NFPA®

54

ANSI Z223.1

National Fuel Gas Code

2021

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

The National Fuel Gas Code Committee is a committee functioning jointly under American National Standards Institute Accredited Standard Committee Z223 procedures and the National Fire Protection Association and, accordingly, the National Fuel Gas Code bears two designations, ANSI Z223.1 and NFPA 54. In the ANSI context, the code is prepared by the Accredited Standards Committee on National Fuel Gas Code, Z223, sponsored by the American Gas Association (Administrative Secretariat). In the NFPA context, the committee is an NFPA Technical Committee submitted to ANSI under NFPA audited designation.

Committee Scope: This Committee shall have primary responsibility for documents on safety code for gas piping systems on consumers' premises and the installation of gas utilization equipment and accessories for use with fuel gases such as natural gas, manufactured gas, liquefied petroleum gas in the vapor phase, liquefied petroleum gas-air mixtures, or mixtures of these gases, including: a. The design, fabrication, installation, testing, operation, and maintenance of gas piping systems from the point of delivery to the connections with each gas utilization device. Piping systems covered by this Code are limited to a maximum operating pressure of 125 psig. For purposes of this Code, the point of delivery is defined as the outlet of the meter set assembly, or the outlet of the service regulator or service shutoff valve where no meter is provided. b. The installation of gas utilization equipment, related accessories, and their ventilation and venting systems.

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National Fuel Gas Code

2021 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex K.

All pressures used in this code are gauge pressure unless otherwise indicated.

Chapter 1 Administration

1.1 Scope.

1.1.1 Applicability.

1.1.1.1 This code is a safety code that shall apply to the installation of fuel gas piping systems, appliances, equipment, and related accessories as shown in 1.1.1.1(A) through 1.1.1.1(F).

(A)* Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas (LP-Gas) systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas systems, the point of delivery shall be considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter.

(B) This code shall apply to natural gas systems operating at a pressure of 125 psi (862 kPa) or less.

(C) This code shall apply to LP-Gas systems operating at a pressure of 50 psi (345 kPa) or less.

(D) This code shall apply to gas–air mixture systems operating within the flammable range at a pressure of 10 psi (69 kPa) or less.

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

(F) Requirements for appliances, equipment, and related accessories shall include installation, combustion, and ventilation air and venting.

1.1.1.2 This code shall not apply to the following items:

(1) Portable LP-Gas appliances and equipment of all types that are not connected to a fixed fuel piping system
(2) Installation of appliances such as brooders, dehydrators, dryers, and irrigation equipment used for agricultural purposes
(3) Raw material (feedstock) applications except for piping to special atmosphere generators
(4) Oxygen–fuel gas cutting and welding systems
(5) Industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen
(6) Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants
(7) Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions
(8) LP-Gas installations at utility gas plants
(9) Liquefied natural gas (LNG) installations
(10) Fuel gas piping in electric utility power plants
(11) Proprietary items of equipment, apparatus, or instruments such as gas generating sets, compressors, and calorimeters
(12) LP-Gas equipment for vaporization, gas mixing, and gas manufacturing
(13) LP-Gas piping for buildings under construction or renovations that is not to become part of the permanent building piping system — that is, temporary fixed piping for building heat
(14) Installation of LP-Gas systems for railroad switch heating
(15) Installation of LP-Gas and compressed natural gas (CNG) systems on vehicles
(16) Gas piping, meters, gas pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas
(17) Building design and construction, except as specified herein
(18) Fuel gas systems on recreational vehicles manufactured in accordance with NFPA 1192
(19) Fuel gas systems using hydrogen as a fuel
(20) Construction of appliances

1.1.2 Other Standards. In applying this code, reference shall also be made to the manufacturers' instructions and the serving gas supplier regulations.

1.2 Purpose. (Reserved)

1.3 Retroactivity. Unless otherwise stated, the provisions of this code shall not be applied retroactively to existing systems that were in compliance with the provisions of the code in effect at the time of installation.

Δ **1.4 Equivalency.** The provisions of this code are not intended to prevent the use of any material, appliance, equipment, method of construction, or installation procedure, provided that any such alternative is acceptable to the authority having jurisdiction. The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternatives.

1.5 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages,* 2021 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2018 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2018 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code,* 2019 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2020 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2019 edition.

NFPA 88A, *Standard for Parking Structures,* 2019 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2021 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2021 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2021 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2019 edition.

NFPA 409, *Standard on Aircraft Hangars,* 2016 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2020 edition.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems,* 2020 edition.

NFPA 1192, *Standard on Recreational Vehicles,* 2021 edition.

2.3 Other Publications.

Δ **2.3.1 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990, (800) 843-2763. www.asme.org

ANSI/ASME B1.20.1, *Pipe Threads, General Purpose, Inch,* 2013.

ANSI/ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250,* 2015.

ANSI/ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard,* 2017.

ANSI/ASME B16.20, *Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound and Jacketed,* 2017.

ANSI/ASME B16.21, *Nonmetallic Flat Gaskets for Pipe Flanges,* 2016.

ANSI/ASME B16.24, *Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500,* 2016.

ANSI/ASME B16.33, *Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS 1/2 through NPS 2),* 2012.

ANSI/ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300,* 2016.

ANSI/ASME B16.44, *Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi,* 2012 (R2017).

ANSI/ASME B16.47, *Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard,* 2017.

ANSI/ASME B36.10M, *Welded and Seamless Wrought Steel Pipe,* 2018.

Δ **2.3.2 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, (610) 832-9585. www.astm.org

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless,* 2018.

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service,*2019.

ASTM A254, *Standard Specification for Copper-Brazed Steel Tubing,* 2012.

ASTM A268, *Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service,* 2010, reaffirmed 2016.

ASTM A269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service,* 2015a.

ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes,* 2018a.

ASTM B88, *Standard Specification for Seamless Copper Water Tube,* 2016.

ASTM B210, *Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes,*2019.

ASTM B241, *Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube,*2016.

ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service,* 2018.

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings,* 2018a.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2019.

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C,* 2018.

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*, 2013, reaffirmed 2018.

ASTM F2509, *Standard Specification for Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing*, 2015.

ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*,2018.

Δ **2.3.3 CSA Group Publications.** CSA Group, 178 Rexdale Boulevard, Toronto, ON M9W 1R3, Canada, (216) 524-4990. www.csagroup.org

ANSI/CSA FC 1, *Fuel Cell Technologies — Part 3-100: Stationary Fuel Cell Power Systems — Safety*, 2014, reaffirmed 2018.

ANSI/CSA NGV 5.1, *Residential Fueling Appliances*, 2016.

ANSI/CSA NVG 5.2, *Vehicle Fueling Appliances (VFA)*, 2017.

ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)*, 2018.

ANSI LC 4/CSA 6.32, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems*, 2012, reaffirmed 2016.

ANSI Z21.1/CSA 1.1, *Household Cooking Gas Appliances*, 2018.

ANSI Z21.5.1/CSA 7.1, *Gas Clothes Dryers, Volume I, Type 1 Clothes Dryers*, 2017.

ANSI Z21.5.2/CSA 7.2, *Gas Clothes Dryers, Volume II, Type 2 Clothes Dryers*, 2016.

ANSI Z21.8, *Installation of Domestic Gas Conversion Burners*, 1994, reaffirmed 2017.

ANSI Z21.10.1/CSA 4.1, *Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less*, 2017.

ANSI Z21.10.3/CSA 4.3, *Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating or Instantaneous*, 2017.

ANSI Z21.11.2, *Gas-Fired Room Heaters — Volume II, Unvented Room Heaters*, 2016.

ANSI Z21.13/CSA 4.9, *Gas-Fired Low-Pressure Steam and Hot Water Boilers*, 2017.

ANSI Z21.15/CSA 9.1, *Manually operated gas valves for appliances, appliance connector valves and hose end valves*, 2009, reaffirmed 2014.

ANSI Z21.18/CSA 6.3, *Gas Appliance Pressure Regulators*, 2007, reaffirmed 2016.

ANSI Z21.19/CSA 1.4, *Refrigerators Using Gas Fuel*, 2014.

ANSI Z21.22/CSA 4.4, *Relief Valves for Hot Water Supply Systems*, 2015.

ANSI Z21.24/CSA 6.10, *Connectors for Gas Appliances*, 2015.

ANSI Z21.40.1/CSA 2.91, *Gas-Fired Heat Activated Air Conditioning and Heat Pump Appliances*, 1996, reaffirmed 2017.

ANSI Z21.40.2/CSA 2.92, *Air Conditioning and Heat Pump Appliances (Internal Combustion)*, 1996, reaffirmed 2017.

ANSI Z21.41/CSA 6.9, *Quick-Disconnect Devices for Use with Gas Fuel Appliances*, 2014.

ANSI Z21.47/CSA 2.3, *Gas-Fired Central Furnaces*, 2016.

ANSI Z21.50/CSA 2.22, *Vented Decorative Gas Appliances*, 2019.

ANSI Z21.54/CSA 8.4, *Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances*,2019.

ANSI Z21.56/CSA 4.7, *Gas-Fired Pool Heaters*, 2017.

ANSI Z21.60/CSA 2.26, *Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces*, 2017.

ANSI Z21.69/CSA 6.16, *Connectors for Movable Gas Appliances*, 2015.

ANSI Z21.75/CSA 6.27, *Connectors for Outdoor Gas Appliances and Manufactured Homes*, 2016.

ANSI Z21.80/CSA 6.22, *Line Pressure Regulators*,2019.

ANSI Z21.86/CSA 2.32, *Vented Gas-Fired Space Heating Appliances*, 2016.

ANSI Z21.90/CSA 6.24, *Gas Convenience Outlets and Optional Enclosures*, 2015.

ANSI Z21.93/CSA 6.30, *Excess Flow Valves for Natural and LP-Gas with Pressures Up to 5 psig*, 2017.

ANSI Z21.97/CSA 2.41, *Outdoor Decorative Gas Appliances*, 2017.

ANSI Z83.4/CSA 3.7, *Non-Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application*, 2017.

ANSI Z83.8/CSA 2.6, *Gas Unit Heaters, as Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces*, 2016.

ANSI Z83.11/CSA 1.8, *Gas Food Service Equipment*, 2016.

ANSI Z83.18, *Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application*, 2017.

ANSI Z83.19/CSA 2.35, *Gas-Fired High-Intensity Infrared Heaters*, 2017.

ANSI Z83.20/CSA 2.34, *Gas-Fired Tubular and Low-Intensity Infrared Heaters*, 2016.

ANSI Z83.26/CSA 2.27, *Gas-Fired Outdoor Infrared Patio Heaters*, 2014.

Δ **2.3.4 MSS Publications.** Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, NE, Vienna, VA 22180-4602, (703) 281-6613. www.msshq.org

ANSI/MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*, 2018.

