPA 54:7.13]

5.5.7 Electrical connections

All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70. [NFPA 54:7.14.1]

5.5.7.1 Safety control

Any essential safety control depending on electric current as the operating medium shall be of a type that shuts off (fail safe) the flow of gas in the event of current failure. [NFPA 54:7.14.2]

5.6 Appliance and equipment connections to building piping

5.6.1 Connecting appliances and equipment

Appliances and equipment shall be connected to the building piping conforming to 5.6.6 through 5.6.8 by one of the following:

- (1) Rigid metallic pipe and fittings.
- (2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
- (3) A connector for gas appliances listed in accordance with ANSI Z21.24/CSA 6.10. The connector shall be used in accordance with the manufacturer's installation instructions and shall be in the same room as the appliance. Only one connector shall be used per appliance.
- (4) A connector for outdoor gas appliances and manufactured homes listed in accordance with ANSI Z21.75/CSA 6.27. Only one connector shall be used per appliance.
- (5) CSST where installed in accordance with the manufacturer's installation instructions. CSST shall not be directly routed into a metallic appliance enclosure where the appliance is connected to a metallic vent that terminates above a roofline. CSST shall connect only to appliances that are fixed in place.
- (6) Listed nonmetallic gas hose connectors in accordance with XXXX.
- (7) Unlisted gas hose connectors for use in laboratories and educational facilities in accordance with XXXX. [NFPA 54:9.6.1]

5.6.1.1 Protection of connectors

Connectors and tubing addressed in 5.6.1.1(2), 5.6.1(3), 5.6.1(4), 5.6.1(5), and 5.6.1(6) shall be installed 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 detergents, sewage, or water other than rainwater.

Materials addressed in 5.6.1(2), 5.6.1(3), 5.6.1(4), 5.6.1(5), and 5.6.1(6) shall not be installed through an opening in an appliance housing, cabinet, or casing, unless the tubing or connector is protected against damage. [NFPA 54:9.6.1.2]

5.6.1.2 Food service appliance connectors

Connectors used with food service appliances that are moved for cleaning and sanitation purposes shall be installed in accordance with the connector manufacturer's installation instructions. Such connectors shall be listed in accordance with ANSI Z21.69/CSA 6.16. [NFPA 54:9.6.1.3]

5.6.1.3 Restraining device

Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer's installation instructions. [NFPA 54:9.6.1.4]

5.6.2 Suspended low-intensity infrared tube heaters

Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with ANSI Z21.24/CSA 6.10 as follows:

- (1) The connector shall be installed in accordance with the tube heater installation instructions and shall be in the same room as the appliance.
- (2) Only one connector shall be used per appliance. [NFPA 54:9.6.1.5]

5.6.3 Use of nonmetallic gas hose connectors

Listed gas hose connectors shall be used in accordance with the manufacturer's installation instructions and in accordance with 5.6.3.1 and 5.6.3.2. [NFPA 54:9.6.2]

5.6.3.1 Indoor

Indoor gas hose connectors shall be used only to connect laboratory, shop, and ironing appliances requiring mobility during operation and installed in accordance with the following:

- (1) An appliance shutoff valve shall be installed where the connector is attached to the building piping.
- (2) The connector shall be of minimum length and shall not exceed 6 feet (1829 mm).
- (3) The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors. [NFPA 54:9.6.2(1)]

5.6.3.2 Outdoor

Where outdoor gas hose connectors are used to connect portable outdoor appliances, the connector shall be listed in accordance with CSA/ANSI Z21.54/CSA 8.4 and installed in accordance with the following:

- (1) An appliance 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 so as to prevent the accumulation of water or foreign matter.
- (2) This connection shall be made only in the outdoor area where the appliance is to be used. [NFPA 54:9.6.2(2)]
- (3) The connector length shall not exceed 15 feet (4572 mm).

5.6.4 Injection (Bunsen) burners

Injection (Bunsen) burners used in laboratories and educational facilities shall be permitted to be connected to the gas supply by an unlisted hose. [NFPA 54:9.6.3]

5.6.5 Connection of portable and mobile industrial gas appliances

Where portable industrial appliances or appliances requiring mobility or subject to vibration are 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 54:9.6.4.1]

5.6.5.1 Swivel joints or couplings

Where industrial appliances requiring mobility are 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 54:9.6.4.2]

5.6.5.2 Metal flexible connectors

Where industrial appliances subject to vibration are connected to the building piping system by the use of all metal flexible connectors, the connectors shall be suitable for the service required. [NFPA 54:9.6.4.3]

5.6.5.3 Flexible connectors

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 54:9.6.4.4]

5.6.6 Appliance shutoff valves and connections

Each appliance connected to a piping system shall have an accessible, approved manual shutoff valve with a nondisplaceable valve member, or a listed gas convenience outlet. Appliance shutoff valves and convenience outlets shall serve a single appliance only. [NFPA 54:9.6.5] The shutoff valve shall be located within 6 feet (1829 mm) of the appliance it serves. [NFPA 54:9.6.5.1] Where a connector is used, the valve shall be installed upstream of the connector. A union or flanged connection shall be provided downstream from the valve to permit removal of appliance controls. [NFPA 54:9.6.5.1(A)]

Exceptions:

- (1) Shutoff valves serving decorative appliances in a fireplace shall not be located within the fireplace firebox except where the valve is listed for such use. [NFPA 54:9.6.5.1(B)]
- (2) Shutoff valves shall be permitted to be accessibly located inside wall heaters and wall furnaces listed for recessed installation where necessary maintenance is performed without removal of the shutoff valve.

5.6.7 Quick-disconnect devices

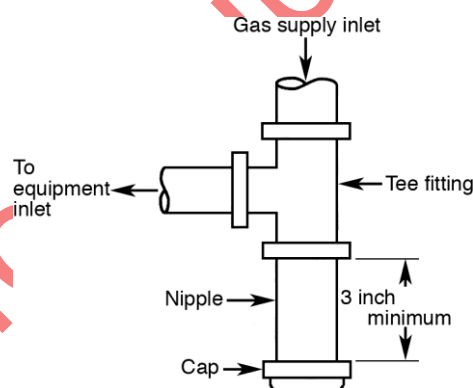
Quick-disconnect devices used to connect appliances to the building piping shall be listed in accordance with ANSI Z21.41/CSA 6.9. Where installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54:9.6.6.1 – 9.6.6.2]

5.6.8 Gas convenience outlets

Appliances shall be permitted to be connected to the building piping by means of a listed gas convenience outlet, in conjunction with a listed appliance connector, installed in accordance with the manufacturer's installation instructions. Gas convenience outlets shall be listed in accordance with CSA/ANSI Z21.90/CSA 6.24 and installed in accordance with the manufacturer's installation instructions. [NFPA 54:9.6.7]

5.6.9 Sediment trap

Where a sediment trap is not incorporated as a part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical at the time of appliance installation. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet, as illustrated in Figure 1, or another device recognized as an effective sediment trap. Illuminating appliances, gas ranges, clothes dryers, decorative appliances for installation in vented fireplaces, gas fireplaces, and outdoor cooking appliances shall not be required to be so equipped. [NFPA 54:9.6.8]



NOTE For SI units: 1 inch = 25.4 mm

Figure 1 — Method of installing a tee fitting sediment trap [NFPA 54: FIGURE 9.6.8]

5.6.10 Installation of piping

Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the appliances. [NFPA 54:9.6.9]

5.6.11 Liquefied Petroleum Gas facilities and piping

Liquefied petroleum gas facilities shall be in accordance with NFPA 58.

5.7 Pressure testing, inspection and purging

5.7.1 Piping installations

Prior to acceptance and initial operation, all piping installations shall be visually inspected and pressure tested to determine that the materials, design, fabrication, and installation practices conform to the requirements of this code of practice. [NFPA 54:8.1.1.1]

5.7.1.1 Inspection requirements

Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly, or pressure tests. [NFPA 54:8.1.1.2]

5.7.1.2 Repairs and additions

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 Competent Authority. [NFPA 54:8.1.1.3]

5.7.1.3 New branches

Where new branches are installed to new appliance(s), only the newly installed branch(es) 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]

5.7.1.4 Piping system

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 a double block and bleed valve system is installed. 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]

5.7.1.5 Regulators and valves

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]

5.7.1.6 Test medium

The test medium shall be air, nitrogen, carbon dioxide, or an inert gas. Oxygen shall not be used as a test medium. [NFPA 54:8.1.2]

5.7.2 Test preparation

Test preparation shall conform to 5.7.2.1 through 5.7.2.6.

5.7.2.1 Pipe joints

Pipe joints, including welds, shall be left exposed for examination during the test.

Exception: Covered or concealed pipe end joints that have been previously tested in accordance with this code of practice. [NFPA 54:8.1.3.1]

5.7.2.2 Expansion joints

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

5.7.2.3 Appliances and equipment

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 tested¹. [NFPA 54:8.1.3.3]

5.7.2.4 Designed for operating pressures less than test pressure

Where the piping system is connected to appliances or equipment designed for operating pressures of less than the test pressure, such appliances or equipment shall be isolated from the piping system by disconnecting them and capping the outlet(s). [NFPA 54:8.1.3.4]

5.7.2.5 Designed for operating pressures equal to or greater than test pressure

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

5.7.2.6 Safety

All testing of piping systems shall be performed in a manner that protects the safety of employees and the public during the test. [NFPA 54:8.1.3.6]

¹ [NFPA 54:8.1.3.3]

5.7.3 Test pressure

This inspection shall include an air, CO₂, or nitrogen pressure test, at which time the gas piping shall stand a pressure of not less than 10 psi (69 kPa) gauge pressure. Test pressures shall be held for a length of time satisfactory to the Competent Authority but in no case less than 15 minutes with no perceptible drop in pressure. For welded piping, and for piping carrying gas at pressures in excess of 14 inches water column pressure (3.5 kPa), the test pressure shall be not less than 60 psi (414 kPa) and shall be continued for a length of time satisfactory to the Competent Authority, but in no case for less than 30 minutes. For CSST carrying gas at pressures in excess of 14 inches water column (3.5 kPa) pressure, the test pressure shall be not less than 30 psi (207 kPa) for 30 minutes. These tests shall be made using air, CO₂, or nitrogen pressure and shall be made in the presence of the Competent Authority. Necessary apparatus for conducting tests shall be furnished by the permit holder. Test gauges used in conducting tests shall be in accordance with 7.3.1.

7.3.1 Test gauges**7.3.1.1 General**

Tests in accordance with this code, which are performed utilizing dial gauges, shall be limited to gauges having the following pressure graduations or incrementations.

7.3.1.2 Pressure tests (10 psi or less)

Required pressure tests of 10 pounds-force per square inch (psi) (69 kPa) or less shall be performed with gauges of 0.10 psi (0.69 kPa) incrementation or less.

7.3.1.3 Pressure tests (greater than 10 psi to 100 psi)

Required pressure tests exceeding 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall be performed with gauges of 1 psi (7 kPa) incrementation or less.

7.3.1.4 Pressure tests (exceeding 100 psi)

Required pressure tests exceeding 100 psi (689 kPa) shall be performed with gauges incremented for 2 percent or less of the required test pressure.

7.3.1.5 Pressure range

Test gauges shall have a pressure range not exceeding twice the test pressure applied.

5.7.4 Detection of leaks and defects. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause. [NFPA 54:8.1.5.1]

5.7.4.1 Detecting leaks

The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. [NFPA 54:8.1.5.2]

5.7.4.2 Repair or replace

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

5.7.5 Piping system leak test

Leak checks using fuel gas shall be permitted in piping systems that have been pressure-tested in accordance with XXXX through XXXXX. [NFPA 54:8.2.1]

5.7.5.1 Turning gas on

During the process of turning gas on into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that all valves at unused outlets are closed and plugged or capped. [NFPA 54:8.2.2]

5.7.5.2 Leak check

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

5.7.5.3 Placing appliances and equipment in operation

Appliances and equipment shall not be placed in operation until after the piping system has been checked for leakage in accordance with 5.7.5.2, the piping system is purged in accordance with 5.7.6, and connections to the appliance are checked for leakage. [NFPA 54:8.2.4]

5.7.6 Purging requirements

The purging of piping shall be in accordance with 5.7.6.1 through 5.7.6.3. [NFPA 54:8.3]

5.7.6.1 Piping systems required to be purged outdoors

The purging of piping systems shall be in accordance with 5.7.6.1.1 through 5.7.6.1.5 where the piping system meets either of the following:

- (1) The design operating gas pressure is greater than 2 psig (14 kPa).
- (2) The piping being purged contains one or more sections of pipe or tubing meeting the size and length criteria of Table 5. [NFPA 54:8.3.1]

Table 5 — Size and length of piping² [NFPA 54: TABLE 8.3.1]*

Nominal piping size (inches)	Length of piping (feet)
$\geq 2\frac{1}{2} < 3$	>50
$\geq 3 < 4$	>30
$\geq 4 < 6$	>15
$\geq 6 < 8$	>10
≥ 8	Any length
For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm CSSTEHD size of 62 is equivalent to nominal 2 inches (50 mm) pipe or tubing size	

5.7.6.1.1 Removal from service

Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented in accordance with 5.7.6.1.4. Where gas piping meeting the criteria of Table 5 is removed from service, the residual fuel gas in the piping shall be displaced with an inert gas. [NFPA 54:8.3.1.1]

5.7.6.1.2 Removal of piping

Where piping containing gas is to be removed, the line shall be first disconnected from sources of gas and then thoroughly purged with air, water, or inert gas before cutting, or welding is done.

5.7.6.1.3 Placing in operation

Where gas piping containing air and meeting the criteria of Table 5 is placed in operation, the air in the piping shall first be displaced with an inert gas. The inert gas shall then be displaced with fuel gas in accordance with 5.7.6.1.4. [NFPA 54:8.3.1.2]

5.7.6.1.4 Outdoor discharge of purged gases

² [NFPA 54:TABLE 8.3.1]

The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location. Purging operations shall conform to all of the following requirements:

- (1) The point of discharge shall be controlled with a shutoff valve.
- (2) The point of discharge shall be located at least 10 feet (3048 mm) from sources of ignition, at least 10 feet (3048 mm) from building openings and at least 25 feet (7620 mm) from mechanical air intake openings.
- (3) During discharge, the open point of discharge shall be continuously attended and monitored with a combustible gas indicator that complies with 5.7.6.1.5.
- (4) Purging operations introducing fuel gas shall be stopped when 90 percent fuel gas by volume is detected within the pipe.
- (5) Persons not involved in the purging operations shall be evacuated from all areas within 10 feet (3048 mm) of the point of discharge. [NFPA 54:8.3.1.3]

5.7.6.1.5 Combustible gas indicator

Combustible gas indicators shall be listed and calibrated in accordance with the manufacturer's instructions. Combustible gas indicators shall numerically display a volume scale from 0 percent to 100 percent in 1 percent or smaller increments. [NFPA 54:8.3.1.4]

5.7.6.2 Piping systems allowed to be purged indoors or outdoors.

The purging of piping systems shall be in accordance with the provisions of 5.7.6.2.1 where the piping system meets both of the following:

- (1) The design operating pressure is 2 psig (14 kPag) or less.
- (2) The piping being purged is constructed entirely from pipe or tubing not meeting the size and length criteria of Table 5. [NFPA 54:8.3.2]

5.7.6.2.1 Purging procedure

The piping system shall be purged in accordance with one or more of the following:

- (1) The piping shall be purged with fuel gas and shall discharge to the outdoors.
- (2) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through an appliance burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.
- (3) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.
- (4) The piping shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector in accordance with 5.7.6.2.2. Purging shall be stopped when fuel gas is detected.
- (5) The piping shall be purged by the gas supplier in accordance with written procedures. [NFPA 54:8.3.2.1]

5.7.6.2.2 Combustible gas detector

Combustible gas detectors shall be listed and calibrated or tested in accordance with the manufacturer's instructions. Combustible gas detectors shall be capable of indicating the presence of fuel gas. [NFPA 54:8.3.2.2]

5.7.6.3 Purging appliances and equipment.

After the piping system has been placed in operation, appliances and equipment shall be purged before being placed into operation. [NFPA 54:8.3.3]

5.8 Required gas supply

5.8.1 General

The following regulations shall conform to this Clause and Section 5.9, shall be the standard for the installation of gas piping. Natural gas regulations and tables are based on the use of a gas having a specific gravity of 0.60 and for undiluted liquefied petroleum gas, having a specific gravity of 1.50. Where gas of a different specific gravity is to be delivered, the specific gravity conversion factors provided by the serving gas supplier shall be used in sizing piping systems from the pipe sizing tables in this chapter.

5.8.2 Volume

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.

5.8.3 Gas appliances

Where the gas appliances to be installed have not been specified, Table 1 shall be permitted to be used as a reference to estimate requirements of typical appliances. To obtain the cubic feet per hour (m³/h) of gas

required, divide the input of the appliances by the average Btu (kW/h) heating value per cubic foot (m³) of the gas. The average Btu (kW/h) per cubic foot (m³) of the gas in the area of the installation shall be permitted to be obtained from the serving gas supplier.

5.8.4 Size of piping outlets

The size of the supply piping outlet for a gas appliance shall be not less than ½ of an inch in diameter (15 mm). The size of a piping outlet for a mobile home shall be not less than ¾ of an inch in diameter (20 mm).

5.9 Required gas piping size

5.9.1 Pipe sizing methods

Where the pipe size is to be determined using any of the methods in 5.9.1.1 through 5.9.1.3, the diameter of each pipe segment shall be obtained from the pipe sizing tables in 5.9.2 or from the sizing equations in 5.9.3. [NFPA 54:6.1]

5.9.1.1 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] (see calculation example in Figure XXXX)

5.9.1.2 Branch length method

Pipe shall be sized as follows:

- (1) Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.
- (2) The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section. [NFPA 54:6.1.2]

5.9.1.3 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]

5.9.2 Sizing of gas piping systems

Sizing of piping systems shall be in accordance with 5.9.2.1 for natural gas piping systems and 5.9.2.2 for propane piping systems.

5.9.2.1 Natural gas piping systems

Table XXXX through Table XXXX shall be used in conjunction with one of the methods specified in 5.9.1.1 through 5.9.1.3 for piping materials other than non-corrugated stainless steel tubing. 5.9.3 shall be used in conjunction with one of the methods specified in 5.9.1.1 through 5.9.1.3 for non-corrugated stainless steel tubing. [NFPA 54:6.2.1, 6.2.2]

5.9.2.2 Propane piping systems

Table XXXX through XXXX shall be used in conjunction with one of the methods specified in 5.9.1.1 through 5.9.1.3 for piping materials other than non-corrugated stainless steel tubing. Clause 5.9.3 shall be used in conjunction with one of the methods specified in 5.9.1.1 through 5.9.1.3 for non-corrugated stainless steel tubing. [NFPA 54:6.3.1, 6.3.2]

5.9.3 Sizing equations

The inside diameter of smooth wall pipe or tubing shall be determined by Equation 5.9.3(1), Equation 5.9.3(2) and Table 6 using the equivalent pipe length determined by the methods in Clause 5.9.1.1 through Clause 5.9.1.3. [NFPA 54:6.4]

Low-pressure gas formula (less than 1.5 psi)³ [NFPA 54:6.4.1]

³ [NFPA 54:6.4.1]

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

Equation 5.9.3 (1)

where

- D = inside diameter of pipe, inches
 Q = input rate appliance(s), cubic feet per hour at 60 °F and 30 inch mercury column
 L = equivalent length of pipe, feet
 ΔH = pressure drop, inches water column
 Cr = in accordance with Table 6

High-pressure gas formula (1.5 psi and above)⁴ [NFPA 54:6.4.2]

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

Equation 5.9.3 (2)

where

- D = inside diameter of pipe, inches;
 Q = input rate appliance(s), cubic feet per hour at 60 °F and 30 inch mercury column;
 P_1 = upstream pressure, psia ($P_1 + 14.7$);
 P_2 = downstream pressure, psia ($P_2 + 14.7$);
 L = equivalent length of pipe, feet;
 Cr = in accordance with Table 6;
 Y = in accordance with Table 6.

NOTE For SI units: 1 cubic foot = 0.0283 m³, 1 000 British thermal units per hour = 0.293 kW, 1 inch = 25 mm, 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa, °C = (°F-32)/1.8, 1 inch mercury column = 3.39 kPa, 1 inch water column = 0.249 kPa

⁴ [NFPA 54:6.4.2]

Table 6 provides factors for natural gas and undiluted propane at standard conditions.

Table 6 — C_r and Y for natural gas and undiluted propane at standard conditions⁵ [NFPA 54: TABLE 6.4.2]

Gas	Formula factors	
	C_r	Y
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.9910

5.9.4 Sizing of piping sections

To determine the size of each section of pipe in a system within the range of Table XXXX through Table XXXX proceed as follows:

- (1) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
- (2) Select the length in feet column and row showing the distance, or the next longer distance where 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. Where 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 to 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 appliances and the installation prevents both units from operating simultaneously, the larger of the two demand loads needs to 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. Size branch piping in the order of their distance from the meter location, beginning with the most distant outlet not previously sized.

5.9.5 Engineering methods

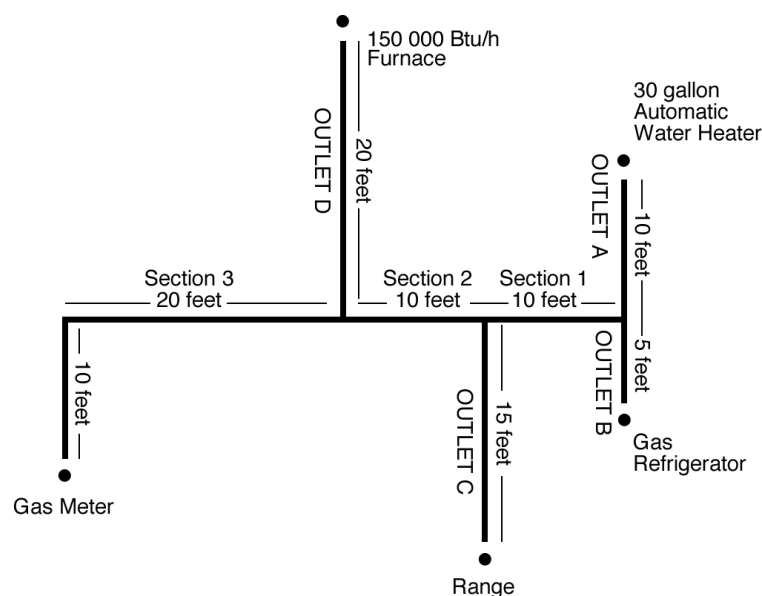
For conditions other than those covered by Clause 5.9.1, such as longer runs or greater gas demands, the size of each gas piping system shall be determined by standard engineering methods acceptable to the Competent Authority, and each such system shall be so designed that the total pressure drop between the meter or another point of supply and an outlet where full demand is being supplied to all outlets, shall be in accordance with the requirements of Clause 5.1.5.

5.9.6 Variable gas pressure

Where the supply gas pressure exceeds 5 psi (34.6 kPa) for natural gas and 10 psi (69 kPa) for undiluted propane or is less than 6 inches (1.5 kPa) of water column, or where diversity demand factors are used, the design, pipe, sizing, materials, location, and use of such systems first shall be approved by the Competent Authority. Piping systems designed for pressures exceeding the serving gas supplier's standard delivery pressure shall have prior verification from the gas supplier of the availability of the design pressure.

⁵ [NFPA 54:Table 6.4.2]

Problem: Determine the required pipe size of each section and outlet of the piping system shown in Figure X. Gas to be used has a specific gravity of 0.60 and 1 100 British thermal units (Btu) per cubic foot (0.0114 kW/h/L), delivered at 8 inch water column (2.0 kPa) pressure.



NOTE For SI units: 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1 000 British thermal units per hour = 0.293 kW, 1 cubic foot per hour = 0.0283 m³/h.

Figure — Example illustrating use of Table 1

Solution:

- (1) Maximum gas demand of Outlet A — 32 cubic feet per hour (0.91 m³/h) (from Table 1).
 Maximum gas demand of Outlet B — 3 cubic feet per hour (0.08 m³/h) (from Table 1).
 Maximum gas demand of Outlet C — 59 cubic feet per hour (1.67 m³/h) (from Table 1).
 Maximum gas demand of Outlet D — 136 cubic feet per hour (3.85 m³/h) [150 000 Btu/h (44 kW) divided by 1 100 Btu per cubic foot (0.0114 kW/h/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 XXXX:
 Outlet A, supplying 32 cubic feet per hour (0.91 m³/h), requires ½ of an inch (15 mm) pipe.
 Section 1, supplying Outlets A and B, or 35 cubic feet per hour (0.99 m³/h) requires ½ of an inch (15 mm) pipe.
 Section 2, supplying Outlets A, B and C or 94 cubic feet per hour (2.66 m³/h) requires ¾ of an inch (20 mm) pipe.
 Section 3, supplying Outlets A, B, C, and D, or 230 cubic feet per hour (6.51 m³/h), requires 1 inch (25 mm) pipe.
- (4) Using the column marked 60 feet (18 288 mm) in Table XXXX:
 Outlet B supplying 3 cubic feet per hour (0.08 m³/h), requires ½ of an inch (15 mm) pipe.
 Outlet C, supplying 59 cubic feet per hour (1.67 m³/h), requires ½ of an inch (15 mm) pipe.
- (5) Using the column marked 60 feet (18 288 mm) in Table XXXX:
 Outlet D, supplying 136 cubic feet per hour (3.85 m³/h), requires ¾ of an inch (20 mm) pipe.

6 Firestop protection systems requirements

6.1 Construction documents

Construction documents shall indicate with sufficient detail how penetrations of fire-resistance-rated assemblies shall be firestopped prior to obtaining design approval.

6.2 Installation of firestop systems materials

In addition to the provision of the present plumbing code of practice, firestop systems shall be installed in accordance with the Rwanda building code, and the manufacturer's installation instructions.

6.3 Combustible's piping installations

Combustible's piping installations shall be fire-protected in accordance with the appropriate fire resistance rating requirements in the Rwanda building code that lists the acceptable area, height, and type of construction for use in specific occupancies to assure compliance and integrity of the fire resistance rating specified.

6.3.1 Fire-resistance rating

Where penetrating a fire-resistance-rated wall, partition, floor, floor-ceiling assembly, roof-ceiling assembly, or shaft enclosure, the fire-resistance rating of the assembly shall be restored to its original rating.

6.3.2 Firestop systems

Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E119, ASTM E814, UL 263, or UL 1479 with a positive pressure differential of not less than 0.01 of an inch of water (0.002 kPa). Systems shall have an F rating of not less than 1 h but not less than the required fire-resistance rating of the assembly being penetrated. Systems protecting floor penetrations shall have a T rating of not less than 1 hour but not less than the required fire-resistance rating of the floor being penetrated. Floor penetrations contained within the cavity of a wall at the location of the floor penetration do not require a T rating. No T rating shall be required for floor penetrations by piping that is not in direct contact with combustible material.

6.3.3 Connections

Where piping penetrates a rated assembly, the combustible piping shall not connect to non-combustible piping unless it is capable of being demonstrated that the transition is in accordance with 6.3.2.

6.3.4 Insulation and coverings

Insulation and coverings on or in the penetrating item shall not be permitted unless the specific insulating or covering material has been tested as part of the penetrating firestop system.

6.3.5 Sleeves

Where sleeves are used, the sleeves shall be securely fastened to the fire-resistance-rated assembly. The (inside) annular space between the sleeve and the penetrating item and the (outside) annular space between the sleeve and the fire-resistance-rated assembly shall be firestopped in accordance with this clause.

6.4 Non-combustible piping installations

Noncombustible piping installations shall be protected in accordance with the appropriate fire resistance rating requirements in the building code that list the acceptable area, height, and type of construction for use in specific occupancies to ensure compliance and integrity of the fire-resistance rating prescribed.

6.4.1 Fire-resistance rating

Where penetrating a fire-resistance-rated wall, partition, floor, floor-ceiling assembly, roof-ceiling assembly, or shaft enclosure, the fire-resistance rating of the assembly shall be restored to its original rating.

Exceptions:

- (1) Concrete, mortar, or grout shall be permitted to be used to fill the annular spaces around cast-iron, copper, copper alloy, or steel piping that penetrates concrete or masonry fire-resistant-rated assemblies. The nominal diameter of the penetrating item shall not exceed 6 inches (150 mm), and the opening size shall not exceed 144 square inches (0.093 m²).
The thickness of concrete, mortar, or grout shall be the full thickness of the assembly or the thickness necessary to provide a fire-resistance rating not less than the required fire-resistance rating of the assembly penetrated.
- (2) The material used to fill the annular space shall prevent the passage of flame and hot gases capable of igniting cotton waste for the time period equivalent to the fire-resistance rating of the assembly, where tested to standard(s) referenced in 6.4.2.

6.4.2 Firestop systems

Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E119, ASTM E814, UL 263, or UL 1479 with a positive pressure differential of not less than 0.01 of an inch of water (0.002 kPa). Systems shall have an F rating of not less than 1 hour but not less than the required fire-resistance rating of the assembly being penetrated. Systems protecting floor penetrations shall have a T rating of not less than 1 h but not less than the required fire-resistance rating of the floor being penetrated. Floor penetrations contained within the cavity of a wall at the location of the floor penetration do not require a T rating. No T rating shall be required for floor penetrations by piping that is not in direct contact with combustible material.