Δ **2.3.5 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. www.ul.com

UL 103, *Chimneys, Factory-Built, Residential Type and Building Heating Appliances*, 2010, revised 2017.

UL 441, *Gas Vents*, 2016.

UL 467, *Grounding and Bonding Equipment*, 2013.

UL 641, *Type L Low-Temperature Venting Systems*, 2010, revised 2018.

UL 651, *Schedule 40 and 80 Rigid PVC Conduit and Fittings*, 2011, revised 2018.

UL 959, *Medium Heat Appliance Factory-Built Chimneys*, 2010, revised 2014.

UL 1738, *Venting Systems for Gas Burning Appliances, Categories II, III and IV*, 2010, revised 2014.

UL 1777, *Chimney Liners*, 2015, revised 2019.

UL 2158A, *Clothes Dryer Transition Ducts*, 2013, revised 2017.

UL 2561, *1400 Degree Fahrenheit Factory-Built Chimneys*, 2016, revised 2018.

UL 378, *Draft Equipment*, 2006, revised 2013.

Δ **2.3.6 US Government Publications.** US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001. www.gpo.gov

Title 49, Code of Federal Regulations, Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Standards."

2.3.7 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2016 edition.

NFPA 70®, National Electrical Code®, 2017 edition.

NFPA 88A, *Standard for Parking Structures*, 2019 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2018 edition.

NFPA *101®, Life Safety Code®*, 2018 edition.

NFPA 501, *Standard on Manufactured Housing*, 2017 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

Δ **3.3 General Definitions.**

3.3.1 Accessible. Having access to but which first requires the removal of a panel, door, or similar covering of the item described.

3.3.1.1 *Readily Accessible.* Having direct access without the need of removing or moving any panel, door, or similar covering of the item described.

3.3.2 Air.

3.3.2.1 *Circulating Air.* Air for cooling, heating, or ventilation distributed to habitable spaces.

3.3.2.2 *Dilution Air.* Air that enters a draft hood or draft regulator and mixes with the flue gases.

3.3.2.3 *Excess Air.* Air that passes through the combustion chamber and the appliance flues in excess of that which is theoretically required for complete combustion.

3.3.2.4 *Primary Air.* The air introduced into a burner that mixes with the gas before it reaches the port or ports.

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3.3.3 Anodeless Riser. An assembly of steel-cased plastic pipe used to make the transition between plastic piping installed underground and metallic piping installed aboveground.

3.3.4 Appliance. Any device that utilizes a fuel to produce light, heat, power, refrigeration, or air conditioning, or any device that compresses fuel gas.

3.3.4.1 *Decorative Appliance for Installation in a Vented Fireplace.* A self-contained, freestanding, fuel gas–burning appliance designed for installation only in a vented fireplace and whose primary function lies in the aesthetic effect of the flame.

3.3.4.2 *Direct Vent Appliances.* Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors.

3.3.4.3 *Fan-Assisted Combustion Appliance.* An appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.

3.3.4.4 ***Food Service Appliance.***

Δ **3.3.4.4.1** ***Baking and Roasting Oven.*** An oven primarily intended for volume food preparation that is composed of one or more sections or units of the following types: (1) cabinet oven, an oven having one or more cavities heated by a single burner or group of burners; (2) reel-type oven, an oven employing trays that are moved by mechanical means; or (3) sectional oven, an oven composed of one or more independently heated cavities.

3.3.4.4.2 ***Gas Counter Appliance.*** An appliance such as a gas coffee brewer and coffee urn and any appurtenant water heating appliance, food and dish warmer, hot plate, and griddle.

3.3.4.4.3 ***Gas Deep Fat Fryer.*** An appliance, including a cooking vessel in which oils or fats are placed to such a depth that the cooking food is essentially supported by displacement of the cooking fluid or a perforated container immersed in the cooking fluid rather than by the bottom of the vessel, designed primarily for use in hotels, restaurants, clubs, and similar institutions.

• **3.3.4.4.4** ***Kettle.*** An appliance with a cooking chamber that is heated either by a steam jacket in which steam is generated by gas heat or by direct gas heat applied to the cooking chamber.

Δ **3.3.4.4.5** ***Steam Cooker.*** An appliance that cooks, defrosts, or reconstitutes food by direct contact with steam.

Δ **3.3.4.4.6** ***Steam Generator.*** A separate appliance primarily intended to supply steam for use with food service appliances.

3.3.4.5 ***Gas Counter Appliances.*** See 3.3.4.4.2.

3.3.4.6 ***Household Cooking Appliance.*** An appliance for domestic food preparation, providing at least one function of (1) top or surface cooking, (2) oven cooking, or (3) broiling.

3.3.4.6.1 ***Household Broiler Cooking Appliance.*** A unit that cooks primarily by radiated heat.

3.3.4.6.2 ***Household Built-In Unit Cooking Appliance.*** A unit designed to be recessed into, placed upon, or attached to the construction of a building, but not for installation on the floor.

Δ **3.3.4.7** ***Low-Heat Appliance.*** An appliance needing a chimney capable of withstanding a continuous flue gas temperature not exceeding 1000°F (538°C).

Δ **3.3.4.8** ***Medium-Heat Appliance.*** An appliance needing a chimney capable of withstanding a continuous flue gas temperature not exceeding 1800°F (982°C).

3.3.4.9 ***Outdoor Cooking Appliance.*** A gas-fired cooking appliance for outdoor use only that is provided with a means of support by the manufacturer and is connected to a fixed gas piping system.

3.3.4.10 ***Vented Appliance.***

3.3.4.10.1* ***Category I Vented Appliance.*** An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

3.3.4.10.2 ***Category II Vented Appliance.*** An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent.

3.3.4.10.3 ***Category III Vented Appliance.*** An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

3.3.4.10.4 ***Category IV Vented Appliance.*** An appliance that operates with a positive vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent.

• **3.3.5 Appliance Categorized Vent Diameter/Area.** The minimum vent diameter/area permissible for Category I appliances to maintain a nonpositive vent static pressure when tested in accordance with nationally recognized standards.

3.3.6 Automatic Firecheck. A device for stopping the progress of a flame front in burner mixture lines (flashback) and for automatically shutting off the fuel–air mixture.

3.3.7 Automatic Vent Damper. A device that is intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual automatically operated appliance and that is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

3.3.8 Backfire Preventer. See 3.3.86, Safety Blowout.

3.3.9 Baffle. An object placed in an appliance to change the direction of or retard the flow of air, air–gas mixtures, or flue gases.

3.3.10 Boiler.

3.3.10.1 ***Hot Water Heating Boiler.*** A boiler designed to heat water for circulation through an external space heating system.

3.3.10.2 ***Hot Water Supply Boiler.*** A boiler used to heat water for purposes other than space heating.

3.3.10.3 ***Low Pressure Boiler.*** A boiler for generating steam at gauge pressures not in excess of 15 psi (gauge pressure of 103 kPa) or for furnishing water at a maximum temperature of 250°F (121°C) at a maximum gauge pressure of 160 psi (gauge pressure of 1100 kPa). [**31,** 2016]

3.3.10.4 ***Steam Boiler.*** A boiler designed to convert water into steam that is supplied to an external system.

3.3.11 Bonding Jumper. A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. [**70:**100]

3.3.12 Branch Line. Gas piping that conveys gas from a supply line to the appliance.

3.3.13 Breeching. See 3.3.100, Vent Connector.

3.3.14 Broiler. A general term including broilers, salamanders, barbecues, and other devices cooking primarily by radiated heat, excepting toasters.

3.3.14.1 ***Unit Broiler.*** A broiler constructed as a separate appliance.

3.3.15 Btu. Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit (equivalent to 1055 joules).

3.3.16 Burner. A device for the final conveyance of gas, or a mixture of gas and air, to the combustion zone.

3.3.16.1 ***Forced-Draft Burner.*** See 3.3.16.5, Power Burner.

3.3.16.2 ***Gas Conversion Burner.*** A unit consisting of a burner and its controls utilizing gaseous fuel for installation in an appliance originally utilizing another fuel.

3.3.16.3 ***Injection- (Bunsen-) Type Burner.*** A burner employing the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.

3.3.16.4 ***Main Burner.*** A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone and on which combustion takes place to accomplish the function for which the appliance is designed.

3.3.16.5 ***Power Burner.*** A burner in which either gas or air, or both, are supplied at a pressure exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure being applied at the burner. A burner for which air for combustion is supplied by a fan ahead of the appliance is commonly designated as a forced-draft burner.

3.3.16.5.1 ***Fan-Assisted Power Burner.*** A burner that uses either induced or forced draft.

3.3.17 Chimney. One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors.

3.3.17.1 ***Exterior Masonry Chimneys.*** Masonry chimneys exposed to the outdoors on one or more sides below the roof line.

3.3.17.2 ***Factory-Built Chimney.*** A chimney composed of listed factory-built components assembled in accordance with the manufacturer's installation instructions to form the completed chimney.

3.3.17.3 ***Masonry Chimney.*** A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced Portland cement concrete, lined with suitable chimney flue liners.

3.3.17.4 ***Metal Chimney.*** A field-constructed chimney of metal.

3.3.18 Clothes Dryer. An appliance used to dry wet laundry by means of heat.

3.3.18.1 ***Type 1 Clothes Dryer.*** Primarily used in family living environment. May or may not be coin-operated for public use.

3.3.18.2 ***Type 2 Clothes Dryer.*** Used in business with direct intercourse of the function with the public. May or may not be operated by public or hired attendant. May or may not be coin-operated.

3.3.19 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. [**5000,** 2018]

3.3.20 Combustion Chamber. The portion of an appliance within which combustion occurs.

3.3.21 Combustion Products. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert but excluding excess air.

Δ **3.3.22 Condensate.** The liquid that separates from a gas because of a reduction in temperature or an increase in pressure.

3.3.23 Controls. Devices designed to regulate the gas, air, water, or electrical supply to an appliance, either manually or automatically.

3.3.23.1 ***Limit Control.*** A device responsive to changes in pressure, temperature, or liquid level for turning on, shutting off, or throttling the gas supply to an appliance.

3.3.24 Copper Alloy. A homogenous mixture of two or more metals in which copper is the primary component, such as brass and bronze.

3.3.25 Cubic Foot (ft^3) of Gas. The amount of gas that would occupy 1 ft^3 (0.03 m^3) when at a temperature of 60°F (16°C), saturated with water vapor and under a pressure equivalent to that of 30 in. mercury (101 kPa).

3.3.26 Deep Fat Fryer. See 3.3.4.4.3, Gas Deep Fat Fryer.

3.3.27 Device.

3.3.27.1 ***Automatic Gas Shutoff Device.*** A device constructed so that the attainment of a water temperature in a hot water supply system in excess of some predetermined limit acts in such a way as to cause the gas to the system to be shut off.