6.4.3 Connections

Where piping penetrates a rated assembly, the combustible piping shall not connect to noncombustible piping unless it is capable of being demonstrated that the transition is in accordance with the requirements of 6.4.2.

6.4.4 Unshielded couplings

Unshielded couplings shall not be used to connect noncombustible piping unless it is capable of being demonstrated that the fire-resistive integrity of the penetration is maintained.

6.4.5 Sleeves

Where sleeves are used, the sleeves shall be securely fastened to the fire-resistance-rated assembly. The (inside) annular space between the sleeve and the penetrating item and the (outside) annular space between the sleeve and the fire-resistance-rated assembly shall be firestopped in accordance with this chapter.

6.4.6 Insulation and coverings

Insulation and coverings on or in the penetrating item shall not be permitted unless the specific insulating or covering material has been tested as part of the penetrating firestop system.

6.5 Required inspection

Prior to being concealed, piping penetrations shall be inspected by the Competent Authority to verify compliance with the fire-resistance rating prescribed in the building code.

6.5.1 Examination

The Competent Authority shall conduct a thorough examination of sufficient representative installations, including destructive inspection, to provide verification of satisfactory compliance with this chapter, the appropriate manufacturer's installation instructions applied by the installer, construction documents, specifications, and applicable manufacturer's product information.

6.5.2 Penetrations

The Competent Authority shall determine the type, size and quantity of penetrations to be inspected.

6.5.3 Field installations

The Competent Authority shall compare the field installations with the documentation supplied by the installer to determine the following:

- The required F ratings (1 h, 2 h, 3 h, or 4 h) and T ratings (0 h, 1 h, 2 h, 3 , or 4 h) of the penetration firestop systems are at least the same as the hourly rating of the assembly being penetrated.
- The penetrating firestop system includes the penetrating item as documented through testing of the systems conducted by an independent testing agency.
- The penetrating firestop system is installed as tested.

Annex A (normative)

Schedule 40 metallic pipe

Table A.1 — Schedule 40 metallic pipe⁶ [NFPA 54: TABLE 6.2.1(b)]

										GAS: NATURAL				
										INLET PRESSURE:		LESS THAN 2 psi		
										PRESSURE DROP:		0.5 in .w.c.		
										SPECIFIC GRAVITY:		0.60		
	PIPE SIZE (inch)													
NOMINAL:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
10	172	360	678	1390	2090	4020	6400	11 300	23 100	41 800	67 600	139 000	252 000	399 000
20	118	247	466	957	1430	2760	4400	7780	15 900	28 700	46 500	95 500	173 000	275 000
30	95	199	374	768	1150	2220	3530	6250	12 700	23 000	37 300	76 700	139 000	220 000
40	81	170	320	657	985	1900	3020	5350	10 900	19 700	31 900	65 600	119 000	189 000
50	72	151	284	583	873	1680	2680	4740	9660	17 500	28 300	58 200	106 000	167 000
60	65	137	257	528	791	1520	2430	4290	8760	15 800	25 600	52 700	95 700	152 000
70	60	126	237	486	728	1400	2230	3950	8050	14 600	23 600	48 500	88 100	139 000
80	56	117	220	452	677	1300	2080	3670	7490	13 600	22 000	45 100	81 900	130 000
90	52	110	207	424	635	1220	1950	3450	7030	12 700	20 600	42 300	76 900	122 000
100	50	104	195	400	600	1160	1840	3260	6640	12 000	19 500	40 000	72 600	115 000
125	44	92	173	355	532	1020	1630	2890	5890	10 600	17 200	35 400	64 300	102 000
150	40	83	157	322	482	928	1480	2610	5330	9650	15 600	32 100	58 300	92 300
175	37	77	144	296	443	854	1360	2410	4910	8880	14 400	29 500	53 600	84 900
200	34	71	134	275	412	794	1270	2240	4560	8260	13 400	27 500	49 900	79 000
250	30	63	119	244	366	704	1120	1980	4050	7320	11 900	24 300	44 200	70 000
300	27	57	108	221	331	638	1020	1800	3670	6630	10 700	22 100	40 100	63 400
350	25	53	99	203	305	587	935	1650	3370	6100	9880	20 300	36 900	58 400
400	23	49	92	189	283	546	870	1540	3140	5680	9190	18 900	34 300	54 300
450	22	46	86	177	266	512	816	1440	2940	5330	8620	17 700	32 200	50 900
500	21	43	82	168	251	484	771	1360	2780	5030	8150	16 700	30 400	48 100
550	20	41	78	159	239	459	732	1290	2640	4780	7740	15 900	28 900	45 700
600	19	39	74	152	228	438	699	1240	2520	4560	7380	15 200	27 500	43 600
650	18	38	71	145	218	420	669	1180	2410	4360	7070	14 500	26 400	41 800
700	17	36	68	140	209	403	643	1140	2320	4190	6790	14 000	25 300	40 100
750	17	35	66	135	202	389	619	1090	2230	4040	6540	13 400	24 400	38 600
800	16	34	63	130	195	375	598	1060	2160	3900	6320	13 000	23 600	37 300
850	16	33	61	126	189	363	579	1020	2090	3780	6110	12 600	22 800	36 100
900	15	32	59	122	183	352	561	992	2020	3660	5930	12 200	22 100	35 000
950	15	31	58	118	178	342	545	963	1960	3550	5760	11 800	21 500	34 000
1000	14	30	56	115	173	333	530	937	1910	3460	5600	11 500	20 900	33 100
1100	14	28	53	109	164	316	503	890	1810	3280	5320	10 900	19 800	31 400
1200	13	27	51	104	156	301	480	849	1730	3130	5070	10 400	18 900	30 000

⁶ [NFPA 54:Table 6.2.1(b)]^{1,2}

1300	12	26	49	100	150	289	460	813	1660	3000	4860	9980	18 100	28 700
1400	12	25	47	96	144	277	442	781	1590	2880	4670	9590	17 400	27 600
1500	11	24	45	93	139	267	426	752	1530	2780	4500	9240	16 800	26 600
1600	11	23	44	89	134	258	411	727	1480	2680	4340	8920	16 200	25 600
1700	11	22	42	86	130	250	398	703	1430	2590	4200	8630	15 700	24 800
1800	10	22	41	84	126	242	386	682	1390	2520	4070	8370	15 200	24 100
1900	10	21	40	81	122	235	375	662	1350	2440	3960	8130	14 800	23 400
2000	NA	20	39	79	119	229	364	644	1310	2380	3850	7910	14 400	22 700

NOTE 1 For SI units: 1inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa.

NOTE 2 Table entries are rounded to 3 significant digits.

NOTE 3 NA means a flow of less than 10 ft 3/h (0.283 m³/h).

Table A.2 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.2.1(c)]

						GAS: NATURAL			
						INLET PRESSURE: LESS THAN 2 psi			
						PRESSURE DROP: 3.0 in w.c.			
						SPECIFIC GRAVITY: 0.60			
INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 IN. W.C. OR GREATER									
	PIPE SIZE (inch)								
NOMINAL:	1/2	3/4	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 (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	454	949	1790	3670	5500	10 600	16 900	29 800	60 800
20	312	652	1230	2520	3780	7280	11 600	20 500	41 800
30	250	524	986	2030	3030	5840	9310	16 500	33 600
40	214	448	844	1730	2600	5000	7970	14 100	28 700
50	190	397	748	1540	2300	4430	7060	12 500	25 500
60	172	360	678	1390	2090	4020	6400	11 300	23 100
70	158	331	624	1280	1920	3690	5890	10 400	21 200
80	147	308	580	1190	1790	3440	5480	9690	19 800
90	138	289	544	1120	1670	3230	5140	9090	18 500
100	131	273	514	1060	1580	3050	4860	8580	17 500
125	116	242	456	936	1400	2700	4300	7610	15 500
150	105	219	413	848	1270	2450	3900	6890	14 100
175	96	202	380	780	1170	2250	3590	6340	12 900
200	90	188	353	726	1090	2090	3340	5900	12 000
250	80	166	313	643	964	1860	2960	5230	10 700
300	72	151	284	583	873	1680	2680	4740	9660
350	66	139	261	536	803	1550	2470	4360	8890
400	62	129	243	499	747	1440	2290	4050	8270
450	58	121	228	468	701	1350	2150	3800	7760
500	55	114	215	442	662	1280	2030	3590	7330
550	52	109	204	420	629	1210	1930	3410	6960
600	50	104	195	400	600	1160	1840	3260	6640
650	47	99	187	384	575	1110	1760	3120	6360
700	46	95	179	368	552	1060	1690	3000	6110
750	44	92	173	355	532	1020	1630	2890	5890
800	42	89	167	343	514	989	1580	2790	5680
850	41	86	162	332	497	957	1530	2700	5500
900	40	83	157	322	482	928	1480	2610	5330
950	39	81	152	312	468	901	1440	2540	5180
1000	38	79	148	304	455	877	1400	2470	5040
1100	36	75	141	289	432	833	1330	2350	4780
1200	34	71	134	275	412	794	1270	2240	4560
1300	33	68	128	264	395	761	1210	2140	4370
1400	31	65	123	253	379	731	1160	2060	4200

1500	30	63	119	244	366	704	1120	1980	4050
1600	29	61	115	236	353	680	1080	1920	3910
1700	28	59	111	228	342	658	1050	1850	3780
1800	27	57	108	221	331	638	1020	1800	3670
1900	27	56	105	215	322	619	987	1750	3560
2000	26	54	102	209	313	602	960	1700	3460

NOTE 1 For SI units: 1 inch = 25mm, 1 foot= 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column =0.249 kPa

NOTE 2 Table entries are rounded to 3 significant digits.

Table A.3 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.2.1(d)]

						GAS: NATURAL			
						INLET PRESSURE: LESS THAN 2 psi			
						PRESSURE DROP: 6.0 in w.c.			
						SPECIFIC GRAVITY: 0.60			
INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 IN .W.C. OR GREATER									
	PIPE SIZE (inch)								
NOMINAL:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL ID:	0.622	0.824	1.049	1.38	1.61	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	660	1380	2600	5340	8000	15 400	24 600	43 400	88 500
20	454	949	1790	3670	5500	10 600	16 900	29 800	60 800
30	364	762	1440	2950	4410	8500	13 600	24 000	48 900
40	312	652	1230	2520	3780	7280	11 600	20 500	41 800
50	276	578	1090	2240	3350	6450	10 300	18 200	37 100
60	250	524	986	2030	3030	5840	9310	16 500	33 600
70	230	482	907	1860	2790	5380	8570	15 100	30 900
80	214	448	844	1730	2600	5000	7970	14 100	28 700
90	201	420	792	1630	2440	4690	7480	13 200	27 000
100	190	397	748	1540	2300	4430	7060	12 500	25 500
125	168	352	663	1360	2040	3930	6260	11 100	22 600
150	153	319	601	1230	1850	3560	5670	10 000	20 500
175	140	293	553	1140	1700	3270	5220	9230	18 800
200	131	273	514	1056	1580	3050	4860	8580	17 500
250	116	242	456	936	1400	2700	4300	7610	15 500
300	105	219	413	848	1270	2450	3900	6890	14 100
350	96	202	380	780	1170	2250	3590	6340	12 900
400	90	188	353	726	1090	2090	3340	5900	12 000
450	84	176	332	681	1020	1960	3130	5540	11 300
500	80	166	313	643	964	1860	2960	5230	10 700
550	76	158	297	611	915	1760	2810	4970	10 100
600	72	151	284	583	873	1680	2680	4740	9660
650	69	144	272	558	836	1610	2570	4540	9250
700	66	139	261	536	803	1550	2470	4360	8890
750	64	134	252	516	774	1490	2380	4200	8560
800	62	129	243	499	747	1440	2290	4050	8270
850	60	125	235	483	723	1390	2220	3920	8000
900	58	121	228	468	701	1350	2150	3800	7760
950	56	118	221	454	681	1310	2090	3690	7540
1000	55	114	215	442	662	1280	2030	3590	7330
1100	52	109	204	420	629	1210	1930	3410	6960
1200	50	104	195	400	600	1160	1840	3260	6640
1300	47	99	187	384	575	1110	1760	3120	6360
1400	46	95	179	368	552	1060	1690	3000	6110
1500	44	92	173	355	532	1020	1630	2890	5890
1600	42	89	167	343	514	989	1580	2790	5680

NOTE 1 For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

NOTE 2 Table entries are rounded to 3 significant digits.

Table A.5 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.2.1(f)]

						GAS: NATURAL			
						INLET PRESSURE:		3.0 psi	
						PRESSURE DROP:		2.0 psi	
						SPECIFIC GRAVITY:		0.60	
	PIPE SIZE (inch)								
NOMINAL:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	2350	4920	9270	19 000	28 500	54 900	87 500	155 000	316 000
20	1620	3380	6370	13 100	19 600	37 700	60 100	106 000	217 000
30	1300	2720	5110	10 500	15 700	30 300	48 300	85 400	174 000
40	1110	2320	4380	8990	13 500	25 900	41 300	73 100	149 000
50	985	2060	3880	7970	11 900	23 000	36 600	64 800	132 000
60	892	1870	3520	7220	10 800	20 800	33 200	58 700	120 000
70	821	1720	3230	6640	9950	19 200	30 500	54 000	110 000
80	764	1600	3010	6180	9260	17 800	28 400	50 200	102 000
90	717	1500	2820	5800	8680	16 700	26 700	47 100	96 100
100	677	1420	2670	5470	8200	15 800	25 200	44 500	90 800
125	600	1250	2360	4850	7270	14 000	22 300	39 500	80 500
150	544	1140	2140	4400	6590	12 700	20 200	35 700	72 900
175	500	1050	1970	4040	6060	11 700	18 600	32 900	67 100
200	465	973	1830	3760	5640	10 900	17 300	30 600	62 400
250	412	862	1620	3330	5000	9620	15 300	27 100	55 300
300	374	781	1470	3020	4530	8720	13 900	24 600	50 100
350	344	719	1350	2780	4170	8020	12 800	22 600	46 100
400	320	669	1260	2590	3870	7460	11 900	21 000	42 900
450	300	627	1180	2430	3640	7000	11 200	19 700	40 200
500	283	593	1120	2290	3430	6610	10 500	18 600	38 000
550	269	563	1060	2180	3260	6280	10 000	17 700	36 100
600	257	537	1010	2080	3110	5990	9550	16 900	34 400
650	246	514	969	1990	2980	5740	9150	16 200	33 000
700	236	494	931	1910	2860	5510	8790	15 500	31 700
750	228	476	897	1840	2760	5310	8470	15 000	30 500
800	220	460	866	1780	2660	5130	8180	14 500	29 500
850	213	445	838	1720	2580	4960	7910	14 000	28 500
900	206	431	812	1670	2500	4810	7670	13 600	27 700
950	200	419	789	1620	2430	4670	7450	13 200	26 900
1000	195	407	767	1580	2360	4550	7240	12 800	26 100
1100	185	387	729	1500	2240	4320	6890	12 200	24 800
1200	177	369	695	1430	2140	4120	6570	11 600	23 700
1300	169	353	666	1370	2050	3940	6290	11 100	22 700
1400	162	340	640	1310	1970	3790	6040	10 700	21 800
1500	156	327	616	1270	1900	3650	5820	10 300	21 000
1600	151	316	595	1220	1830	3530	5620	10 000	20 300
1700	146	306	576	1180	1770	3410	5440	9610	19 600
1800	142	296	558	1150	1720	3310	5270	9320	19 000
1900	138	288	542	1110	1670	3210	5120	9050	18 400
2000	134	280	527	1080	1620	3120	4980	8800	18 000

NOTE 1 For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

NOTE 2 Table entries are rounded to 3 significant digits.

Table A.6 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.2.1(g)]

						GAS: NATURAL			
						INLET PRESSURE: 5.0 psi			
						PRESSURE DROP: 3.5 psi			
						SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)								
NOMINAL:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	3190	6430	11 800	24 200	36 200	69 700	111 000	196 000	401 000
20	2250	4550	8320	17 100	25 600	49 300	78 600	139 000	283 000
30	1840	3720	6790	14 000	20 900	40 300	64 200	113 000	231 000
40	1590	3220	5880	12 100	18 100	34 900	55 600	98 200	200 000
50	1430	2880	5260	10 800	16 200	31 200	49 700	87 900	179 000
60	1300	2630	4800	9860	14 800	28 500	45 400	80 200	164 000
70	1200	2430	4450	9130	13 700	26 400	42 000	74 300	151 000
80	1150	2330	4260	8540	12 800	24 700	39 300	69 500	142 000
90	1060	2150	3920	8050	12 100	23 200	37 000	65 500	134 000
100	979	1980	3620	7430	11 100	21 400	34 200	60 400	123 000
125	876	1770	3240	6640	9950	19 200	30 600	54 000	110 000
150	786	1590	2910	5960	8940	17 200	27 400	48 500	98 900
175	728	1470	2690	5520	8270	15 900	25 400	44 900	91 600
200	673	1360	2490	5100	7650	14 700	23 500	41 500	84 700
250	558	1170	2200	4510	6760	13 000	20 800	36 700	74 900
300	506	1060	1990	4090	6130	11 800	18 800	33 300	67 800
350	465	973	1830	3760	5640	10 900	17 300	30 600	62 400
400	433	905	1710	3500	5250	10 100	16 100	28 500	58 100
450	406	849	1600	3290	4920	9480	15 100	26 700	54 500
500	384	802	1510	3100	4650	8950	14 300	25 200	51 500
550	364	762	1440	2950	4420	8500	13 600	24 000	48 900
600	348	727	1370	2810	4210	8110	12 900	22 900	46 600
650	333	696	1310	2690	4030	7770	12 400	21 900	44 600
700	320	669	1260	2590	3880	7460	11 900	21 000	42 900
750	308	644	1210	2490	3730	7190	11 500	20 300	41 300
800	298	622	1170	2410	3610	6940	11 100	19 600	39 900
850	288	602	1130	2330	3490	6720	10 700	18 900	38 600
900	279	584	1100	2260	3380	6520	10 400	18 400	37 400
950	271	567	1070	2190	3290	6330	10 100	17 800	36 400
1000	264	551	1040	2130	3200	6150	9810	17 300	35 400
1100	250	524	987	2030	3030	5840	9320	16 500	33 600
1200	239	500	941	1930	2900	5580	8890	15 700	32 000
1300	229	478	901	1850	2770	5340	8510	15 000	30 700
1400	220	460	866	1780	2660	5130	8180	14 500	29 500
1500	212	443	834	1710	2570	4940	7880	13 900	28 400
1600	205	428	806	1650	2480	4770	7610	13 400	27 400
1700	198	414	780	1600	2400	4620	7360	13 000	26 500
1800	192	401	756	1550	2330	4480	7140	12 600	25 700
1900	186	390	734	1510	2260	4350	6930	12 300	25 000
2000	181	379	714	1470	2200	4230	6740	11 900	24 300

NOTE 1 For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

NOTE 2 Table entries are rounded to 3 significant digits.

Table A.7 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.3.1(a)]

						GAS: UNDILUTED PROPANE			
						INLET PRESSURE: 10.0psi			
						PRESSURE DROP: 1.0psi			
						SPECIFIC GRAVITY: 1.50			

INTENDED USE: PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR									
	PIPE SIZE (inch)								
NOMINAL INSIDE:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	3320	6950	13 100	26 900	40 300	77 600	124 000	219 000	446 000
20	2280	4780	9000	18 500	27 700	53 300	85 000	150 000	306 000
30	1830	3840	7220	14 800	22 200	42 800	68 200	121 000	246 000
40	1570	3280	6180	12 700	19 000	36 600	58 400	103 000	211 000
50	1390	2910	5480	11 300	16 900	32 500	51 700	91 500	187 000
60	1260	2640	4970	10 200	15 300	29 400	46 900	82 900	169 000
70	1160	2430	4570	9380	14 100	27 100	43 100	76 300	156 000
80	1080	2260	4250	8730	13 100	25 200	40 100	70 900	145 000
90	1010	2120	3990	8190	12 300	23 600	37 700	66 600	136 000
100	956	2000	3770	7730	11 600	22 300	35 600	62 900	128 000
125	848	1770	3340	6850	10 300	19 800	31 500	55 700	114 000
150	768	1610	3020	6210	9300	17 900	28 600	50 500	103 000
175	706	1480	2780	5710	8560	16 500	26 300	46 500	94 700
200	657	1370	2590	5320	7960	15 300	24 400	43 200	88 100
250	582	1220	2290	4710	7060	13 600	21 700	38 300	78 100
300	528	1100	2080	4270	6400	12 300	19 600	34 700	70 800
350	486	1020	1910	3930	5880	11 300	18 100	31 900	65 100
400	452	945	1780	3650	5470	10 500	16 800	29 700	60 600
450	424	886	1670	3430	5140	9890	15 800	27 900	56 800
500	400	837	1580	3240	4850	9340	14 900	26 300	53 700
550	380	795	1500	3070	4610	8870	14 100	25 000	51 000
600	363	759	1430	2930	4400	8460	13 500	23 900	48 600
650	347	726	1370	2810	4210	8110	12 900	22 800	46 600
700	334	698	1310	2700	4040	7790	12 400	21 900	44 800
750	321	672	1270	2600	3900	7500	12 000	21 100	43 100
800	310	649	1220	2510	3760	7240	11 500	20 400	41 600
850	300	628	1180	2430	3640	7010	11 200	19 800	40 300
900	291	609	1150	2360	3530	6800	10 800	19 200	39 100
950	283	592	1110	2290	3430	6600	10 500	18 600	37 900
1000	275	575	1080	2230	3330	6420	10 200	18 100	36 900
1100	261	546	1030	2110	3170	6100	9720	17 200	35 000
1200	249	521	982	2020	3020	5820	9270	16 400	33 400
1300	239	499	940	1930	2890	5570	8880	15 700	32 000
1400	229	480	903	1850	2780	5350	8530	15 100	30 800
1500	221	462	870	1790	2680	5160	8220	14 500	29 600
1600	213	446	840	1730	2590	4980	7940	14 000	28 600
1700	206	432	813	1670	2500	4820	7680	13 600	27 700
1800	200	419	789	1620	2430	4670	7450	13 200	26 900
1900	194	407	766	1570	2360	4540	7230	12 800	26 100
2000	189	395	745	1530	2290	4410	7030	12 400	25 400

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

*Table entries are rounded to 3 significant digits.

Table A.8 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.3.1(b)]

	GAS:	UNDILUTED PROPANE
	INLET PRESSURE:	10.0psi
	PRESSURE DROP:	3.0 psi
	SPECIFIC GRAVITY:	1.50
INTENDED USE: PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR		
	PIPE SIZE (inch)	

NOMINAL SIZE:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	5890	12 300	23 200	47 600	71 300	137 000	219 000	387 000	789 000
20	4050	8460	15 900	32 700	49 000	94 400	150 000	266 000	543 000
30	3250	6790	12 800	26 300	39 400	75 800	121 000	214 000	436 000
40	2780	5810	11 000	22 500	33 700	64 900	103 000	183 000	373 000
50	2460	5150	9710	19 900	29 900	57 500	91 600	162 000	330 000
60	2230	4670	8790	18 100	27 100	52 100	83 000	147 000	299 000
70	2050	4300	8090	16 600	24 900	47 900	76 400	135 000	275 000
80	1910	4000	7530	15 500	23 200	44 600	71 100	126 000	256 000
90	1790	3750	7060	14 500	21 700	41 800	66 700	118 000	240 000
100	1690	3540	6670	13 700	20 500	39 500	63 000	111 000	227 000
125	1500	3140	5910	12 100	18 200	35 000	55 800	98 700	201 000
150	1360	2840	5360	11 000	16 500	31 700	50 600	89 400	182 000
175	1250	2620	4930	10 100	15 200	29 200	46 500	82 300	167 800
200	1160	2430	4580	9410	14 100	27 200	43 300	76 500	156 100
250	1030	2160	4060	8340	12 500	24 100	38 400	67 800	138 400
300	935	1950	3680	7560	11 300	21 800	34 800	61 500	125 400
350	860	1800	3390	6950	10 400	20 100	32 000	56 500	115 300
400	800	1670	3150	6470	9690	18 700	29 800	52 600	107 300
450	751	1570	2960	6070	9090	17 500	27 900	49 400	100 700
500	709	1480	2790	5730	8590	16 500	26 400	46 600	95 100
550	673	1410	2650	5450	8160	15 700	25 000	44 300	90 300
600	642	1340	2530	5200	7780	15 000	23 900	42 200	86 200
650	615	1290	2420	4980	7450	14 400	22 900	40 500	82 500
700	591	1240	2330	4780	7160	13 800	22 000	38 900	79 300
750	569	1190	2240	4600	6900	13 300	21 200	37 400	76 400
800	550	1150	2170	4450	6660	12 800	20 500	36 200	73 700
850	532	1110	2100	4300	6450	12 400	19 800	35 000	71 400
900	516	1080	2030	4170	6250	12 000	19 200	33 900	69 200
950	501	1050	1970	4050	6070	11 700	18 600	32 900	67 200
1000	487	1020	1920	3940	5900	11 400	18 100	32 000	65 400
1100	463	968	1820	3740	5610	10 800	17 200	30 400	62 100
1200	442	923	1740	3570	5350	10 300	16 400	29 000	59 200
1300	423	884	1670	3420	5120	9870	15 700	27 800	56 700
1400	406	849	1600	3280	4920	9480	15 100	26 700	54 500
1500	391	818	1540	3160	4740	9130	14 600	25 700	52 500
1600	378	790	1490	3060	4580	8820	14 100	24 800	50 700
1700	366	765	1440	2960	4430	8530	13 600	24 000	49 000
1800	355	741	1400	2870	4300	8270	13 200	23 300	47 600
1900	344	720	1360	2780	4170	8040	12 800	22 600	46 200
2000	335	700	1320	2710	4060	7820	12 500	22 000	44 900

For SI units: 1 inch=25.4mm, 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 pound-force per square inch=6.8947kPa

*Table entries are rounded to 3 significant digits.

Table A.9 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.3.1(c)]

GAS: UNDILUTED PROPANE									
INLET PRESSURE: 2.0 psi									
PRESSURE DROP: 1.0psi									
SPECIFIC GRAVITY: 1.50									
INTENDED USE: PIPE SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR									
	PIPE SIZE (inch)								
NOMINAL:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026

LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	2680	5590	10 500	21 600	32 400	62 400	99 500	176 000	359 000
20	1840	3850	7240	14 900	22 300	42 900	68 400	121 000	247 000
30	1480	3090	5820	11 900	17 900	34 500	54 900	97 100	198 000
40	1260	2640	4980	10 200	15 300	29 500	47 000	83 100	170 000
50	1120	2340	4410	9060	13 600	26 100	41 700	73 700	150 000
60	1010	2120	4000	8210	12 300	23 700	37 700	66 700	136 000
70	934	1950	3680	7550	11 300	21 800	34 700	61 400	125 000
80	869	1820	3420	7020	10 500	20 300	32 300	57 100	116 000
90	815	1700	3210	6590	9880	19 000	30 300	53 600	109 000
100	770	1610	3030	6230	9330	18 000	28 600	50 600	103 000
125	682	1430	2690	5520	8270	15 900	25 400	44 900	91 500
150	618	1290	2440	5000	7490	14 400	23 000	40 700	82 900
175	569	1190	2240	4600	6890	13 300	21 200	37 400	76 300
200	529	1110	2080	4280	6410	12 300	19 700	34 800	71 000
250	469	981	1850	3790	5680	10 900	17 400	30 800	62 900
300	425	889	1670	3440	5150	9920	15 800	27 900	57 000
350	391	817	1540	3160	4740	9120	14 500	25 700	52 400
400	364	760	1430	2940	4410	8490	13 500	23 900	48 800
450	341	714	1340	2760	4130	7960	12 700	22 400	45 800
500	322	674	1270	2610	3910	7520	12 000	21 200	43 200
550	306	640	1210	2480	3710	7140	11 400	20 100	41 100
600	292	611	1150	2360	3540	6820	10 900	19 200	39 200
650	280	585	1100	2260	3390	6530	10 400	18 400	37 500
700	269	562	1060	2170	3260	6270	9990	17 700	36 000
750	259	541	1020	2090	3140	6040	9630	17 000	34 700
800	250	523	985	2020	3030	5830	9300	16 400	33 500
850	242	506	953	1960	2930	5640	9000	15 900	32 400
900	235	490	924	1900	2840	5470	8720	15 400	31 500
950	228	476	897	1840	2760	5310	8470	15 000	30 500
1000	222	463	873	1790	2680	5170	8240	14 600	29 700
1100	210	440	829	1700	2550	4910	7830	13 800	28 200
1200	201	420	791	1620	2430	4680	7470	13 200	26 900
1300	192	402	757	1550	2330	4490	7150	12 600	25 800
1400	185	386	727	1490	2240	4310	6870	12 100	24 800
1500	178	372	701	1440	2160	4150	6620	11 700	23 900
1600	172	359	677	1390	2080	4010	6390	11 300	23 000
1700	166	348	655	1340	2010	3880	6180	10 900	22 300
1800	161	337	635	1300	1950	3760	6000	10 600	21 600
1900	157	327	617	1270	1900	3650	5820	10 300	21 000
2000	152	318	600	1230	1840	3550	5660	10 000	20 400

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

*Table entries are rounded to 3 significant digits.