3.3.27.2 ***Pressure Limiting Device.*** Equipment that under abnormal conditions will act to reduce, restrict, or shut off the supply of gas flowing into a system in order to prevent the gas pressure in that system from exceeding a predetermined value.

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

3.3.27.4 ***Safety Shutoff Device.*** A device that will shut off the gas supply to the controlled burner(s) in the event the source of ignition fails. This device can interrupt the flow of gas to main burner(s) only or to pilot(s) and main burner(s) under its supervision.

3.3.28 Diversity Factor. Ratio of the maximum probable demand to the maximum possible demand.

3.3.29 Draft. A pressure difference that causes gases or air to flow through a chimney, vent, flue, or appliance.

3.3.29.1 ***Mechanical Draft.*** Draft produced by a fan or an air or steam jet. When a fan is located so as to push the flue gases through the chimney or vent, the draft is forced. When the fan is located so as to pull the flue gases through the chimney or vent, the draft is induced.

3.3.29.2 ***Natural Draft.*** Draft produced by the difference in the weight of a column of flue gases within a chimney or vent system and a corresponding column of air of equal dimension outside the chimney or venting system. [**31,** 2016]

3.3.30 Draft Hood. A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood, (2) prevent a backdraft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

3.3.31 Drip. The container placed at a low point in a system of piping to collect condensate and from which it may be removed.

3.3.32 Dry Gas. A gas having a moisture and hydrocarbon dew point below any normal temperature to which the gas piping is exposed.

3.3.33 Effective Ground-Fault Current Path. An intentionally constructed, low impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors. [**70:**100]

N **3.3.34 Engineering Methods.** Design methods that rely on the application of mathematics, sciences, empirical evidence, and engineering principles.

3.3.35 Equipment. Devices other than appliances.

3.3.36 Explosion Heads (Soft Heads or Rupture Discs). A protective device for relieving excessive pressure in a premix system by bursting of a rupturable disc.

3.3.37 FAN Max. The maximum input rating of a Category I, fan-assisted appliance attached to a vent or connector.

3.3.38 FAN Min. The minimum input rating of a Category I, fan-assisted appliance attached to a vent or connector.

3.3.39 FAN+FAN. The maximum combined appliance input rating of two or more Category I, fan-assisted appliances attached to the common vent.

3.3.40 FAN+NAT. The maximum combined appliance input rating of one or more Category I, fan-assisted appliances and one or more Category I, draft hood–equipped appliances attached to the common vent.

3.3.41 Fireplace. A fire chamber and hearth constructed of noncombustible material for use with solid fuels and provided with a chimney.

3.3.41.1 ***Gas Fireplace.***

3.3.41.1.1 ***Direct Vent Gas Fireplace.*** A system consisting of (1) an appliance for indoor installation that allows the view of flames and provides the simulation of a solid fuel fireplace, (2) combustion air connections between the appliance and the vent air intake terminal, (3) flue-gas connections between the appliance and the vent-air intake terminal, and (4) a vent air intake terminal for installation outdoors, constructed such that all air for combustion is obtained from the outdoor atmosphere and all flue gases are discharged to the outdoor atmosphere.

3.3.41.1.2 ***Vented Gas Fireplace.*** A vented appliance that allows the view of flames and provides the simulation of a solid fuel fireplace.

3.3.42 Flame Arrester. A nonvalve device for use in a gas–air mixture line containing a means for temporarily stopping the progress of a flame front (flashback).

3.3.43 Flue.

3.3.43.1 ***Appliance Flue.*** The passage(s) within an appliance through which combustion products pass from the combustion chamber of the appliance to the draft hood inlet opening on an appliance equipped with a draft hood or to the outlet of the appliance on an appliance not equipped with a draft hood.

3.3.43.2 ***Chimney Flue.*** The passage(s) in a chimney for conveying the flue or vent gases to the outdoors.

3.3.44 Flue Collar. That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system.

3.3.45 Furnace.

3.3.45.1 ***Central Furnace.*** A self-contained appliance for heating air by transfer of heat of combustion through metal to the air and designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

3.3.45.2 ***Direct Vent Wall Furnace.*** A system consisting of an appliance, combustion air, and flue gas connections between the appliance and the outdoor atmosphere, and a vent cap supplied by the manufacturer and constructed so that all air for combustion is obtained from the outdoor atmosphere and all flue gases are discharged to the outdoor atmosphere.

3.3.45.3 ***Duct Furnace.*** A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating. This definition applies only to an appliance that, for air circulation, depends on a blower not furnished as part of the furnace.

3.3.45.4 ***Enclosed Furnace.*** A specific heating, or heating and ventilating, furnace incorporating an integral total enclosure and using only outdoor air for combustion.

3.3.45.5 ***Floor Furnace.*** A completely self-contained unit furnace suspended from the floor of the space being heated, taking air for combustion from outside this space.

3.3.45.6 ***Forced-Air Furnace.*** A furnace equipped with a fan or blower that provides the primary means for circulation of air.

3.3.45.7 ***Vented Wall Furnace.*** A self-contained, vented, fuel gas–burning appliance complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building and furnishing heated air, circulated by gravity or by a fan, directly into the space to be heated through openings in the casing.

3.3.46 Furnace Plenum. A compartment or chamber that is supplied with the furnace or constructed of ductwork that is attached to the inlet or outlet of a furnace or air-handling unit and has one or more circulating air ducts connected to it.

3.3.47 Garage.

3.3.47.1 ***Repair Garage.*** A building, structure, or portions thereof wherein major repair, painting, or body and fender work is performed on motorized vehicles or automobiles,

and includes associated floor space used for offices, parking, and showrooms.

3.3.47.2 ***Residential Garage.*** A building or room in which self-propelled passenger vehicles are or can be stored and that will not normally be used for other than minor service or repair operations on such stored vehicles.

3.3.48 Gas Convenience Outlet. A permanently mounted, hand-operated device providing a means for connecting and disconnecting an appliance or an appliance connector to the gas supply piping.

3.3.49 Gases. Include natural gas, manufactured gas, liquefied petroleum (LP) gas in the vapor phase only, liquefied petroleum gas–air mixtures, and mixtures of these gases, plus gas–air mixtures within the flammable range, with the fuel gas or the flammable component of a mixture being a commercially distributed product.

3.3.49.1 ***Flue Gases.*** Products of combustion plus excess air in appliance flues or heat exchangers.

3.3.49.2 ***Utility Gases.*** Natural gas, manufactured gas, liquefied petroleum gas–air mixtures, or mixtures of any of these gases.

3.3.49.3 ***Vent Gases.*** Products of combustion from appliances plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.

3.3.50 Gas-Fired Air Conditioner. An automatically operated appliance for supplying cooled and/or dehumidified air or chilled liquid.

3.3.51 Gas-Fired Heat Pump. An automatically operated appliance utilizing a refrigeration system for supplying either heated air or liquid or heated and/or cooled air or liquid.

3.3.52 Gas-Mixing Machine. Any combination of automatic proportioning control devices, blowers, or compressors that supply mixtures of gas and air to multiple burner installations where control devices or other accessories are installed between the mixing device and burner.

3.3.53* Gas Vent. A passageway composed of listed factory-built components assembled in accordance with the manufacturer's installation instructions for conveying vent gases from appliances or their vent connectors to the outdoors.

3.3.53.1 ***Common Vent.*** That portion of a vent or chimney system that conveys vent gases from more than one appliance.

3.3.53.2 ***Special-Type Gas Vent.*** Gas vents for venting listed Category II, III, and IV appliances.

3.3.53.3 ***Type B Gas Vent.*** A gas vent for venting listed gas appliances with draft hoods and other Category I appliances listed for use with Type B gas vents.

3.3.53.4 ***Type B-W Gas Vent.*** A gas vent for venting listed wall furnaces.

3.3.53.5 ***Type L Gas Vent.*** A gas vent for venting appliances listed for use with Type L vents and appliances listed for use with Type B gas vents.

3.3.54 Gravity. See 3.3.91, Specific Gravity.

3.3.55 Grounding Electrode. A conducting object through which a direct connection to earth is established. [**70:**100]

3.3.56 Heater.

3.3.56.1 ***Infrared Heater.*** A heater that directs a substantial amount of its energy output in the form of infrared energy into the area to be heated. Such heaters may be of either the vented or unvented type.

3.3.56.2 ***Nonrecirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application.*** A nonrecirculating direct gas-fired heating and forced ventilation appliance in which all the products of combustion generated by the appliance are released into the outdoor airstream being heated.

3.3.56.3 ***Pool Heater.*** An appliance designed for heating nonpotable water stored at atmospheric pressure, such as water in swimming pools, therapeutic pools, and similar applications.

3.3.56.4 ***Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application.*** A recirculating direct gas-fired heating and forced ventilation appliance in which all of the products of combustion generated by the appliance are released into the airstream being heated.

3.3.56.5 ***Unit Heater.*** A self-contained, automatically controlled, vented, fuel gas–burning, space-heating appliance intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air.

3.3.56.6 ***Unvented Room Heater.*** An unvented, self-contained, freestanding, nonrecessed, fuel gas–burning appliance for furnishing warm air by gravity or fan circulation to the space in which installed, directly from the heater without duct connection.

3.3.56.7 ***Water Heater.*** An appliance for supplying hot water for domestic or commercial purposes.

3.3.57 Heating Value (Total). The number of British thermal units produced by the combustion, at constant pressure, of 1 ft^3 (0.03 m^3) of gas when the products of combustion are cooled to the initial temperature of the gas and air, when the water vapor formed during combustion is condensed, and when all the necessary corrections have been applied.

3.3.58 Hot Plate. See 3.3.4.4.2, Gas Counter Appliance.

3.3.58.1 ***Domestic Hot Plate.*** A fuel gas–burning appliance consisting of one or more open-top-type burners installed on short legs or a base.

3.3.59 Ignition.

3.3.59.1 ***Automatic Ignition.*** Ignition of gas at the burner(s) when the gas-controlling device is turned on, including re-ignition if the flames on the burner(s) have been extinguished by means other than by the closing of the gas-controlling device.

3.3.59.2 ***Sources of Ignition.*** Appliances or equipment that, because of their intended modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable gas–air mixtures.

3.3.60 Insulating Millboard. A factory-fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu/in./ft²/°F/hr (0.14 W/m/°K).

3.3.61 Kettle. See 3.3.4.4.4.

3.3.62 Manifold.

3.3.62.1 ***Common Vent Manifold.*** A horizontal extension of the common vent within the room in which the appliances are installed.

3.3.62.2 ***Gas Manifold.*** The conduit of an appliance that supplies gas to the individual burners.

3.3.63 Manufactured Home. A structure, transportable in one or more sections, that, in the traveling mode, is 8 body-ft (2.4 m) or more in width or 40 body-ft (12.2 m) or more in length or, that on site is 320 ft² (29.7 m²) or more, is built on a permanent chassis, is designed to be used as a dwelling with or without a permanent foundation, whether or not connected to the utilities, and includes plumbing, heating, air-conditioning, and electrical systems contained therein. Such terms shall include any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square feet in a structure are based on the structure's exterior dimensions, include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows. [**501,** 2017]

3.3.64 Material.

Δ **3.3.64.1*** ***Combustible (Material).*** A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible. [***101,*** 2015]

3.3.64.2 ***Noncombustible Material.*** A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

3.3.65 Meter. An instrument installed to measure the volume of gas delivered through it.

3.3.66 Mixing Blower. A motor-driven blower to produce gas–air mixtures for combustion.

3.3.67 NA. Vent configuration that is not allowed due to potential for condensate formation or pressurization of the venting system or that is not applicable due to physical or geometric restraints.

3.3.68 NAT Max. The maximum input rating of a Category I, draft hood–equipped appliance attached to a vent or connector.

3.3.69 NAT+NAT. The maximum combined appliance input rating of two or more Category I, draft hood–equipped appliances attached to the common vent.

3.3.70 Occupancy.

3.3.70.1 ***Health Care Occupancy.*** An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [**5000,** 2018]

3.3.70.2 ***Residential Board and Care Occupancy.*** An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services. [**5000,** 2018]

3.3.71 Orifice. The opening in a cap, spud, or other device whereby the flow of gas is limited and through which the gas is discharged to the burner.

Δ **3.3.72 Oven, Baking and Roasting.** See 3.3.4.4.1, Baking and Roasting Oven.

3.3.73 Parking Structure. A building, structure, or portion thereof used for the parking, storage, or both, of motor vehicles. [**88A,** 2019]

3.3.73.1 ***Basement or Underground Parking Structure.*** A parking structure or portion thereof located below finished ground level.

3.3.73.2 ***Enclosed Parking Structure.*** Having exterior enclosing walls that have less than 25 percent of the total wall area open to atmosphere at each level using at least two sides of the structure.

3.3.74 Pilot. A small flame that is utilized to ignite the gas at the main burner or burners.

3.3.75 Pipe. Rigid conduit used to convey fuel gas or other fluids.

3.3.75.1 ***Equivalent Length Pipe.*** The resistance of valves, controls, and fittings to gas flow expressed as equivalent length of straight pipe for convenience in calculating pipe sizes.

3.3.76 Piping. Pipe or tubing.

3.3.76.1 ***Concealed Gas Piping.*** Gas piping that, when in place in a finished building, would require removal of permanent construction to gain access to the piping.

3.3.76.2 ***Control Piping.*** All piping, valves, and fittings used to interconnect air, gas, or hydraulically operated control apparatus or instrument transmitters and receivers.

3.3.77 Plenum. A compartment or chamber to which one or more ducts are connected and that forms part of the air distribution system. [**90A,** 2018]

N **3.3.78 Point of Delivery.** The location point where the customer-owned fuel gas piping begins *[see 1.1.1.1(A)].*

3.3.79 Pressure. Unless otherwise stated, a measurement expressed in pounds per square inch above atmospheric pressure.

3.3.79.1 ***Atmospheric Pressure.*** The pressure of the weight of air on the surface of the earth, approximately 14.7 pounds per square inch (psia) (101 kPa absolute) at sea level.

3.3.79.2 ***Back Pressure.*** Pressure against which a fluid is flowing, resulting from friction in lines, restrictions in pipes or valves, pressure in vessel to which fluid is flowing, hydrostatic head, or other impediment that causes resistance to fluid flow.

3.3.79.3 ***Design Pressure.*** The maximum operating pressure permitted by this code, as determined by the design procedures applicable to the materials involved.

3.3.79.4 ***Maximum Working Pressure.*** The maximum pressure at which a piping system can be operated in accordance with the provisions of this code.

N **3.3.79.5** ***Supply Pressure.*** The gas pressure measured at the inlet to the appliance.

3.3.80 Pressure Drop. The loss in pressure due to friction or obstruction in pipes, valves, fittings, regulators, and burners.

3.3.81 Purge. To free a gas conduit of air or gas, or a mixture of gas and air.

3.3.82 Qualified Agency. Any individual, firm, corporation, or company that either in person or through a representative is engaged in and is responsible for (1) the design, installation, testing, or replacement of gas piping or (2) the connection, installation, testing, repair, or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction.

• **3.3.83 Refrigerator (Using Gas Fuel).** An appliance that is designed to extract heat from a suitable chamber.

3.3.84 Regulator.

3.3.84.1 ***Draft Regulator.*** A device that functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

3.3.84.1.1 ***Barometric Draft Regulator.*** A balanced damper device attached to a chimney, vent connector, breeching, or flue gas manifold to control chimney draft.

3.3.84.2 ***Gas Appliance Pressure Regulator.*** A pressure regulator for controlling pressure to the appliance manifold.

3.3.84.3 ***Line Pressure Regulator.*** A pressure regulator placed in a gas line between the service regulator and the appliance regulator.

3.3.84.4* ***Monitor Regulator.*** A pressure regulator that is installed in series with another pressure regulator for the purpose of preventing an overpressure in the downstream piping system.

3.3.84.5 ***Pressure Regulator.*** Equipment placed in a gas line for reducing, controlling, and maintaining the pressure in that portion of the piping system downstream of the equipment.

3.3.84.6 ***Regulator Vent.*** The opening in the atmospheric side of the regulator housing permitting the in and out movement of air to compensate for the movement of the regulator diaphragm.

3.3.84.7 ***Series Regulator.*** A pressure regulator in series with one or more other pressure regulators.

3.3.84.8 ***Service Regulator.*** A pressure regulator installed by the serving gas supplier to reduce and limit the service line gas pressure to delivery pressure.

3.3.85 Relief Opening. The opening provided in a draft hood to permit the ready escape to the atmosphere of the flue products from the draft hood in the event of no draft, backdraft, or stoppage beyond the draft hood and to permit inspiration of air into the draft hood in the event of a strong chimney updraft.

3.3.86 Safety Blowout (Backfire Preventer). A protective device incorporating a bursting disc for excessive pressure release, means for stopping a flame front, and an electric switch or other release mechanism for actuating a built-in or separate safety shutoff.

3.3.87 Service Head Adapter. A transition fitting for use with plastic piping (which is encased in non-pressure-carrying metal pipe) that connects the metal pipe casing and plastic pipe and tubing to the remainder of the piping system.

3.3.88 Service Meter Assembly. The meter, valves, piping, fittings, and equipment installed by the serving gas supplier to connect the gas supply to the customer's house or yard piping.

3.3.89 Service Regulator. See 3.3.84.5, Pressure Regulator; and 3.3.84.8, Service Regulator.

3.3.90 Shutoff. See 3.3.98, Valve.

3.3.91 Specific Gravity. As applied to gas, the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

Δ **3.3.92 Steam Cooker.** See 3.3.4.4.5, Steam Cooker.

Δ **3.3.93 Steam Generator.** See 3.3.4.4.6, Steam Generator.

3.3.94 Stress. The resultant internal force that resists change in the size or shape of a body acted on by external forces. In this code, the term *stress* is often used as being synonymous with unit stress, which is the stress per unit area (psi).

3.3.94.1 ***Hoop Stress.*** The stress in a pipe wall, acting circumferentially in a plane perpendicular to the longitudinal axis of the pipe and produced by the pressure of the fluid in the pipe.

3.3.95 System.

3.3.95.1 ***Central Premix System.*** A system that distributes flammable gas–air mixtures to two or more remote stations.

3.3.95.2 ***Fan-Assisted Combustion System.*** An appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.

3.3.95.3 ***Hybrid Pressure System.*** A piping system in which the pressure at the point of delivery is reduced by one or more line pressure regulators prior to the appliance connection.

3.3.95.4 ***Mechanical Exhaust System.*** Equipment installed in and made a part of the vent to provide the required flow of gases through the vent.

3.3.95.5 ***Natural Draft Venting System.*** A venting system that relies on natural draft to convey the products of combustion.

3.3.95.6 ***Piping System.*** All pipe, tubing, valves, and fittings from the point of delivery to the outlets of the appliance shutoff valves.

3.3.95.7* ***Venting System.*** A continuous open passageway from the flue collar or draft hood of an appliance to the outdoors for the purpose of removing flue or vent gases.

3.3.95.7.1 ***Mechanical Draft Venting System.*** A venting system designed to remove flue or vent gases by mechanical means, which can consist of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

• **3.3.96 Tensile Strength.** The highest unit tensile stress (referred to the original cross section) a material can sustain before failure (psi).

• **3.3.97 Tubing.** Semirigid conduit of copper, steel, aluminum, corrugated stainless steel tubing (CSST), or plastic.

Δ **3.3.98 Valve.**

Δ **3.3.98.1** ***Appliance Shutoff Valve.*** A valve used to shut off the fuel gas to an individual appliance.

3.3.98.2 ***Automatic Valve.*** An automatic or semiautomatic device consisting essentially of a valve and operator that control the gas supply to the burner(s) during operation of an appliance.

3.3.98.3 ***Excess Flow Valve (EFV).*** A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate.

3.3.98.4 ***Manual Reset Valve.*** An automatic shutoff valve installed in the gas supply piping and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.

3.3.98.5 ***Relief Valve.*** A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature, or vacuum in a hot water supply system.

3.3.98.5.1 ***Pressure Relief Valve.*** A valve that automatically opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

3.3.98.5.2 ***Temperature Relief Valve.*** A valve that automatically opens and automatically closes a relief vent, depending on whether the temperature is above or below a predetermined value.

3.3.98.5.3 ***Vacuum Relief Valve.*** A valve that automatically opens and closes a vent for relieving a vacuum within the hot water supply system, depending on whether the vacuum is above or below a predetermined value.

Δ **3.3.98.6** ***Service Shutoff Valve.*** A valve, installed by the serving gas supplier between the source of supply and the customer piping system, to shut off the fuel gas to the entire piping system.

N **3.3.98.7** ***System Shutoff Valve.*** A valve installed after the point of delivery to shut off the fuel gas to the entire piping system.

3.3.99 Valve Member. That part of a gas valve rotating within or in respect to the valve body that, by its position with respect to the valve body, controls the flow of gas.

3.3.99.1 ***Nondisplaceable Valve Member.*** A valve member that cannot be moved from its seat by a force applied to the handle or to any exterior portion of the valve.