Table A.10 — Schedule 40 metallic pipe [NFPA 54: TABLE 6.3.1(d)]

						GAS:		UNDILUTED PROPANE	
						INLET PRESSURE:		11.0 in.w.c.	
						PRESSURE DROP:		0.5 in.w.c.	
						SPECIFIC GRAVITY:		1.50	
INTENDED USE: PIPE SIZING BETWEEN SINGLE-OR SECOND-STAGE (LOW-PRESSURE) REGULATOR AND APPLIANCE									
	PIPE SIZE (inch)								
NOMINAL INSI DE:	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
ACTUAL:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026

LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR								
10	291	608	1150	2350	3520	6790	10 800	19 100	39 000
20	200	418	787	1620	2420	4660	7430	13 100	26 800
30	160	336	632	1300	1940	3750	5970	10 600	21 500
40	137	287	541	1110	1660	3210	5110	9030	18 400
50	122	255	480	985	1480	2840	4530	8000	16 300
60	110	231	434	892	1340	2570	4100	7250	14 800
70	101	212	400	821	1230	2370	3770	6670	13 600
80	94	197	372	763	1140	2200	3510	6210	12 700
90	89	185	349	716	1070	2070	3290	5820	11 900
100	84	175	330	677	1010	1950	3110	5500	11 200
125	74	155	292	600	899	1730	2760	4880	9950
150	67	140	265	543	814	1570	2500	4420	9010
175	62	129	243	500	749	1440	2300	4060	8290
200	58	120	227	465	697	1340	2140	3780	7710
250	51	107	201	412	618	1190	1900	3350	6840
300	46	97	182	373	560	1080	1720	3040	6190
350	42	89	167	344	515	991	1580	2790	5700
400	40	83	156	320	479	922	1470	2600	5300
450	37	78	146	300	449	865	1380	2440	4970
500	35	73	138	283	424	817	1300	2300	4700
550	33	70	131	269	403	776	1240	2190	4460
600	32	66	125	257	385	741	1180	2090	4260
650	30	64	120	246	368	709	1130	2000	4080
700	29	61	115	236	354	681	1090	1920	3920
750	28	59	111	227	341	656	1050	1850	3770
800	27	57	107	220	329	634	1010	1790	3640
850	26	55	104	213	319	613	978	1730	3530
900	25	53	100	206	309	595	948	1680	3420
950	25	52	97	200	300	578	921	1630	3320
1000	24	50	95	195	292	562	895	1580	3230
1100	23	48	90	185	277	534	850	1500	3070
1200	22	46	86	176	264	509	811	1430	2930
1300	21	44	82	169	253	487	777	1370	2800
1400	20	42	79	162	243	468	746	1320	2690
1500	19	40	76	156	234	451	719	1270	2590
1600	19	39	74	151	226	436	694	1230	2500
1700	18	38	71	146	219	422	672	1190	2420
1800	18	37	69	142	212	409	652	1150	2350
1900	17	36	67	138	206	397	633	1120	2280
2000	17	35	65	134	200	386	615	1090	2220

For SI units: 1 inch = 25 mm, 1 foot=304.8 mm, 1000 British thermal units per hour=0.293kW, 1 inch water column=0.249kPa

*Table entries are rounded to 3 significant digits.

Annex B (normative)

Semi-rigid copper tubing

Table B.1 — Semi-rigid copper tubing⁷ [NFPA 54: TABLE 6.2.1(h)]

							GAS: NATURAL			
							INLET PRESSURE: LESS THAN 2 psi			
							PRESSURE DROP: 0.3 in w.c.			
							SPECIFIC GRAVITY: 0.60			
	TUBE SIZE (inch)									
NOMINAL:	K & L:	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR:	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ³		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10	20	42	85	148	210	448	806	1270	2650	
20	14	29	58	102	144	308	554	873	1820	
30	11	23	47	82	116	247	445	701	1460	
40	10	20	40	70	99	211	381	600	1250	
50	NA	17	35	62	88	187	337	532	1110	
60	NA	16	32	56	79	170	306	482	1000	
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	

⁷ [NFPA 54:TABLE 6.2.1(h)]^{1,2}

1000	NA	NA	NA	12	17	37	67	105	219
1100	NA	NA	NA	12	16	35	63	100	208
1200	NA	NA	NA	11	16	34	60	95	199
1300	NA	NA	NA	11	15	32	58	91	190
1400	NA	NA	NA	10	14	31	56	88	183
1500	NA	NA	NA	NA	14	30	54	84	176
1600	NA	NA	NA	NA	13	29	52	82	170
1700	NA	NA	NA	NA	13	28	50	79	164
1800	NA	NA	NA	NA	13	27	49	77	159
1900	NA	NA	NA	NA	12	26	47	74	155
2000	NA	NA	NA	NA	12	25	46	72	151

NOTE 1 For SI units: 1inch=25mm, 1foot=304.8mm, 1cubicfootperhour=0.0283m³/h, 1pound-forcepersquareinch=6.8947kPa, 1inchwatercolumn=0.249kPa

NOTE 2 Tableentriesareroundedto3significantdigits.

NOTE 3 NAmeansaflowoflessthan10ft³/h(0.283m³/h).

NOTE 4 Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

Table B.2 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(i)]

							GAS: NATURAL			
							INLET PRESSURE:		LESSTHAN 2 psi	
							PRESSURE DROP:		0.5 in.w.c.	
							SPECIFIC GRAVITY:		0.60	
		TUBE SIZE (inch)								
NOMINAL:	K &L:	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR:	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	-	-
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ³		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		27	55	111	195	276	590	1060	1680	3490
20		18	38	77	134	190	406	730	1150	2400
30		15	30	61	107	152	326	586	925	1930
40		13	26	53	92	131	279	502	791	1650
50		11	23	47	82	116	247	445	701	1460
60		10	21	42	74	105	224	403	635	1320
70		NA	19	39	68	96	206	371	585	1220
80		NA	18	36	63	90	192	345	544	1130
90		NA	17	34	59	84	180	324	510	1060
100		NA	16	32	56	79	170	306	482	1000
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
1000		NA	NA	NA	16	23	49	88	139	289
1100		NA	NA	NA	15	22	46	84	132	274
1200		NA	NA	NA	15	21	44	80	126	262
1300		NA	NA	NA	14	20	42	76	120	251
1400		NA	NA	NA	13	19	41	73	116	241
1500		NA	NA	NA	13	18	39	71	111	232
1600		NA	NA	NA	13	18	38	68	108	224
1700		NA	NA	NA	12	17	37	66	104	217
1800		NA	NA	NA	12	17	36	64	101	210
1900		NA	NA	NA	11	16	35	62	98	204
2000		NA	NA	NA	11	16	34	60	95	199

NOTE 1 For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

NOTE 2 Table entries are rounded to 3 significant digits.

NOTE 3 NA means a flow of less than 10 ft³/h (0.283 m³/h).

NOTE 4 Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

Table B.3 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(j)]

							GAS: NATURAL			
							INLET PRESSURE: LESS THAN 2 psi			
							PRESSURE DROP: 1.0in.w.c.			
							SPECIFIC GRAVITY: 0.60			
INTENDED USE: TUBE SIZING BETWEEN HOUSELINE REGULATOR AND THE APPLIANCE										
NOMINAL:		TUBE SIZE (inch)								
		K &L:	¼	⅜	½	⅝	¾	1	1¼	1½
ACR:		⅜	½	⅝	¾	7⁄8	1⅛	1⅜	–	–
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ³		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		39	80	162	283	402	859	1550	2440	5080
20		27	55	111	195	276	590	1060	1680	3490
30		21	44	89	156	222	474	853	1350	2800
40		18	38	77	134	190	406	730	1150	2400
50		16	33	68	119	168	359	647	1020	2130
60		15	30	61	107	152	326	586	925	1930
70		13	28	57	99	140	300	539	851	1770
80		13	26	53	92	131	279	502	791	1650
90		12	24	49	86	122	262	471	742	1550
100		11	23	47	82	116	247	445	701	1460
125		NA	20	41	72	103	219	394	622	1290
150		NA	18	37	65	93	198	357	563	1170
175		NA	17	34	60	85	183	329	518	1080
200		NA	16	32	56	79	170	306	482	1000
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
1000		NA	NA	13	23	33	71	128	202	420
1100		NA	NA	13	22	32	68	122	192	399
1200		NA	NA	12	21	30	64	116	183	381
1300		NA	NA	12	20	29	62	111	175	365
1400		NA	NA	11	20	28	59	107	168	350
1500		NA	NA	11	19	27	57	103	162	338
1600		NA	NA	10	18	26	55	99	156	326
1700		NA	NA	10	18	25	53	96	151	315
1800		NA	NA	NA	17	24	52	93	147	306
1900		NA	NA	NA	17	24	50	90	143	297
2000		NA	NA	NA	16	23	49	88	139	289

For Sl units: 1 inch=25mm, 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa, 1 inch water column=0.249kPa

Notes:

¹Table entries are rounded to 3 significant digits.

²NA means a flow of less than 10 ft³/h (0.283m³/h).

³Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

Table B.4 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(k)]

		GAS: NATURAL								
		INLET PRESSURE: LESS THAN 2 psi								
		PRESSURE DROP: 17.0 in.w.c.								
		SPECIFIC GRAVITY: 0.60								
		TUBE SIZE (inch)								
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: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		190	391	796	1390	1970	4220	7590	12 000	24 900
20		130	269	547	956	1360	2900	5220	8230	17 100
30		105	216	439	768	1090	2330	4190	6610	13 800
40		90	185	376	657	932	1990	3590	5650	11 800
50		79	164	333	582	826	1770	3180	5010	10 400
60		72	148	302	528	749	1600	2880	4540	9460
70		66	137	278	486	689	1470	2650	4180	8700
80		62	127	258	452	641	1370	2460	3890	8090
90		58	119	243	424	601	1280	2310	3650	7590
100		55	113	229	400	568	1210	2180	3440	7170
125		48	100	203	355	503	1080	1940	3050	6360
150		44	90	184	321	456	974	1750	2770	5760
175		40	83	169	296	420	896	1610	2540	5300
200		38	77	157	275	390	834	1500	2370	4930
250		33	69	140	244	346	739	1330	2100	4370
300		30	62	126	221	313	670	1210	1900	3960
350		28	57	116	203	288	616	1110	1750	3640
400		26	53	108	189	268	573	1030	1630	3390
450		24	50	102	177	252	538	968	1530	3180
500		23	47	96	168	238	508	914	1440	3000
550		22	45	91	159	226	482	868	1370	2850
600		21	43	87	152	215	460	829	1310	2720
650		20	41	83	145	206	441	793	1250	2610
700		19	39	80	140	198	423	762	1200	2500
750		18	38	77	135	191	408	734	1160	2410
800		18	37	74	130	184	394	709	1120	2330
850		17	35	72	126	178	381	686	1080	2250
900		17	34	70	122	173	370	665	1050	2180
950		16	33	68	118	168	359	646	1020	2120
1000		16	32	66	115	163	349	628	991	2060
1100		15	31	63	109	155	332	597	941	1960
1200		14	29	60	104	148	316	569	898	1870
1300		14	28	57	100	142	303	545	860	1790
1400		13	27	55	96	136	291	524	826	1720
1500		13	26	53	93	131	280	505	796	1660
1600		12	25	51	89	127	271	487	768	1600
1700		12	24	49	86	123	262	472	744	1550
1800		11	24	48	84	119	254	457	721	1500
1900		11	23	47	81	115	247	444	700	1460
2000		11	22	45	79	112	240	432	681	1420

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

Table B.5 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(I)]

							GAS: NATURAL			
							INLET PRESSURE: 2.0 psi			
							PRESSURE DROP: 1.0psi			
							SPECIFIC GRAVITY: 0.60			
		TUBE SIZE (inch)								
NOMINAL:	K & L:	¼	⅜	½	¾	1	1¼	1½	2	
	ACR:	⅜	½	¾	1	1¼	1½	2		
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		245	506	1030	1800	2550	5450	9820	15 500	32 200
20		169	348	708	1240	1760	3750	6750	10 600	22 200
30		135	279	568	993	1410	3010	5420	8550	17 800
40		116	239	486	850	1210	2580	4640	7310	15 200
50		103	212	431	754	1070	2280	4110	6480	13 500
60		93	192	391	683	969	2070	3730	5870	12 200
70		86	177	359	628	891	1900	3430	5400	11 300
80		80	164	334	584	829	1770	3190	5030	10 500
90		75	154	314	548	778	1660	2990	4720	9820
100		71	146	296	518	735	1570	2830	4450	9280
125		63	129	263	459	651	1390	2500	3950	8220
150		57	117	238	416	590	1260	2270	3580	7450
175		52	108	219	383	543	1160	2090	3290	6850
200		49	100	204	356	505	1080	1940	3060	6380
250		43	89	181	315	448	956	1720	2710	5650
300		39	80	164	286	406	866	1560	2460	5120
350		36	74	150	263	373	797	1430	2260	4710
400		33	69	140	245	347	741	1330	2100	4380
450		31	65	131	230	326	696	1250	1970	4110
500		30	61	124	217	308	657	1180	1870	3880
550		28	58	118	206	292	624	1120	1770	3690
600		27	55	112	196	279	595	1070	1690	3520
650		26	53	108	188	267	570	1030	1620	3370
700		25	51	103	181	256	548	986	1550	3240
750		24	49	100	174	247	528	950	1500	3120
800		23	47	96	168	239	510	917	1450	3010
850		22	46	93	163	231	493	888	1400	2920
900		22	44	90	158	224	478	861	1360	2830
950		21	43	88	153	217	464	836	1320	2740
1000		20	42	85	149	211	452	813	1280	2670
1100		19	40	81	142	201	429	772	1220	2540
1200		18	38	77	135	192	409	737	1160	2420
1300		18	36	74	129	183	392	705	1110	2320
1400		17	35	71	124	176	376	678	1070	2230
1500		16	34	68	120	170	363	653	1030	2140
1600		16	33	66	116	164	350	630	994	2070
1700		15	31	64	112	159	339	610	962	2000
1800		15	30	62	108	154	329	592	933	1940
1900		14	30	60	105	149	319	575	906	1890
2000		14	29	59	102	145	310	559	881	1830

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

Table B.6 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(m)]