3.3.100 Vent Connector. The pipe or duct that connects a fuel gas–burning appliance to a vent or chimney.

3.3.101 Vent Offset. An arrangement of two or more fittings and pipe installed for the purpose of locating a vertical section of vent pipe in a different but parallel plane with respect to an adjacent section of vertical vent pipe.

3.3.102 Venting. The conveyance of combustion products to the outdoors.

3.3.103 Wall Head Adapter. A transition fitting for terminating plastic pipe inside of buildings at the building wall.

3.3.104 Zero Governor. A regulating device that is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

Chapter 4 General

4.1 Qualified Agency. The following shall be performed only by a qualified agency:

(1) The design, installation, testing, purging, and replacement of gas piping, appliances, equipment, and accessories
(2) The repair and servicing of appliances and equipment

4.2 Interruption of Service.

4.2.1 Notification of Interrupted Service. When the gas supply is to be turned off, it shall be the duty of the qualified agency to notify all affected users. Where two or more users are served from the same supply system, precautions shall be exercised to ensure that service only to the proper user is turned off.

Exception: In cases of emergency, affected users shall be notified as soon as possible of the actions taken by the qualified agency.

4.2.2 Work Interruptions. When interruptions in work occur while repairs or alterations are being made to an existing piping system, the system shall be left in a safe condition.

4.3 Prevention of Accidental Ignition.

4.3.1 Potential Ignition Sources. Where work is being performed on piping that contains or has contained gas, the following shall apply:

(1) Provisions for electrical continuity shall be made before alterations are made in a metallic piping system.
(2) Smoking, open flames, lanterns, welding, or other sources of ignition shall not be permitted.
(3) A metallic electrical bond shall be installed around the location of cuts in metallic gas pipes made by other than cutting torches. Where cutting torches, welding, or other sources of ignition are to be used, it shall be determined that all sources of gas or gas–air mixtures have been secured and that all flammable gas or liquids have been cleared from the area. Piping shall be purged as required in Section 8.3 before welding or cutting with a torch is attempted.
(4) Artificial illumination shall be restricted to listed safety-type flashlights and safety lamps. Electric switches shall not be turned on or turned off.

4.3.2 Handling of Flammable Liquids.

Δ **4.3.2.1* Drip Liquids.** Liquid that is removed from a drip in existing gas piping shall be handled to avoid spillage or ignition.

4.3.2.2 Other Flammable Liquids. Flammable liquids used by the installer shall be handled with precaution and shall not be left within the premises from the end of one working day to the beginning of the next.

4.4* Noncombustible Material. A material that complies with any of the following shall be considered a noncombustible material:

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat
(2) A material that is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*
(3) A material that is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*

N **4.5 Engineering Methods.** Where an engineering method is used to calculate flow of air or gas, or to determine the size of gas pipe or a gas vent, the authority having jurisdiction shall be permitted to require submittal of any or all of the following:

(1) Calculations including documentation that the method used is published and recognized as being valid for the calculations provided
(2) The name of any software used, input and output developed, and documentation that the software is recognized as being valid for the calculations provided
(3)* The name of the person that performed the calculation or design, along with their qualifications to perform the calculation or design

Chapter 5 Gas Piping System Design, Materials, and Components

5.1 Piping Plan.

5.1.1 Installation of Piping System. Where required by the authority having jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. 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.

5.1.2 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.

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5.2 Interconnections Between Gas Piping Systems.

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

5.2.2 Interconnections for Standby Fuels.

5.2.2.1 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.

5.2.2.2 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.

5.3 Sizing of Gas Piping Systems.

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

5.3.2* Maximum Gas Demand.

5.3.2.1* The volumetric flow rate of gas to be provided shall be the sum of the maximum input of the appliances served.

5.3.2.2 The volumetric flow rate of gas to be provided shall be adjusted for altitude where the installation is above 2,000 ft (609.6 m).

5.3.2.3 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.

Δ **5.3.3* Sizing Methods.** Gas piping shall be sized in accordance with one of the following:

(1) Pipe sizing tables or sizing equations in Chapter 6
(2) Sizing tables included in a listed piping system manufacturer's installation instructions
(3) Engineering methods

5.3.4 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.

5.4 Operating Pressure.

5.4.1 Piping System Operating Pressure Limitations. The maximum operating pressure for any piping system shall not exceed 125 psi (862 kPa).

5.4.2 Flammable Gas–Air Mixtures. The maximum operating pressure for piping systems for gas–air mixtures within the flammable range shall be 10 psi (69 kPa).

5.4.3 LP-Gas Piping Systems. The maximum operating pressure for LP-Gas piping systems shall be 20 psi (140 kPa), except as provided in 5.4.4(8).

5.4.4 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:

(1)* The piping joints are welded or brazed.
(2) The piping is joined by fittings listed to ANSI LC 4/CSA 6.32, *Press-Connect Metallic Fittings for Use in Fuel Gas Distri-*

bution Systems, and installed according to the manufacturer's installation instructions.

(3) The piping joints are flanged and all pipe-to-flange connections are made by welding or brazing.

(4) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.

(5) The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:

(a) Industrial processing or heating
(b) Research
(c) Warehousing
(d) Boiler or mechanical rooms

(6) The piping is a temporary installation for buildings under construction.

(7) The piping serves appliances or equipment used for agricultural purposes.

(8) The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58.

5.4.5 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.

Δ 5.5 Piping Materials and Joining Methods.

5.5.1 General.

5.5.1.1 Acceptable Materials. Materials used for piping systems shall either comply with the requirements of this chapter or be acceptable to the authority having jurisdiction.

5.5.1.2 Used Materials. Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended.

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5.5.2 Metallic Pipe.

5.5.2.1 Cast Iron. Cast-iron pipe shall not be used.

5.5.2.2 Steel, Stainless Steel, and Wrought Iron. Steel, stainless steel, and wrought-iron pipe shall be at least Schedule 10 and shall comply with the dimensional standards of ANSI/ASME B36.10M, *Welded and Seamless Wrought Steel Pipe,* and one of the following:

(1) ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
(2) ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
(3) ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

5.5.2.3* Copper and Copper Alloy. 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 scf of gas (0.7 mg/100 L).

5.5.2.4 Threaded Copper, Copper Alloy, and Aluminum. Threaded copper, copper alloy, or aluminum alloy pipe shall not be used with gases corrosive to such material.

5.5.2.5 Aluminum Alloy. Aluminum alloy pipe shall comply with ASTM B241, *Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube* (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage.

5.5.2.6 Aluminum Installation. Aluminum alloy pipe shall not be used in exterior locations or underground.

5.5.3 Metallic Tubing.

5.5.3.1 Tubing shall not be used with gases corrosive to the tubing material

5.5.3.2 Steel. Steel tubing shall comply with ASTM A254, *Standard Specification for Copper-Brazed Steel Tubing.*

5.5.3.3 Stainless Steel. Stainless steel tubing shall comply with one of the following:

(1) ASTM A268, *Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service*
(2) ASTM A269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

5.5.3.4* Copper and Copper Alloy. 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 comply with standard Type K or Type L of ASTM B88, *Standard Specification for Seamless Copper Water Tube,* or ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.*

5.5.3.5 Aluminum. Aluminum alloy tubing shall comply with ASTM B210, *Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes,* or ASTM B241, *Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.* Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground.

5.5.3.6 Corrugated Stainless Steel. Corrugated stainless steel tubing shall be listed in accordance with ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.*

5.5.4 Plastic Pipe, Tubing, and Fittings.

5.5.4.1 Standard and Marking.

5.5.4.1.1 Polyethylene plastic pipe, tubing, and fittings used to supply fuel gas shall conform to ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.* Pipe to be used shall be marked "gas" and "ASTM D2513."

5.5.4.1.2 Polyamide pipe, tubing, and fittings shall be identified in and conform to ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings.* Pipe to be used shall be marked "gas" and "ASTM F2945."

5.5.4.1.3 Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) plastic pipe, tubing, and fittings shall not be used to supply fuel gas.

Δ 5.5.4.2* Regulator Vent Piping. Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to UL 651, *Schedule 40 and 80 Rigid PVC*

Conduit and Fittings. PVC vent piping shall not be installed indoors.

5.5.4.3 Anodeless Risers. Anodeless risers shall comply with the following:

(1) Factory-assembled anodeless risers shall be recommended by the manufacturer for the gas used and shall be leak tested by the manufacturer in accordance with written procedures.
(2) Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used and shall be design-certified to meet the requirements of Category I of ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings,* and 49 CFR 192.281(e). The manufacturer shall provide the user qualified installation instructions as prescribed by 49 CFR 192.283(b).
(3) The use of plastic pipe, tubing, and fittings in undiluted LP-Gas piping systems shall be in accordance with NFPA 58.

5.5.5 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.

5.5.6 Metallic Pipe Threads.

5.5.6.1 Specifications for Pipe Threads. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ANSI/ASME B1.20.1, *Pipe Threads, General Purpose, Inch.*

5.5.6.2 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.

5.5.6.3 Number of Threads. Field threading of metallic pipe shall be in accordance with Table 5.5.6.3.

Δ 5.5.6.4* Thread Joint Sealing.

***N* 5.5.6.4.1** Threaded joints shall be made using a thread joint sealing material.

Table 5.5.6.3 Specifications for Threading Metallic Pipe

Iron Pipe Size (in.)	Approximate Length of Threaded Portion (in.)	Approximate No. of Threads to Be Cut
½	¾	10
¾	¾	10
1	⅞	10
1¼	1	11
1½	1	11
2	1	11
2½	1½	12
3	1½	12
4	1⅝	13

For SI units, 1 in. = 25.4 mm.

***N* 5.5.6.4.2** Thread joint sealing materials shall be compatible with the pipe and fitting material on which the compounds are used.

***N* 5.5.6.4.3** Thread joint sealing materials shall be nonhardening and shall be resistant to the chemical constituents of the gases to be conducted through the piping.

5.5.7 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.

5.5.7.1* 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, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems.*

(A) Pipe lighter than Schedule 40 shall be connected using press-connect fittings, flanges, brazing, or welding.

(B) Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1000°F (538°C).

(C) Brazing alloys shall not contain more than 0.05 percent phosphorus.

5.5.7.2 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, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems.* Brazing alloys shall not contain more than 0.05 percent phosphorus.

5.5.7.3 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 1000°F (538°C), or assembled with press-connect fittings listed to ANSI LC 4/CSA 6.32, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems.* Brazing alloys and fluxes shall be recommended by the manufacturer for use on stainless steel alloys.

5.5.7.4 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.

5.5.7.5 Metallic Pipe Fittings. Metallic fittings shall comply with the following:

(1) Threaded fittings in sizes larger than 4 in. (100 mm) shall not be used.
(2) Fittings used with steel, stainless steel, or wrought-iron pipe shall be steel, stainless steel, copper alloy, malleable iron, or cast iron.
(3) Fittings used with copper or copper alloy pipe shall be copper or copper alloy.
(4) Fittings used with aluminum alloy pipe shall be aluminum alloy.
(5) *Cast-Iron Fittings.* Cast-iron fittings shall comply with the following:
    (a) Flanges shall be permitted.
    (b) Bushings shall not be used.