							GAS: NATURAL			
							INLET PRESSURE: 2.0 psi			
							PRESSURE DROP: 1.5psi			
							SPECIFIC GRAVITY: 0.60			
INTENDED USE: PIPE SIZING BETWEEN POINT OF DELIVERY AND THE HOUSE LINE REGULATOR. TOTAL LOADS SUPPLIED BY A SINGLE HOUSE LINE REGULATOR NOT EXCEEDING 150 CUBIC FEET PER HOUR. ²										
		TUBE SIZE (inch)								
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: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		303	625	1270	2220	3150	6740	12 100	19 100	39 800
20		208	430	874	1530	2170	4630	8330	13 100	27 400
30		167	345	702	1230	1740	3720	6690	10 600	22 000
40		143	295	601	1050	1490	3180	5730	9030	18 800
50		127	262	532	931	1320	2820	5080	8000	16 700
60		115	237	482	843	1200	2560	4600	7250	15 100
70		106	218	444	776	1100	2350	4230	6670	13 900
80		98	203	413	722	1020	2190	3940	6210	12 900
90		92	190	387	677	961	2050	3690	5820	12 100
100		87	180	366	640	907	1940	3490	5500	11 500
125		77	159	324	567	804	1720	3090	4880	10 200
150		70	144	294	514	729	1560	2800	4420	9200
175		64	133	270	472	670	1430	2580	4060	8460
200		60	124	252	440	624	1330	2400	3780	7870
250		53	110	223	390	553	1180	2130	3350	6980
300		48	99	202	353	501	1070	1930	3040	6320
350		44	91	186	325	461	984	1770	2790	5820
400		41	85	173	302	429	916	1650	2600	5410
450		39	80	162	283	402	859	1550	2440	5080
500		36	75	153	268	380	811	1460	2300	4800
550		35	72	146	254	361	771	1390	2190	4560
600		33	68	139	243	344	735	1320	2090	4350
650		32	65	133	232	330	704	1270	2000	4160
700		30	63	128	223	317	676	1220	1920	4000
750		29	60	123	215	305	652	1170	1850	3850
800		28	58	119	208	295	629	1130	1790	3720
850		27	57	115	201	285	609	1100	1730	3600
900		27	55	111	195	276	590	1060	1680	3490
950		26	53	108	189	268	573	1030	1630	3390
1000		25	52	105	184	261	558	1000	1580	3300
1100		24	49	100	175	248	530	954	1500	3130
1200		23	47	95	167	237	505	910	1430	2990
1300		22	45	91	160	227	484	871	1370	2860
1400		21	43	88	153	218	465	837	1320	2750
1500		20	42	85	148	210	448	806	1270	2650
1600		19	40	82	143	202	432	779	1230	2560
1700		19	39	79	138	196	419	753	1190	2470
1800		18	38	77	134	190	406	731	1150	2400
1900		18	37	74	130	184	394	709	1120	2330
2000		17	36	72	126	179	383	690	1090	2270

For Sl units: 1 inch=25mm, 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa

Notes:

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

²Where this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 inch water column (0.249 kPa).

³Table entries are rounded to 3 significant digits.

Table B.7 — Semi-rigid copper tubing [NFPA 54: TABLE 6.2.1(n)]

							GAS: NATURAL			
							INLET PRESSURE: 5.0 psi			
							PRESSURE DROP: 3.5 psi			
							SPECIFIC GRAVITY: 0.60			
		TUBE SIZE (inch)								
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: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR								
10		511	1050	2140	3750	5320	11 400	20 400	32 200	67 100
20		351	724	1470	2580	3650	7800	14 000	22 200	46 100
30		282	582	1180	2070	2930	6270	11 300	17 800	37 000
40		241	498	1010	1770	2510	5360	9660	15 200	31 700
50		214	441	898	1570	2230	4750	8560	13 500	28 100
60		194	400	813	1420	2020	4310	7750	12 200	25 500
70		178	368	748	1310	1860	3960	7130	11 200	23 400
80		166	342	696	1220	1730	3690	6640	10 500	21 800
90		156	321	653	1140	1620	3460	6230	9820	20 400
100		147	303	617	1080	1530	3270	5880	9270	19 300
125		130	269	547	955	1360	2900	5210	8220	17 100
150		118	243	495	866	1230	2620	4720	7450	15 500
175		109	224	456	796	1130	2410	4350	6850	14 300
200		101	208	424	741	1050	2250	4040	6370	13 300
250		90	185	376	657	932	1990	3580	5650	11 800
300		81	167	340	595	844	1800	3250	5120	10 700
350		75	154	313	547	777	1660	2990	4710	9810
400		69	143	291	509	722	1540	2780	4380	9120
450		65	134	273	478	678	1450	2610	4110	8560
500		62	127	258	451	640	1370	2460	3880	8090
550		58	121	245	429	608	1300	2340	3690	7680
600		56	115	234	409	580	1240	2230	3520	7330
650		53	110	224	392	556	1190	2140	3370	7020
700		51	106	215	376	534	1140	2050	3240	6740
750		49	102	207	362	514	1100	1980	3120	6490
800		48	98	200	350	497	1060	1910	3010	6270
850		46	95	194	339	481	1030	1850	2910	6070
900		45	92	188	328	466	1000	1790	2820	5880
950		43	90	182	319	452	967	1740	2740	5710
1000		42	87	177	310	440	940	1690	2670	5560
1100		40	83	169	295	418	893	1610	2530	5280
1200		38	79	161	281	399	852	1530	2420	5040
1300		37	76	154	269	382	816	1470	2320	4820
1400		35	73	148	259	367	784	1410	2220	4630
1500		34	70	143	249	353	755	1360	2140	4460
1600		33	68	138	241	341	729	1310	2070	4310
1700		32	65	133	233	330	705	1270	2000	4170
1800		31	63	129	226	320	684	1230	1940	4040
1900		30	62	125	219	311	664	1200	1890	3930
2000		29	60	122	213	302	646	1160	1830	3820

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

Corrugated stainless steel tubing

									GAS: NATURAL					
									INLET PRESSURE: LESS THAN 2 psi					
									PRESSURE DROP: 0.5 in. w.c.					
									SPECIFIC GRAVITY: 0.60					
	TUBE SIZE (EHD) ³													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
5	46	63	115	134	225	270	471	546	895	1037	1790	2070	3660	4140
10	32	44	82	95	161	192	330	383	639	746	1260	1470	2600	2930
15	25	35	66	77	132	157	267	310	524	615	1030	1200	2140	2400
20	22	31	58	67	116	137	231	269	456	536	888	1050	1850	2080
25	19	27	52	60	104	122	206	240	409	482	793	936	1660	1860
30	18	25	47	55	96	112	188	218	374	442	723	856	1520	1700
40	15	21	41	47	83	97	162	188	325	386	625	742	1320	1470
50	13	19	37	42	75	87	144	168	292	347	559	665	1180	1320
60	12	17	34	38	68	80	131	153	267	318	509	608	1080	1200
70	11	16	31	36	63	74	121	141	248	295	471	563	1000	1110
80	10	15	29	33	60	69	113	132	232	277	440	527	940	1040
90	10	14	28	32	57	65	107	125	219	262	415	498	887	983
100	9	13	26	30	54	62	101	118	208	249	393	472	843	933
150	7	10	20	23	42	48	78	91	171	205	320	387	691	762
200	6	9	18	21	38	44	71	82	148	179	277	336	600	661
250	5	8	16	19	34	39	63	74	133	161	247	301	538	591
300	5	7	15	17	32	36	57	67	95	148	226	275	492	540

Notes:

²Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with large numbers of bends, fittings, or both 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, bends, or both.

³EHD=EquivalentHydraulicDiameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.2 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.2.1(p)]

									GAS: NATURAL					
									INLET PRESSURE: LESSTHAN 2 psi					
									PRESSURE DROP: 3.0 in.w.c.					
									SPECIFIC GRAVITY: 0.60					
INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 INCH WATER COLUMN GREATER														
	TUBE SIZE (EHD) ³													
FLOWDESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
5	120	160	277	327	529	649	1180	1370	2140	2423	4430	5010	8800	10 100
10	83	112	197	231	380	462	828	958	1530	1740	3200	3560	6270	7160
15	67	90	161	189	313	379	673	778	1250	1433	2540	2910	5140	5850
20	57	78	140	164	273	329	580	672	1090	1249	2200	2530	4460	5070
25	51	69	125	147	245	295	518	599	978	1123	1960	2270	4000	4540
30	46	63	115	134	225	270	471	546	895	1029	1790	2070	3660	4140
40	39	54	100	116	196	234	407	471	778	897	1550	1800	3180	3590
50	35	48	89	104	176	210	363	421	698	806	1380	1610	2850	3210
60	32	44	82	95	161	192	330	383	639	739	1260	1470	2600	2930
70	29	41	76	88	150	178	306	355	593	686	1170	1360	2420	2720
80	27	38	71	82	141	167	285	331	555	644	1090	1280	2260	2540
90	26	36	67	77	133	157	268	311	524	609	1030	1200	2140	2400
100	24	34	63	73	126	149	254	295	498	579	974	1140	2030	2280
150	19	27	52	60	104	122	206	240	409	477	793	936	1660	1860
200	17	23	45	52	91	106	178	207	355	415	686	812	1440	1610
250	15	21	40	46	82	95	159	184	319	373	613	728	1290	1440
300	13	19	37	42	75	87	144	168	234	342	559	665	1180	1320

For SI units: 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa, 1 inch water column=0.249kPa

Notes:

¹Table entries are rounded to 3 significant digits.

²Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with large numbers of bends, fittings, or both 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, bends, or both.

³EHD=Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.3 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.2.1(q)]

								GAS: NATURAL						
								INLETPRESSURE: LESSTHAN 2 psi						
								PRESSUREDROP: 6.0 in.w.c.						
								SPECIFICGRAVITY: 0.60						
INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 INCHWATERCOLUMN OR GREATER														
	TUBE SIZE (EHD) ³													
FLOWDESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR													
5	173	229	389	461	737	911	1690	1950	3000	3375	6280	7050	12 400	14 260
10	120	160	277	327	529	649	1180	1370	2140	2423	4430	5010	8800	10 100
15	96	130	227	267	436	532	960	1110	1760	1996	3610	4100	7210	8260
20	83	112	197	231	380	462	828	958	1530	1740	3120	3560	6270	7160
25	74	99	176	207	342	414	739	855	1370	1564	2790	3190	5620	6400
30	67	90	161	189	313	379	673	778	1250	1433	2540	2910	5140	5850
40	57	78	140	164	273	329	580	672	1090	1249	2200	2530	4460	5070
50	51	69	125	147	245	295	518	599	978	1123	1960	2270	4000	4540
60	46	63	115	134	225	270	471	546	895	1029	1790	2070	3660	4140
70	42	58	106	124	209	250	435	505	830	956	1660	1920	3390	3840
80	39	54	100	116	196	234	407	471	778	897	1550	1800	3180	3590
90	37	51	94	109	185	221	383	444	735	848	1460	1700	3000	3390
100	35	48	89	104	176	210	363	421	698	806	1380	1610	2850	3210
150	28	39	73	85	145	172	294	342	573	664	1130	1320	2340	2630
200	24	34	63	73	126	149	254	295	498	579	974	1140	2030	2280
250	21	30	57	66	114	134	226	263	447	520	870	1020	1820	2040
300	19	27	52	60	104	122	206	240	409	477	793	936	1660	1860

For SI units: 1 foot=304.8 mm, 1 cubic foot per hour=0.0283 m³/h, 1 pound-force per square inch=6.8947 kPa, 1 inch water column=0.249 kPa

Notes:

¹Table entries are rounded to 3 significant digits.

²Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both 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, bends, or both.

³EHD=Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.4 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.2.1(r)]

									GAS: NATURAL					
									INLET PRESSURE: 2.0 psi					
									PRESSURE DROP: 1.0psi					
									SPECIFIC GRAVITY: 0.60					
	TUBE SIZE (EHD) ⁵													
FLOWDESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITYINCUBICFEETOFGASPER HOUR													
10	270	353	587	700	1100	1370	2590	2990	4510	5037	9600	10 700	18 600	21 600
25	166	220	374	444	709	876	1620	1870	2890	3258	6040	6780	11 900	13 700
30	151	200	342	405	650	801	1480	1700	2640	2987	5510	6200	10 900	12 500
40	129	172	297	351	567	696	1270	1470	2300	2605	4760	5380	9440	10 900
50	115	154	266	314	510	624	1140	1310	2060	2343	4260	4820	8470	9720
75	93	124	218	257	420	512	922	1070	1690	1932	3470	3950	6940	7940
80	89	120	211	249	407	496	892	1030	1640	1874	3360	3820	6730	7690
100	79	107	189	222	366	445	795	920	1470	1685	3000	3420	6030	6880
150	64	87	155	182	302	364	646	748	1210	1389	2440	2800	4940	5620
200	55	75	135	157	263	317	557	645	1050	1212	2110	2430	4290	4870
250	49	67	121	141	236	284	497	576	941	1090	1890	2180	3850	4360
300	44	61	110	129	217	260	453	525	862	999	1720	1990	3520	3980
400	38	52	96	111	189	225	390	453	749	871	1490	1730	3060	3450
500	34	46	86	100	170	202	348	404	552	783	1330	1550	2740	3090

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa

Notes:

¹Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.75 psi (5.17 kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

²CAUTION: Capacities shown in table are capable of exceeding maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

³Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with large numbers of bends, fittings, or both 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, bends, or both.

⁴Table entries are rounded to 3 significant digits.

⁵EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.5 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.2.1(s)]

										GAS:		NATURAL			
										INLETPRESSURE:		5.0 psi			
										PRESSUREDROP:		3.5 psi			
										SPECIFICGRAVITY:		0.60			
TUBE SIZE (EHD) ⁵															
FLOWDESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62	
LENGTH (feet)		CAPACITY IN CUBIC FEET OF GAS PER HOUR													
10	523	674	1080	1300	2000	2530	4920	5660	8300	9140	18 100	19 800	34 400	40 400	
25	322	420	691	827	1290	1620	3080	3540	5310	5911	11 400	12 600	22 000	25 600	
30	292	382	632	755	1180	1480	2800	3230	4860	5420	10 400	11 500	20 100	23 400	
40	251	329	549	654	1030	1280	2420	2790	4230	4727	8970	10 000	17 400	20 200	
50	223	293	492	586	926	1150	2160	2490	3790	4251	8020	8930	15 600	18 100	
75	180	238	403	479	763	944	1750	2020	3110	3506	6530	7320	12 800	14 800	
80	174	230	391	463	740	915	1690	1960	3020	3400	6320	7090	12 400	14 300	
100	154	205	350	415	665	820	1510	1740	2710	3057	5650	6350	11 100	12 800	
150	124	166	287	339	548	672	1230	1420	2220	2521	4600	5200	9130	10 500	
200	107	143	249	294	478	584	1060	1220	1930	2199	3980	4510	7930	9090	
250	95	128	223	263	430	524	945	1090	1730	1977	3550	4040	7110	8140	
300	86	116	204	240	394	479	860	995	1590	1813	3240	3690	6500	7430	

400	74	100	177	208	343	416	742	858	1380	1581	2800	3210	5650	6440
500	66	89	159	186	309	373	662	766	1040	1422	2500	2870	5060	5760

For SI units: 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa

Notes:

¹Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 1 psi (7kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across regulator are capable of varying with the flow rate.

²CAUTION: Capacities shown in table are capable of exceeding the maximum capacity of selected regulator. Consult tubing manufacturer for guidance.

³Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3n$, where L is additional length (feet) of tubing and n is the number of additional fittings, bends, or both.

⁴Table entries are rounded to 3 significant digits.

⁵EHD=Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.6 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.3.1(h)]

														GAS: UNDILUTED PROPANE
														INLET PRESSURE: 11.0 in w.c.
														PRESSURE DROP: 0.5 in w.c.
														SPECIFIC GRAVITY: 1.50
INTENDED USE: CSST SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE SHUTOFF VALVE														
FLOW DESIGNATION:	TUBE SIZE (EHD) ³													
	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
5	72	99	181	211	355	426	744	863	1420	1638	2830	3270	5780	6550
10	50	69	129	150	254	303	521	605	971	1179	1990	2320	4110	4640
15	39	55	104	121	208	248	422	490	775	972	1620	1900	3370	3790
20	34	49	91	106	183	216	365	425	661	847	1400	1650	2930	3290
25	30	42	82	94	164	192	325	379	583	762	1250	1480	2630	2940
30	28	39	74	87	151	177	297	344	528	698	1140	1350	2400	2680
40	23	33	64	74	131	153	256	297	449	610	988	1170	2090	2330
50	20	30	58	66	118	137	227	265	397	548	884	1050	1870	2080
60	19	26	53	60	107	126	207	241	359	502	805	961	1710	1900
70	17	25	49	57	99	117	191	222	330	466	745	890	1590	1760
80	15	23	45	52	94	109	178	208	307	438	696	833	1490	1650
90	15	22	44	50	90	102	169	197	286	414	656	787	1400	1550
100	14	20	41	47	85	98	159	186	270	393	621	746	1330	1480
150	11	15	31	36	66	75	123	143	217	324	506	611	1090	1210
200	9	14	28	33	60	69	112	129	183	283	438	531	948	1050
250	8	12	25	30	53	61	99	117	163	254	390	476	850	934
300	8	11	23	26	50	57	90	107	147	234	357	434	777	854

For SI units: 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 inch water column=0.249kPa

Notes:

¹Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both 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, bends, or both.

²Table entries are rounded to 3 significant digits.

³EHD=Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.7 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.3.1(i)]

														GAS: UNDILUTED PROPANE
														INLET PRESSURE: 2.0 psi
														PRESSURE DROP: 1.0 psi

									SPECIFIC GRAVITY: 1.50					
INTENDED USE: CSST SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR														
	TUBE SIZE (EHD) ⁵													
FLOW/DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
10	426	558	927	1110	1740	2170	4100	4720	7130	7958	15 200	16 800	29 400	34 200
25	262	347	591	701	1120	1380	2560	2950	4560	5147	9550	10 700	18 800	21 700
30	238	316	540	640	1030	1270	2330	2690	4180	4719	8710	9790	17 200	19 800
40	203	271	469	554	896	1100	2010	2320	3630	4116	7530	8500	14 900	17 200
50	181	243	420	496	806	986	1790	2070	3260	3702	6730	7610	13 400	15 400
75	147	196	344	406	663	809	1460	1690	2680	3053	5480	6230	11 000	12 600
80	140	189	333	393	643	768	1410	1630	2590	2961	5300	6040	10 600	12 200
100	124	169	298	350	578	703	1260	1450	2330	2662	4740	5410	9530	10 900
150	101	137	245	287	477	575	1020	1180	1910	2195	3860	4430	7810	8890
200	86	118	213	248	415	501	880	1020	1660	1915	3340	3840	6780	7710
250	77	105	191	222	373	448	785	910	1490	1722	2980	3440	6080	6900
300	69	96	173	203	343	411	716	829	1360	1578	2720	3150	5560	6300
400	60	82	151	175	298	355	616	716	1160	1376	2350	2730	4830	5460
500	53	72	135	158	268	319	550	638	1030	1237	2100	2450	4330	4880

For SI units: 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 pound-force per square inch=6.8947kPa

Notes:

¹Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4kPa) [based on 13 inch water column (3.2kPa) outlet pressure], DONOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across regulators are capable of varying with flow rate.

²CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

³Table includes losses for four 90 degree (1.57rad) bends and two end fittings. Tubing runs with large numbers of bends, fittings, or both 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, bends, or both.

⁴Table entries are rounded to 3 significant digits.

⁵EHD=Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table C.8 — Corrugated stainless steel tubing (CSST) [NFPA 54: TABLE 6.3.1(j)]

										GAS: UNDILUTED PROPANE				
										INLET PRESSURE:		5.0 psi		
										PRESSURE DROP:		3.5 psi		
										SPECIFIC GRAVITY:		1.50		
	TUBE SIZE (EHD) ⁵													
FLOW DESIGNATION:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR													
10	826	1070	1710	2060	3150	4000	7830	8950	13 100	14441	28 600	31 200	54 400	63 800
25	509	664	1090	1310	2040	2550	4860	5600	8400	9339	18 000	19 900	34 700	40 400
30	461	603	999	1190	1870	2340	4430	5100	7680	8564	16 400	18 200	31 700	36 900
40	396	520	867	1030	1630	2030	3820	4400	6680	7469	14 200	15 800	27 600	32 000
50	352	463	777	926	1460	1820	3410	3930	5990	6717	12 700	14 100	24 700	28 600
75	284	376	637	757	1210	1490	2770	3190	4920	5539	10 300	11 600	20 300	23 400
80	275	363	618	731	1170	1450	2680	3090	4770	5372	9990	11 200	19 600	22 700
100	243	324	553	656	1050	1300	2390	2760	4280	4830	8930	10 000	17 600	20 300
150	196	262	453	535	866	1060	1940	2240	3510	3983	7270	8210	14 400	16 600
200	169	226	393	464	755	923	1680	1930	3050	3474	6290	7130	12 500	14 400
250	150	202	352	415	679	828	1490	1730	2740	3124	5620	6390	11 200	12 900
300	136	183	322	379	622	757	1360	1570	2510	2865	5120	5840	10 300	11 700
400	117	158	279	328	542	657	1170	1360	2180	2498	4430	5070	8920	10 200
500	104	140	251	294	488	589	1050	1210	1950	2247	3960	4540	8000	9110

For SI units: 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 pound-force per square inch=6.8947kPa

Notes:

¹Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4 kPa) [based on 13 inch water column (3.2 kPa) outlet pressure], DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

²CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

³Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with large numbers of bends, fittings, or both 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, bends, or both.

⁴Table entries are rounded to 3 significant digits.

⁵EHD = 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.

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Annex D (normative)

Polyethylene plastic pipe

Table D.1 — Polyethylene plastic pipe⁸ [NFPA 54: TABLE 6.2.1(t)]

					GAS: NATURAL			
					INLET PRESSURE: LESS THAN 2 psi			
					PRESSURE DROP: 0.3 in.w.c.			
					SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)							
NOMINAL OD:	1/2	3/4	1	1 1/4	1 1/2	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR							
10	153	305	551	955	1440	2590	7170	13 900
20	105	210	379	656	991	1780	4920	9520
30	84	169	304	527	796	1430	3950	7640
40	72	144	260	451	681	1220	3380	6540
50	64	128	231	400	604	1080	3000	5800
60	58	116	209	362	547	983	2720	5250
70	53	107	192	333	503	904	2500	4830
80	50	99	179	310	468	841	2330	4500
90	46	93	168	291	439	789	2180	4220
100	44	88	159	275	415	745	2060	3990
125	39	78	141	243	368	661	1830	3530
150	35	71	127	221	333	598	1660	3200
175	32	65	117	203	306	551	1520	2940
200	30	60	109	189	285	512	1420	2740
250	27	54	97	167	253	454	1260	2430
300	24	48	88	152	229	411	1140	2200
350	22	45	81	139	211	378	1050	2020
400	21	42	75	130	196	352	974	1880
450	19	39	70	122	184	330	914	1770
500	18	37	66	115	174	312	863	1670

For SI units: 1 inch=25mm, 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa, 1 inch water column=0.249kPa

*Table entries are rounded to 3 significant digits.

⁸ [NFPA 54: TABLE 6.2.1(t)]

Table D.2 — Polyethylene plastic pipe [NFPA 54: TABLE 6.2.1(u)]

					GAS: NATURAL			
					INLET PRESSURE: LESS THAN 2 psi			
					PRESSURE DROP: 0.5 in.w.c.			
					SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)							
NOMINAL OD:	1/2	3/4	1	1 1/4	1 1/2	2	3	4
DESIGNATION:	SDR 9.3	SDR 11	SDR 11	SDR 10	SDR 11	SDR 11	SDR 11	SDR 11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR							
10	201	403	726	1260	1900	3410	9450	18 260
20	138	277	499	865	1310	2350	6490	12 550
30	111	222	401	695	1050	1880	5210	10 080
40	95	190	343	594	898	1610	4460	8630
50	84	169	304	527	796	1430	3950	7640
60	76	153	276	477	721	1300	3580	6930
70	70	140	254	439	663	1190	3300	6370
80	65	131	236	409	617	1110	3070	5930
90	61	123	221	383	579	1040	2880	5560
100	58	116	209	362	547	983	2720	5250
125	51	103	185	321	485	871	2410	4660
150	46	93	168	291	439	789	2180	4220
175	43	86	154	268	404	726	2010	3880
200	40	80	144	249	376	675	1870	3610
250	35	71	127	221	333	598	1660	3200
300	32	64	115	200	302	542	1500	2900
350	29	59	106	184	278	499	1380	2670
400	27	55	99	171	258	464	1280	2480
450	26	51	93	160	242	435	1200	2330
500	24	48	88	152	229	411	1140	2200

For Sl units: 1 inch=25mm, 1 foot=304.8mm, 1 cubic foot per hour=0.0283m³/h, 1 pound-force per square inch=6.8947kPa, 1 inch water column=0.249kPa

*Table entries are rounded to 3 significant digits.

Table D.3 — Polyethylene plastic pipe [NFPA 54: TABLE 6.2.1(v)]

					GAS: NATURAL			
					INLET PRESSURE: 2.0 psi			
					PRESSURE DROP: 1.0psi			
					SPECIFIC GRAVITY: 0.60			
	PIPE SIZE (inch)							
NOMINALOD:	1/2	3/4	1	1 1/4	1 1/2	2	3	4
DESIGNATION:	SDR 9.3	SDR11	SDR11	SDR10	SDR11	SDR11	SDR11	SDR11
ACTUALID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY INCUBIC FEET OF GAS PER HOUR							
10	1860	3720	6710	11600	17 600	31 600	87 300	169 000
20	1280	2560	4610	7990	12 100	21 700	60 000	116000
30	1030	2050	3710	6420	9690	17 400	48 200	93 200
40	878	1760	3170	5490	8300	14 900	41 200	79 700
50	778	1560	2810	4870	7350	13 200	36 600	70 700
60	705	1410	2550	4410	6660	12 000	33 100	64 000
70	649	1300	2340	4060	6130	11000	30 500	58 900
80	603	1210	2180	3780	5700	10 200	28 300	54 800
90	566	1130	2050	3540	5350	9610	26 600	51 400
100	535	1070	1930	3350	5050	9080	25 100	48 600
125	474	949	1710	2970	4480	8050	22 300	43 000
150	429	860	1550	2690	4060	7290	20 200	39 000

175	395	791	1430	2470	3730	6710	18 600	35 900
200	368	736	1330	2300	3470	6240	17 300	33 400
250	326	652	1180	2040	3080	5530	15 300	29 600
300	295	591	1070	1850	2790	5010	13 900	26 800
350	272	544	981	1700	2570	4610	12 800	24 700
400	253	506	913	1580	2390	4290	11900	22 900
450	237	475	856	1480	2240	4020	11100	21 500
500	224	448	809	1400	2120	3800	10 500	20 300
550	213	426	768	1330	2010	3610	9990	19 300
600	203	406	733	1270	1920	3440	9530	18 400
650	194	389	702	1220	1840	3300	9130	17 600
700	187	374	674	1170	1760	3170	8770	16 900
750	180	360	649	1130	1700	3050	8450	16 300
800	174	348	627	1090	1640	2950	8160	15 800
850	168	336	607	1050	1590	2850	7890	15 300
900	163	326	588	1020	1540	2770	7650	14 800
950	158	317	572	990	1500	2690	7430	14 400
1000	154	308	556	963	1450	2610	7230	14 000
1100	146	293	528	915	1380	2480	6870	13 300
1200	139	279	504	873	1320	2370	6550	12 700
1300	134	267	482	836	1260	2270	6270	12 100
1400	128	257	463	803	1210	2180	6030	11600
1500	124	247	446	773	1170	2100	5810	11200
1600	119	239	431	747	1130	2030	5610	10 800
1700	115	231	417	723	1090	1960	5430	10 500
1800	112	224	404	701	1060	1900	5260	10 200
1900	109	218	393	680	1030	1850	5110	9900
2000	106	212	382	662	1000	1800	4970	9600

ForSIunits: 1inch=25mm, 1foot=304.8mm, 1cubicfootperhour=0.0283m³/h, 1pound-forcepersquareinch=6.8947kPa

*Tableentriesareroundedto3significanttdigits.