(c) Fittings shall not be used in systems containing flammable gas–air mixtures.
(d) Fittings in sizes 4 in. (100 mm) and larger shall not be used indoors unless approved by the authority having jurisdiction.
(e) Fittings in sizes 6 in. (150 mm) and larger shall not be used unless approved by the authority having jurisdiction.

(6) *Aluminum Alloy Fittings.* Threads shall not form the joint seal.

(7) *Zinc–Aluminum Alloy Fittings.* Fittings shall not be used in systems containing flammable gas–air mixtures.

(8) *Special Fittings.* Fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression-type tubing fittings shall be as follows:

(a) Used within the fitting manufacturer's pressure–temperature recommendations
(b) Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction
(c) Acceptable to the authority having jurisdiction

(9) When pipe fittings are drilled and tapped in the field, the operation shall be in accordance with the following:

(a) The operation shall be performed on systems having operating pressures of 5 psi (34 kPa) or less.
(b) The operation shall be performed by the gas supplier or their designated representative.
(c) The drilling and tapping operation shall be performed in accordance with written procedures prepared by the gas supplier.
(d) The fittings shall be located outdoors.
(e) The tapped fitting assembly shall be inspected and proven to be free of leaks.

5.5.8 Plastic Piping Joints and Fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers' instructions. The following shall be observed when making such joints:

(1) 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.

(2) 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."

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

(4) Plastic piping joints and fittings for use in LP-Gas piping systems shall be in accordance with NFPA 58.

5.5.9 Flanges.

5.5.9.1 Flange Specifications.

5.5.9.1.1 Cast iron flanges shall be in accordance with ANSI/ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.*

5.5.9.1.2 Steel flanges shall be in accordance with the following: ANSI/ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard,* or ANSI/ASME B16.47, *Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard.*

5.5.9.1.3 Non-ferrous flanges shall be in accordance with ANSI/ASME B16.24, *Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600. 900, 1500, and 2500.*

5.5.9.1.4 Ductile iron flanges shall be in accordance with ANSI/ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.*

5.5.9.2 Dissimilar Flange Connections. Raised-face flanges shall not be joined to flat-faced cast iron, ductile iron or non-ferrous material flanges.

5.5.9.3 Flange Facings. Standard facings shall be permitted for use under this code. 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.

5.5.9.4 Lapped Flanges. Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection.

5.5.10 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.

5.5.10.1 Acceptable materials shall include the following:

(1) Metal (plain or corrugated)
(2) Composition
(3) Aluminum "O" rings
(4) Spiral-wound metal gaskets
(5) Rubber-faced phenolic
(6) Elastomeric

5.5.10.2 Gasket Specifications.

5.5.10.2.1 Metallic flange gaskets shall be in accordance with ANSI/ASME B16.20, *Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound and Jacketed.*

5.5.10.2.2 Non-metallic flange gaskets shall be in accordance with ANSI/ASME B16.21, *Nonmetallic Flat Gaskets for Pipe Flanges.*

5.5.10.3 Full-face flange gaskets shall be used with all non-steel flanges.

5.5.10.4 When a flanged joint is separated, the gasket shall be replaced.

5.6* Gas Meters.

5.6.1 Capacity. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop.

5.6.2 Location.

5.6.2.1 Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance.

5.6.2.2 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.

5.6.2.3 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.

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

5.6.4 Meter Protection. Meters shall be protected against overpressure, back pressure, and vacuum.

5.6.5 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.

5.7* Gas Pressure Regulators.

5.7.1 Where Required. A line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served.

5.7.2 Listing. Line pressure regulators shall be listed in accordance with ANSI Z21.80/CSA 6.22, *Line Pressure Regulators*, where the outlet pressure is set to 2 psi or less.

5.7.3 Location. The gas pressure regulator shall be accessible for servicing.

5.7.4 Regulator Protection. Pressure regulators shall be protected against physical damage.

5.7.5 Regulator Vents. Regulator vents shall be in accordance with Section 5.14.

5.7.6 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.

5.8 Overpressure Protection Devices.

5.8.1 Where 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 in. w.c. (3.4 kPa)or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 in. w.c. (3.4 kPa) shall be equipped with overpressure protection devices as required by the appliance manufacturer's installation instructions.

5.8.2 Pressure Limitation Requirements.

5.8.2.1 Where piping systems serving appliances designed to operate with a gas supply pressure of 14 in. w.c. (3.4 kPa) or less are required to be equipped with overpressure protection by 5.8.1, 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.

5.8.2.2 Where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 in. w.c. (3.4 kPa) are required to be equipped with overpressure protection by 5.8.1, 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.

5.8.2.3 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.

5.8.2.4 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.

5.8.2.5 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 5.8.2.1 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.

5.8.3 Overpressure Protection Devices.

5.8.3.1 Overpressure protection devices shall be one of the following:

(1) Pressure relief valve.
(2) Monitor regulator.
(3) 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 by 5.8.2.1 or less.
(4) 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 by 5.8.2.1 or less. This device shall be designed so that it will remain closed until manually reset.

5.8.3.2 The devices in 5.8.3.1 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 comply with 5.8.4 through 5.8.9.

5.8.4 Construction and Installation. All overpressure protection devices shall meet the following requirements:

(1) 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.
(2) 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.

5.8.5 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.

5.8.6 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 5.8.2.1 and 5.8.2.2.

5.8.7 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.

5.8.8 Vents.

5.8.8.1 The discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged 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.

5.8.8.2 The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device.

5.8.9 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.

5.9 Back Pressure Protection.

5.9.1 Where to Install.

5.9.1.1 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.

5.9.1.2 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.

5.9.2 Protective Devices. Protective devices shall include but not be limited to the following:

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

5.10* 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.

5.11 Shutoff Valves. Shutoff valves shall be selected in accordance with Table 5.11. Shutoff valves of size 1 in. (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.

N **Table 5.11 Manual Gas Valve Standards**

Shutoff Valve Application	Valve Meeting the Following Standards
Appliance shutoff valve up to ½ psi	ANSI Z21.15/CSA 9.1 ANSI/ASME B16.44 ANSI/ASME B16.33 marked 125 G ANSI LC 4/CSA 6.32
Valve up to ½ psi	ANSI/ASME B16.44 ANSI/ASME B16.33 marked 125 G ANSI LC 4/CSA 6.32
Valve up to 2 psi	ANSI/ASME B16.44 labeled 2G ANSI/ASME B16.33 marked 125 G ANSI LC 4/CSA 6.32 with ANSI/ASME B16.44 labeled 2G or labeled 5G ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G
Valve up to 5 psi	ANSI/ASME B16.44 labeled 5G ANSI/ASME B16.33 ANSI LC 4/CSA 6.32 with ANSI/ASME B16.44 marked 5G ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G
Valve up to 125 psi	ANSI/ASME B16.33 marked 125 G ANSI LC 4/CSA 6.32 with ANSI/ASME B16.33 marked 125 G

For SI units, 1 psi gauge = 6.895 kPa.

5.12 Excess Flow Valve(s). Where automatic excess flow valves are installed, they shall be listed in accordance with ANSI Z21.93/CSA 6.30, *Excess Flow Valves for Natural and LP-Gas with Pressures Up to 5 psig*, and shall be sized and installed in accordance with the manufacturers' instructions.

5.13 Expansion and Flexibility.

5.13.1 Design. Piping systems shall be designed to prevent failure from thermal expansion or contraction.

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

N **5.14 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:

(1) 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.

Exception No. 1: A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22, Line Pressure Regulators, shall not be required to be vented to the outdoors.

Exception No. 2: A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.

(2) Materials for vent piping shall be in accordance with Section 5.5.

(3) The vent terminus shall be designed to prevent the entry of water, insects, and other foreign matter that could cause blockage.

(4) Vent piping shall be installed to minimize static loads and bending moments placed on the regulators and gas pressure control devices.

(5) Vents shall terminate not less than 3 ft (0.9 m) from a possible source of ignition.

(6) 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.

(7) 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.

Chapter 6 Pipe Sizing

6.1* Pipe Sizing Methods. Where the pipe size is to be determined using any of the methods in 6.1.1 through 6.1.3, the diameter of each pipe segment shall be obtained from the pipe sizing tables in Section 6.2 or Section 6.3 or from the sizing equations in Section 6.4. For SI units, 1 ft^3 = 0.028 m^3, 1 ft = 0.305 m, 1 in. w.c. = 0.249 kPa, 1 psi = 6.894 kPa, 1000 Btu/hr = 0.293 kW.

6.1.1* 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.

6.1.2* 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.

6.1.3 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.

6.2 Sizing Natural Gas Piping Systems. Sizing of piping systems shall be in accordance with 6.2.1 or 6.2.2.

6.2.1 Table 6.2.1(a) through Table 6.2.1(x) shall be used in conjunction with one of the methods described in 6.1.1 through 6.1.3 for piping materials other than non-corrugated stainless steel tubing.

6.2.2 Section 6.4 shall be used in conjunction with one of the methods described in 6.1.1 through 6.1.3 for non-corrugated stainless steel tubing.

6.3 Sizing Propane Piping Systems. Sizing of piping systems shall be in accordance with 6.3.1 or 6.3.2.

6.3.1 Table 6.3.1(a) through Table 6.3.1(m) shall be used in conjunction with one of the methods described in 6.1.1 through 6.1.3 for piping materials other than non-corrugated stainless steel tubing.

6.3.2 Section 6.4 shall be used in conjunction with one of the methods described in 6.1.1 through 6.1.3 for non-corrugated stainless steel tubing.

6.4 Sizing Equations. The inside diameter of smooth wall pipe or tubing shall be determined by the sizing equations in 6.4.1 and 6.4.2 using the equivalent pipe length determined by the methods in 6.1.1 through 6.1.3.

6.4.1* Low-Pressure Gas Formula. Less than 1.5 psi (10.3 kPa):

[6.4.1]

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

where:
D = inside diameter of pipe (in.)
Q = input rate appliance(s) (cubic feet per hour at 60°F and 30 in. mercury column)
ΔH = pressure drop [in. w.c. (27.7 in. H_2O = 1 psi)]
L = equivalent length of pipe (ft)
See Table 6.4.2 for values of Cr.

6.4.2* High-Pressure Gas Formula. 1.5 psi (10.3 kPa) and above:

[6.4.2]

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

where:
D = inside diameter of pipe (in.)
Q = input rate appliance(s) (cubic feet per hour at 60°F and 30 in. 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 (ft)
See Table 6.4.2 for values of Cr and Y.

Table 6.2.1(a) Schedule 40 Metallic Pipe

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

NA: A flow of less than 10 cfh.

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

Table 6.2.1(b) Schedule 40 Metallic Pipe

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

	Pipe Size (in.)													
Nominal:	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	81	170	320	657	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	65	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,700	95,700	152,000
70	60	126	237	486	728	1,400	2,230	3,950	8,050	14,600	23,600	48,500	88,100	139,000
80	56	117	220	452	677	1,300	2,080	3,670	7,490	13,600	22,000	45,100	81,900	130,000
90	52	110	207	424	635	1,220	1,950	3,450	7,030	12,700	20,600	42,300	76,900	122,000
100	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	72,600	115,000
125	44	92	173	355	532	1,020	1,630	2,890	5,890	10,600	17,200	35,400	64,300	102,000
150	40	83	157	322	482	928	1,480	2,610	5,330	9,650	15,600	32,100	58,300	92,300
175	37	77	144	296	443	854	1,360	2,410	4,910	8,880	14,400	29,500	53,600	84,900
200	34	71	134	275	412	794	1,270	2,240	4,560	8,260	13,400	27,500	49,900	79,000
250	30	63	119	244	366	704	1,120	1,980	4,050	7,320	11,900	24,300	44,200	70,000
300	27	57	108	221	331	638	1,020	1,800	3,670	6,630	10,700	22,100	40,100	63,400
350	25	53	99	203	305	587	935	1,650	3,370	6,100	9,880	20,300	36,900	58,400
400	23	49	92	189	283	546	870	1,540	3,140	5,680	9,190	18,900	34,300	54,300
450	22	46	86	177	266	512	816	1,440	2,940	5,330	8,620	17,700	32,200	50,900
500	21	43	82	168	251	484	771	1,360	2,780	5,030	8,150	16,700	30,400	48,100
550	20	41	78	159	239	459	732	1,290	2,640	4,780	7,740	15,900	28,900	45,700
600	19	39	74	152	228	438	699	1,240	2,520	4,560	7,380	15,200	27,500	43,600
650	18	38	71	145	218	420	669	1,180	2,410	4,360	7,070	14,500	26,400	41,800
700	17	36	68	140	209	403	643	1,140	2,320	4,190	6,790	14,000	25,300	40,100
750	17	35	66	135	202	389	619	1,090	2,230	4,040	6,540	13,400	24,400	38,600
800	16	34	63	130	195	375	598	1,060	2,160	3,900	6,320	13,000	23,600	37,300
850	16	33	61	126	189	363	579	1,020	2,090	3,780	6,110	12,600	22,800	36,100
900	15	32	59	122	183	352	561	992	2,020	3,660	5,930	12,200	22,100	35,000
950	15	31	58	118	178	342	545	963	1,960	3,550	5,760	11,800	21,500	34,000
1,000	14	30	56	115	173	333	530	937	1,910	3,460	5,600	11,500	20,900	33,100
1,100	14	28	53	109	164	316	503	890	1,810	3,280	5,320	10,900	19,800	31,400
1,200	13	27	51	104	156	301	480	849	1,730	3,130	5,070	10,400	18,900	30,000
1,300	12	26	49	100	150	289	460	813	1,660	3,000	4,860	9,980	18,100	28,700
1,400	12	25	47	96	144	277	442	781	1,590	2,880	4,670	9,590	17,400	27,600
1,500	11	24	45	93	139	267	426	752	1,530	2,780	4,500	9,240	16,800	26,600
1,600	11	23	44	89	134	258	411	727	1,480	2,680	4,340	8,920	16,200	25,600
1,700	11	22	42	86	130	250	398	703	1,430	2,590	4,200	8,630	15,700	24,800
1,800	10	22	41	84	126	242	386	682	1,390	2,520	4,070	8,370	15,200	24,100
1,900	10	21	40	81	122	235	375	662	1,350	2,440	3,960	8,130	14,800	23,400
2,000	NA	20	39	79	119	229	364	644	1,310	2,380	3,850	7,910	14,400	22,700

NA: A flow of less than 10 cfh.

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

Table 6.2.1(c) Schedule 40 Metallic Pipe

						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 (in.)								
Nominal:	½	¾	1	1¼	1½	2	2 ½	3	4
Actual ID:	**0.622**	**0.824**	**1.049**	**1.380**	**1.610**	**2.067**	**2.469**	**3.068**	**4.026**
Length (ft)	**Capacity in Thousands of Btu per Hour**								
10	454	949	1,790	3,670	5,500	10,600	16,900	29,800	60,800
20	312	652	1,230	2,520	3,780	7,280	11,600	20,500	41,800
30	250	524	986	2,030	3,030	5,840	9,310	16,500	33,600
40	214	448	844	1,730	2,600	5,000	7,970	14,100	28,700
50	190	397	748	1,540	2,300	4,430	7,060	12,500	25,500
60	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100
70	158	331	624	1,280	1,920	3,690	5,890	10,400	21,200
80	147	308	580	1,190	1,790	3,440	5,480	9,690	19,800
90	138	289	544	1,120	1,670	3,230	5,140	9,090	18,500
100	131	273	514	1,060	1,580	3,050	4,860	8,580	17,500
125	116	242	456	936	1,400	2,700	4,300	7,610	15,500
150	105	219	413	848	1,270	2,450	3,900	6,890	14,100
175	96	202	380	780	1,170	2,250	3,590	6,340	12,900
200	90	188	353	726	1,090	2,090	3,340	5,900	12,000
250	80	166	313	643	964	1,860	2,960	5,230	10,700
300	72	151	284	583	873	1,680	2,680	4,740	9,660
350	66	139	261	536	803	1,550	2,470	4,360	8,890
400	62	129	243	499	747	1,440	2,290	4,050	8,270
450	58	121	228	468	701	1,350	2,150	3,800	7,760
500	55	114	215	442	662	1,280	2,030	3,590	7,330
550	52	109	204	420	629	1,210	1,930	3,410	6,960
600	50	104	195	400	600	1,160	1,840	3,260	6,640
650	47	99	187	384	575	1,110	1,760	3,120	6,360
700	46	95	179	368	552	1,060	1,690	3,000	6,110
750	44	92	173	355	532	1,020	1,630	2,890	5,890
800	42	89	167	343	514	989	1,580	2,790	5,680
850	41	86	162	332	497	957	1,530	2,700	5,500
900	40	83	157	322	482	928	1,480	2,610	5,330
950	39	81	152	312	468	901	1,440	2,540	5,180
1000	38	79	148	304	455	877	1,400	2,470	5,040
1100	36	75	141	289	432	833	1,330	2,350	4,780
1200	34	71	134	275	412	794	1,270	2,240	4,560
1300	33	68	128	264	395	761	1,210	2,140	4,370
1400	31	65	123	253	379	731	1,160	2,060	4,200
1500	30	63	119	244	366	704	1,120	1,980	4,050
1600	29	61	115	236	353	680	1,080	1,920	3,910
1700	28	59	111	228	342	658	1,050	1,850	3,780
1800	27	57	108	221	331	638	1,020	1,800	3,670
1900	27	56	105	215	322	619	987	1,750	3,560
2000	26	54	102	209	313	602	960	1,700	3,460

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

Table 6.2.1(d) Schedule 40 Metallic Pipe

Gas:	Natural
Inlet Pressure:	Less than 2 psi
Pressure Drop:	6.0 in. w.c.
Specific Gravity:	0.6

INTENDED USE: Initial supply pressure of 11.0 in. w.c. or greater

	Pipe Size (in.)								
Nominal:	½	¾	1	1¼	1½	2	2½	3	4
Actual ID:	0.622	0.824	1.049	1.38	1.61	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas per Hour								
10	660	1,380	2,600	5,340	8,000	15,400	24,600	43,400	88,500
20	454	949	1,790	3,670	5,500	10,600	16,900	29,800	60,800
30	364	762	1,440	2,950	4,410	8,500	13,600	24,000	48,900
40	312	652	1,230	2,520	3,780	7,280	11,600	20,500	41,800
50	276	578	1,090	2,240	3,350	6,450	10,300	18,200	37,100
60	250	524	986	2,030	3,030	5,840	9,310	16,500	33,600
70	230	482	907	1,860	2,790	5,380	8,570	15,100	30,900
80	214	448	844	1,730	2,600	5,000	7,970	14,100	28,700
90	201	420	792	1,630	2,440	4,690	7,480	13,200	27,000
100	190	397	748	1,540	2,300	4,430	7,060	12,500	25,500
125	168	352	663	1,360	2,040	3,930	6,260	11,100	22,600
150	153	319	601	1,230	1,850	3,560	5,670	10,000	20,500
175	140	293	553	1,140	1,700	3,270	5,220	9,230	18,800
200	131	273	514	1,056	1,580	3,050	4,860	8,580	17,500
250	116	242	456	936	1,400	2,700	4,300	7,610	15,500
300	105	219	413	848	1,270	2,450	3,900	6,890	14,100
350	96	202	380	780	1,170	2,250	3,590	6,340	12,900
400	90	188	353	726	1,090	2,090	3,340	5,900	12,000
450	84	176	332	681	1,020	1,960	3,130	5,540	11,300
500	80	166	313	643	964	1,860	2,960	5,230	10,700
550	76	158	297	611	915	1,760	2,810	4,970	10,100
600	72	151	284	583	873	1,680	2,680	4,740	9,660
650	69	144	272	558	836	1,610	2,570	4,540	9,250
700	66	139	261	536	803	1,550	2,470	4,360	8,890
750	64	134	252	516	774	1,490	2,380	4,200	8,560
800	62	129	243	499	747	1,440	2,290	4,050	8,270
850	60	125	235	483	723	1,390	2,220	3,920	8,000
900	58	121	228	468	701	1,350	2,150	3,800	7,760
950	56	118	221	454	681	1,310	2,090	3,690	7,540
1,000	55	114	215	442	662	1,280	2,030	3,590	7,330
1,100	52	109	204	420	629	1,210	1,930	3,410	6,960
1,200	50	104	195	400	600	1,160	1,840	3,260	6,640
1,300	47	99	187	384	575	1,110	1,760	3,120	6,360
1,400	46	95	179	368	552	1,060	1,690	3,000	6,110
1,500	44	92	173	355	532	1,020	1,630	2,890	5,890
1,600	42	89	167	343	514	989	1,580	2,790	5,680
1,700	41	86	162	332	497	957	1,530	2,700	5,500
1,800	40	83	157	322	482	928	1,480	2,610	5,330
1,900	39	81	152	312	468	901	1,440	2,540	5,180
2,000	38	79	148	304	455	877	1,400	2,470	5,040