Table D.4 — Polyethylene plastic pipe [NFPA 54: TABLE 6.3.1(I)]

					GAS: UNDILUTED PROPANE			
					INLET PRESSURE:		2.0 psi	
					PRESSURE DROP:		1.0psi	
					SPECIFIC GRAVITY: 1.50			
INTENDED USE: PE PIPE SIZING BETWEEN 2 PSI SERVICE REGULATOR AND LINE PRESSURE REGULATOR								
	PIPE SIZE (inch)							
NOMINAL OD:	1/2	3/4	1	1 1/4	1 1/2	2	3	4
DESIGNATION:	SDR 9.3	SDR11	SDR11	SDR10	SDR11	SDR11	SDR11	SDR11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR							
10	3130	6260	11300	19 600	29 500	53 100	147 000	284 000
20	2150	4300	7760	13 400	20 300	36 500	101 000	195 000
30	1730	3450	6230	10 800	16 300	29 300	81 100	157 000
40	1480	2960	5330	9240	14 000	25 100	69 400	134 100
50	1310	2620	4730	8190	12 400	22 200	61 500	119000
60	1190	2370	4280	7420	11200	20 100	55 700	108 000
70	1090	2180	3940	6830	10 300	18 500	51 300	99 100
80	1010	2030	3670	6350	9590	17 200	47 700	92 200
90	952	1910	3440	5960	9000	16 200	44 700	86 500
100	899	1800	3250	5630	8500	15 300	42 300	81 700
125	797	1600	2880	4990	7530	13 500	37 500	72 400
150	722	1450	2610	4520	6830	12 300	33 900	65 600
175	664	1330	2400	4160	6280	11300	31 200	60 300

200	618	1240	2230	3870	5840	10 500	29 000	56 100
250	548	1100	1980	3430	5180	9300	25 700	49 800
300	496	994	1790	3110	4690	8430	23 300	45 100
350	457	914	1650	2860	4320	7760	21 500	41 500
400	425	851	1530	2660	4020	7220	12 000	38 600
450	399	798	1440	2500	3770	6770	18 700	36 200
500	377	754	1360	2360	3560	6390	17 700	34 200
550	358	716	1290	2240	3380	6070	16 800	32 500
600	341	683	1230	2140	3220	5790	16 000	31 000
650	327	654	1180	2040	3090	5550	15 400	29 700
700	314	628	1130	1960	2970	5330	14 700	28 500
750	302	605	1090	1890	2860	5140	14 200	27 500
800	292	585	1050	1830	2760	4960	13 700	26 500
850	283	566	1020	1770	2670	4800	13 300	25 700
900	274	549	990	1710	2590	4650	12 900	24 900
950	266	533	961	1670	2520	4520	12 500	24 200
1000	259	518	935	1620	2450	4400	12 200	23 500
1100	246	492	888	1540	2320	4170	11500	22 300
1200	234	470	847	1470	2220	3980	11000	21 300
1300	225	450	811	1410	2120	3810	10 600	20 400
1400	216	432	779	1350	2040	3660	10 100	19 600
1500	208	416	751	1300	1960	3530	9760	18 900
1600	201	402	725	1260	1900	3410	9430	18 200
1700	194	389	702	1220	1840	3300	9130	17 600
1800	188	377	680	1180	1780	3200	8850	17 100
1900	183	366	661	1140	1730	3110	8590	16 600
2000	178	356	643	1110	1680	3020	8360	16 200

For SI units: 1inch=25mm, 1foot=304.8mm, 1000Britishthermalunitsperhour=0.293kW, 1pound-forcepersquareinch=6.8947kPa

*Table entries are rounded to 3 significant digits.

Annex E (normative)

Polyethylene plastic tubing

Table E.1 — Polyethylene plastic tubing⁹ [NFPA 54: TABLE 6.2.1(w)]

	GAS: NATURAL	
	INLET PRESSURE:	LESS THAN 2.0 psi
	PRESSURE DROP:	0.3 in w.c.
	SPECIFIC GRAVITY:	0.60
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	1/2	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	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

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:

¹CTS = Copper tube size.

²Table entries are rounded to 3 significant digits.

³NA means a flow of less than 10 ft³/h (0.283 m³/h).

⁹ [NFPA 54: TABLE 6.2.1(w)]^{2,3}

Table E.2 — Polyethylene plastic tubing [NFPA 54: TABLE 6.2.1(x)]

	GAS: NATURAL	
	INLET PRESSURE: LESS THAN 2.0 psi	
	PRESSURE DROP: 0.5 in w.c.	
	SPECIFIC GRAVITY: 0.60	
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	1/2	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	CAPACITY IN CUBIC FEET OF GAS PER HOUR	
10	72	490
20	49	337
30	39	271
40	34	232
50	30	205
60	27	186
70	25	171
80	23	159
90	22	149
100	21	141
125	18	125
150	17	113
175	15	104
200	14	97
225	13	91
250	12	86
275	11	82
300	11	78
350	10	72
400	NA	67
450	NA	63
500	NA	59

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m³/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:

¹CTS = Copper tube size.

²Table entries are rounded to 3 significant digits.

³NA means a flow of less than 10 ft³/h (0.283 m³/h).

Table E.3 — Polyethylene plastic tubing [NFPA 54: TABLE 6.3.1(k)]

					GAS: UNDILUTED PROPANE			
					INLET PRESSURE: 11.0 in w.c.			
					PRESSURE DROP: 0.5 in w.c.			
					SPECIFIC GRAVITY: 1.50			
INTENDED USE: PE PIPE SIZING BETWEEN INTEGRAL SECOND-STAGE REGULATOR ATTANK OR SECOND-STAGE(LOW PRESSURE) REGULATOR AND BUILDING								
	PIPE SIZE (inch)							
NOMINAL OD:	1/2	3/4	1	1 1/4	1 1/2	2	3	4
DESIGNATION:	SDR 9.3	SDR11	SDR11	SDR10	SDR11	SDR11	SDR11	SDR11
ACTUAL ID:	0.660	0.860	1.077	1.328	1.554	1.943	2.864	3.682
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR							
10	340	680	1230	2130	3210	5770	16 000	30 900
20	233	468	844	1460	2210	3970	11000	21 200
30	187	375	677	1170	1770	3180	8810	17 000
40	160	321	580	1000	1520	2730	7540	14 600

50	142	285	514	890	1340	2420	6680	12 900
60	129	258	466	807	1220	2190	6050	11700
70	119	237	428	742	1120	2010	5570	10 800
80	110	221	398	690	1040	1870	5180	10 000
90	103	207	374	648	978	1760	4860	9400
100	98	196	353	612	924	1660	4590	8900
125	87	173	313	542	819	1470	4070	7900
150	78	157	284	491	742	1330	3690	7130
175	72	145	261	452	683	1230	3390	6560
200	67	135	243	420	635	1140	3160	6100
250	60	119	215	373	563	1010	2800	5410
300	54	108	195	338	510	916	2530	4900
350	50	99	179	311	469	843	2330	4510
400	46	92	167	289	436	784	2170	4190
450	43	87	157	271	409	736	2040	3930
500	41	82	148	256	387	695	1920	3720

For SI units: 1 inch=25mm, 1 foot=304.8mm, 1000 British thermal units per hour=0.293 kW, 1 inch water column=0.249 kPa

*Table entries are rounded to 3 significant digits.

Table E.4 — Polyethylene plastic tubing [NFPA 54: TABLE 6.3.1(m)]

	GAS: UNDILUTED PROPANE	
	INLET PRESSURE:	11.0 in w.c.
	PRESSURE DROP:	0.5 in w.c.
	SPECIFIC GRAVITY:	1.50
INTENDED USE: SIZING BETWEEN INTEGRAL 2-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW-PRESSURE REGULATOR) AND THE BUILDING		
	PLASTIC TUBING SIZE (CTS) ¹ (inch)	
NOMINAL OD:	½	1
DESIGNATION:	SDR 7	SDR 11
ACTUAL ID:	0.445	0.927
LENGTH (feet)	CAPACITY IN THOUSANDS OF BTU PER HOUR	
10	121	828
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113
450	15	106
500	15	100

For SI units: 1 inch=25mm, 1 foot=304.8mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

Notes:

¹CTS=Coppertube size.

²Table entries are rounded to 3 significant digits.

Annex F (normative)

Semi-rigid copper tubing

Table F.1 — Semi-rigid copper tubing¹⁰ [NFPA 54: TABLE 6.3.1(e)]

						GAS: UNDILUTED PROPANE				
						INLET PRESSURE: 10.0psi				
						PRESSURE DROP: 1.0psi				
						SPECIFIC GRAVITY: 1.50				
INTENDED USE: TUBESIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR										
NOMINAL:		TUBE SIZE (inch)								
		K &L:	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2
ACR:		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: 1		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		513	1060	2150	3760	5330	11 400	20 500	32 300	67 400
20		352	727	1480	2580	3670	7830	14 100	22 200	46 300
30		283	584	1190	2080	2940	6290	11 300	17 900	37 200
40		242	500	1020	1780	2520	5380	9690	15 300	31 800
50		215	443	901	1570	2230	4770	8590	13 500	28 200
60		194	401	816	1430	2020	4320	7780	12 300	25 600
70		179	369	751	1310	1860	3980	7160	11 300	23 500
80		166	343	699	1220	1730	3700	6660	10 500	21 900
90		156	322	655	1150	1630	3470	6250	9850	20 500
100		147	304	619	1080	1540	3280	5900	9310	19 400
125		131	270	549	959	1360	2910	5230	8250	17 200
150		118	244	497	869	1230	2630	4740	7470	15 600
175		109	225	457	799	1130	2420	4360	6880	14 300
200		101	209	426	744	1060	2250	4060	6400	13 300
250		90	185	377	659	935	2000	3600	5670	11 800
300		81	168	342	597	847	1810	3260	5140	10 700
350		75	155	314	549	779	1660	3000	4730	9840
400		70	144	292	511	725	1550	2790	4400	9160
450		65	135	274	480	680	1450	2620	4130	8590
500		62	127	259	453	643	1370	2470	3900	8120
550		59	121	246	430	610	1300	2350	3700	7710
600		56	115	235	410	582	1240	2240	3530	7350
650		54	111	225	393	558	1190	2140	3380	7040
700		51	106	216	378	536	1140	2060	3250	6770
750		50	102	208	364	516	1100	1980	3130	6520
800		48	99	201	351	498	1060	1920	3020	6290
850		46	96	195	340	482	1030	1850	2920	6090
900		45	93	189	330	468	1000	1800	2840	5910
950		44	90	183	320	454	970	1750	2750	5730
1000		42	88	178	311	442	944	1700	2680	5580
1100		40	83	169	296	420	896	1610	2540	5300

¹⁰ [NFPA54:TABLE6.3.1(e)]²

1200	38	79	161	282	400	855	1540	2430	5050
1300	37	76	155	270	383	819	1470	2320	4840
1400	35	73	148	260	368	787	1420	2230	4650
1500	34	70	143	250	355	758	1360	2150	4480
1600	33	68	138	241	343	732	1320	2080	4330
1700	32	66	134	234	331	708	1270	2010	4190
1800	31	64	130	227	321	687	1240	1950	4060
1900	30	62	126	220	312	667	1200	1890	3940
2000	29	60	122	214	304	648	1170	1840	3830

For SI units: 1 inch=25mm, 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 pound-force per square inch=6.8947kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

Table F.2 — Semi-rigid copper tubing [NFPA 54: TABLE 6.3.1(f)]

							GAS: UNDILUTED PROPANE			
							INLET PRESSURE: 11.0 in w.c.			
							PRESSURE DROP: 0.5 in w.c.			
							SPECIFIC GRAVITY: 1.50			
INTENDED USE: TUBESIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE										
		TUBE SIZE (inch)								
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: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		45	93	188	329	467	997	1800	2830	5890
20		31	64	129	226	321	685	1230	1950	4050
30		25	51	104	182	258	550	991	1560	3250
40		21	44	89	155	220	471	848	1340	2780
50		19	39	79	138	195	417	752	1180	2470
60		17	35	71	125	177	378	681	1070	2240
70		16	32	66	115	163	348	626	988	2060
80		15	30	61	107	152	324	583	919	1910
90		14	28	57	100	142	304	547	862	1800
100		13	27	54	95	134	287	517	814	1700
125		11	24	48	84	119	254	458	722	1500
150		10	21	44	76	108	230	415	654	1360
175		NA	20	40	70	99	212	382	602	1250
200		NA	18	37	65	92	197	355	560	1170
250		NA	16	33	58	82	175	315	496	1030
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
1000		NA	NA	16	27	39	83	149	234	488
1100		NA	NA	15	26	37	78	141	223	464
1200		NA	NA	14	25	35	75	135	212	442
1300		NA	NA	14	24	34	72	129	203	423
1400		NA	NA	13	23	32	69	124	195	407
1500		NA	NA	13	22	31	66	119	188	392
1600		NA	NA	12	21	30	64	115	182	378
1700		NA	NA	12	20	29	62	112	176	366
1800		NA	NA	11	20	28	60	108	170	355
1900		NA	NA	11	19	27	58	105	166	345
2000		NA	NA	11	19	27	57	102	161	335

For Sl units: 1 inch=25mm, 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 inch water column=0.249kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

³NA means a flow of less than 10000 Btu/h (2.93kW).

Table F.3 — Semi-rigid copper tubing [NFPA 54: TABLE 6.3.1(g)]

							GAS: UNDILUTED PROPANE			
							INLET PRESSURE: 2.0 psi			
							PRESSURE DROP: 1.0psi			
							SPECIFIC GRAVITY: 1.50			
INTENDED USE: TUBE SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR										
		TUBE SIZE (inch)								
NOMINAL:	K & L:	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR:	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	-	-
OUTSIDE:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
INSIDE: ¹		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
LENGTH (feet)		CAPACITY IN THOUSANDS OF BTU PER HOUR								
10		413	852	1730	3030	4300	9170	16 500	26 000	54 200
20		284	585	1190	2080	2950	6310	11 400	17 900	37 300
30		228	470	956	1670	2370	5060	9120	14 400	29 900
40		195	402	818	1430	2030	4330	7800	12 300	25 600
50		173	356	725	1270	1800	3840	6920	10 900	22 700
60		157	323	657	1150	1630	3480	6270	9880	20 600
70		144	297	605	1060	1500	3200	5760	9090	18 900
80		134	276	562	983	1390	2980	5360	8450	17 600
90		126	259	528	922	1310	2790	5030	7930	16 500
100		119	245	498	871	1240	2640	4750	7490	15 600
125		105	217	442	772	1100	2340	4210	6640	13 800
150		95	197	400	700	992	2120	3820	6020	12 500
175		88	181	368	644	913	1950	3510	5540	11 500
200		82	168	343	599	849	1810	3270	5150	10 700
250		72	149	304	531	753	1610	2900	4560	9510
300		66	135	275	481	682	1460	2620	4140	8610
350		60	124	253	442	628	1340	2410	3800	7920
400		56	116	235	411	584	1250	2250	3540	7370
450		53	109	221	386	548	1170	2110	3320	6920
500		50	103	209	365	517	1110	1990	3140	6530
550		47	97	198	346	491	1050	1890	2980	6210
600		45	93	189	330	469	1000	1800	2840	5920
650		43	89	181	316	449	959	1730	2720	5670
700		41	86	174	304	431	921	1660	2620	5450
750		40	82	168	293	415	888	1600	2520	5250
800		39	80	162	283	401	857	1540	2430	5070
850		37	77	157	274	388	829	1490	2350	4900
900		36	75	152	265	376	804	1450	2280	4750
950		35	72	147	258	366	781	1410	2220	4620
1000		34	71	143	251	356	760	1370	2160	4490
1100		32	67	136	238	338	721	1300	2050	4270
1200		31	64	130	227	322	688	1240	1950	4070
1300		30	61	124	217	309	659	1190	1870	3900
1400		28	59	120	209	296	633	1140	1800	3740
1500		27	57	115	201	286	610	1100	1730	3610
1600		26	55	111	194	276	589	1060	1670	3480
1700		26	53	108	188	267	570	1030	1620	3370
1800		25	51	104	182	259	553	1000	1570	3270
1900		24	50	101	177	251	537	966	1520	3170
2000		23	48	99	172	244	522	940	1480	3090

For SI units: 1 inch=25mm, 1 foot=304.8mm, 1000 British thermal units per hour=0.293kW, 1 pound-force per square inch=6.8947kPa

Notes:

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

²Table entries are rounded to 3 significant digits.

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Bibliography

- [1] NFPA 54:2024, *National Fuel Gas Code*

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