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

Table 6.2.1(e) Schedule 40 Metallic Pipe

						Gas:	Natural		
						Inlet Pressure:	2.0 psi		
						Pressure Drop:	1.0 psi		
						Specific Gravity:	0.60		
	Pipe Size (in.)								
Nominal:	½	¾	1	1¼	1½	2	2½	3	4
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Cubic Feet of Gas per Hour								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	37,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	934	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
250	279	583	1,040	2,140	3,210	6,180	9,850	17,400	35,500
300	253	528	945	1,940	2,910	5,600	8,920	15,800	32,200
350	232	486	869	1,790	2,670	5,150	8,210	14,500	29,600
400	216	452	809	1,660	2,490	4,790	7,640	13,500	27,500
450	203	424	759	1,560	2,330	4,500	7,170	12,700	25,800
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
550	182	381	681	1,400	2,090	4,030	6,430	11,400	23,200
600	174	363	650	1,330	2,000	3,850	6,130	10,800	22,100
650	166	348	622	1,280	1,910	3,680	5,870	10,400	21,200
700	160	334	598	1,230	1,840	3,540	5,640	9,970	20,300
750	154	322	576	1,180	1,770	3,410	5,440	9,610	19,600
800	149	311	556	1,140	1,710	3,290	5,250	9,280	18,900
850	144	301	538	1,100	1,650	3,190	5,080	8,980	18,300
900	139	292	522	1,070	1,600	3,090	4,930	8,710	17,800
950	135	283	507	1,040	1,560	3,000	4,780	8,460	17,200
1,000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1,100	125	262	468	960	1,440	2,770	4,420	7,810	15,900
1,200	119	250	446	917	1,370	2,640	4,220	7,450	15,200
1,300	114	239	427	878	1,320	2,530	4,040	7,140	14,600
1,400	110	230	411	843	1,260	2,430	3,880	6,860	14,000
1,500	106	221	396	812	1,220	2,340	3,740	6,600	13,500
1,600	102	214	382	784	1,180	2,260	3,610	6,380	13,000
1,700	99	207	370	759	1,140	2,190	3,490	6,170	12,600
1,800	96	200	358	736	1,100	2,120	3,390	5,980	12,200
1,900	93	195	348	715	1,070	2,060	3,290	5,810	11,900
2,000	91	189	339	695	1,040	2,010	3,200	5,650	11,500

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

Table 6.2.1(f) Schedule 40 Metallic Pipe

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

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

Table 6.2.1(g) Schedule 40 Metallic Pipe

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

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

Table 6.2.1(h) Semirigid Copper Tubing

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

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

NA: A flow of less than 10 cfh.

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

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

Table 6.2.1(i) Semirigid Copper Tubing

							Gas:	Natural		
							Inlet Pressure:	Less than 2 psi		
							Pressure Drop:	0.5 in. w.c.		
							Specific Gravity:	0.60		
		Tube Size (in.)								
Nominal:	K & L:	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:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		27	55	111	195	276	590	1,060	1,680	3,490
20		18	38	77	134	190	406	730	1,150	2,400
30		15	30	61	107	152	326	586	925	1,930
40		13	26	53	92	131	279	502	791	1,650
50		11	23	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320
70		NA	19	39	68	96	206	371	585	1,220
80		NA	18	36	63	90	192	345	544	1,130
90		NA	17	34	59	84	180	324	510	1,060
100		NA	16	32	56	79	170	306	482	1,000
125		NA	14	28	50	70	151	271	427	890
150		NA	13	26	45	64	136	245	387	806
175		NA	12	24	41	59	125	226	356	742
200		NA	11	22	39	55	117	210	331	690
250		NA	NA	20	34	48	103	186	294	612
300		NA	NA	18	31	44	94	169	266	554
350		NA	NA	16	28	40	86	155	245	510
400		NA	NA	15	26	38	80	144	228	474
450		NA	NA	14	25	35	75	135	214	445
500		NA	NA	13	23	33	71	128	202	420
550		NA	NA	13	22	32	68	122	192	399
600		NA	NA	12	21	30	64	116	183	381
650		NA	NA	12	20	29	62	111	175	365
700		NA	NA	11	20	28	59	107	168	350
750		NA	NA	11	19	27	57	103	162	338
800		NA	NA	10	18	26	55	99	156	326
850		NA	NA	10	18	25	53	96	151	315
900		NA	NA	NA	17	24	52	93	147	306
950		NA	NA	NA	17	24	50	90	143	297
1,000		NA	NA	NA	16	23	49	88	139	289
1,100		NA	NA	NA	15	22	46	84	132	274
1,200		NA	NA	NA	15	21	44	80	126	262
1,300		NA	NA	NA	14	20	42	76	120	251
1,400		NA	NA	NA	13	19	41	73	116	241
1,500		NA	NA	NA	13	18	39	71	111	232
1,600		NA	NA	NA	13	18	38	68	108	224
1,700		NA	NA	NA	12	17	37	66	104	217
1,800		NA	NA	NA	12	17	36	64	101	210
1,900		NA	NA	NA	11	16	35	62	98	204
2,000		NA	NA	NA	11	16	34	60	95	199

NA: A flow of less than 10 cfh.

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

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

Table 6.2.1(j) Semirigid Copper Tubing

Gas:	Natural
Inlet Pressure:	Less than 2 psi
Pressure Drop:	1.0 in. w.c.
Specific Gravity:	0.60

INTENDED USE: Tube Sizing Between House Line Regulator and the Appliance.

Nominal:		Tube Size (in.)								
	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		39	80	162	283	402	859	1,550	2,440	5,080
20		27	55	111	195	276	590	1,060	1,680	3,490
30		21	44	89	156	222	474	853	1,350	2,800
40		18	38	77	134	190	406	730	1,150	2,400
50		16	33	68	119	168	359	647	1,020	2,130
60		15	30	61	107	152	326	586	925	1,930
70		13	28	57	99	140	300	539	851	1,770
80		13	26	53	92	131	279	502	791	1,650
90		12	24	49	86	122	262	471	742	1,550
100		11	23	47	82	116	247	445	701	1,460
125		NA	20	41	72	103	219	394	622	1,290
150		NA	18	37	65	93	198	357	563	1,170
175		NA	17	34	60	85	183	329	518	1,080
200		NA	16	32	56	79	170	306	482	1,000
250		NA	14	28	50	70	151	271	427	890
300		NA	13	26	45	64	136	245	387	806
350		NA	12	24	41	59	125	226	356	742
400		NA	11	22	39	55	117	210	331	690
450		NA	10	21	36	51	110	197	311	647
500		NA	NA	20	34	48	103	186	294	612
550		NA	NA	19	32	46	98	177	279	581
600		NA	NA	18	31	44	94	169	266	554
650		NA	NA	17	30	42	90	162	255	531
700		NA	NA	16	28	40	86	155	245	510
750		NA	NA	16	27	39	83	150	236	491
800		NA	NA	15	26	38	80	144	228	474
850		NA	NA	15	26	36	78	140	220	459
900		NA	NA	14	25	35	75	135	214	445
950		NA	NA	14	24	34	73	132	207	432
1,000		NA	NA	13	23	33	71	128	202	420
1,100		NA	NA	13	22	32	68	122	192	399
1,200		NA	NA	12	21	30	64	116	183	381
1,300		NA	NA	12	20	29	62	111	175	365
1,400		NA	NA	11	20	28	59	107	168	350
1,500		NA	NA	11	19	27	57	103	162	338
1,600		NA	NA	10	18	26	55	99	156	326
1,700		NA	NA	10	18	25	53	96	151	315
1,800		NA	NA	NA	17	24	52	93	147	306
1,900		NA	NA	NA	17	24	50	90	143	297
2,000		NA	NA	NA	16	23	49	88	139	289

NA: A flow of less than 10 cfh.

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

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

Table 6.2.1(k) Semirigid Copper Tubing

							Gas:	Natural		
							Inlet Pressure:	Less than 2.0 psi		
							Pressure Drop:	17.0 in. w.c.		
							Specific Gravity:	0.60		
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		190	391	796	1,390	1,970	4,220	7,590	12,000	24,900
20		130	269	547	956	1,360	2,900	5,220	8,230	17,100
30		105	216	439	768	1,090	2,330	4,190	6,610	13,800
40		90	185	376	657	932	1,990	3,590	5,650	11,800
50		79	164	333	582	826	1,770	3,180	5,010	10,400
60		72	148	302	528	749	1,600	2,880	4,540	9,460
70		66	137	278	486	689	1,470	2,650	4,180	8,700
80		62	127	258	452	641	1,370	2,460	3,890	8,090
90		58	119	243	424	601	1,280	2,310	3,650	7,590
100		55	113	229	400	568	1,210	2,180	3,440	7,170
125		48	100	203	355	503	1,080	1,940	3,050	6,360
150		44	90	184	321	456	974	1,750	2,770	5,760
175		40	83	169	296	420	896	1,610	2,540	5,300
200		38	77	157	275	390	834	1,500	2,370	4,930
250		33	69	140	244	346	739	1,330	2,100	4,370
300		30	62	126	221	313	670	1,210	1,900	3,960
350		28	57	116	203	288	616	1,110	1,750	3,640
400		26	53	108	189	268	573	1,030	1,630	3,390
450		24	50	102	177	252	538	968	1,530	3,180
500		23	47	96	168	238	508	914	1,440	3,000
550		22	45	91	159	226	482	868	1,370	2,850
600		21	43	87	152	215	460	829	1,310	2,720
650		20	41	83	145	206	441	793	1,250	2,610
700		19	39	80	140	198	423	762	1,200	2,500
750		18	38	77	135	191	408	734	1,160	2,410
800		18	37	74	130	184	394	709	1,120	2,330
850		17	35	72	126	178	381	686	1,080	2,250
900		17	34	70	122	173	370	665	1,050	2,180
950		16	33	68	118	168	359	646	1,020	2,120
1,000		16	32	66	115	163	349	628	991	2,060
1,100		15	31	63	109	155	332	597	941	1,960
1,200		14	29	60	104	148	316	569	898	1,870
1,300		14	28	57	100	142	303	545	860	1,790
1,400		13	27	55	96	136	291	524	826	1,720
1,500		13	26	53	93	131	280	505	796	1,660
1,600		12	25	51	89	127	271	487	768	1,600
1,700		12	24	49	86	123	262	472	744	1,550
1,800		11	24	48	84	119	254	457	721	1,500
1,900		11	23	47	81	115	247	444	700	1,460
2,000		11	22	45	79	112	240	432	681	1,420

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

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

Table 6.2.1(l) Semirigid Copper Tubing

							Gas:	Natural		
							Inlet Pressure:	2.0 psi		
							Pressure Drop:	1.0 psi		
							Specific Gravity:	0.60		
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		245	506	1,030	1,800	2,550	5,450	9,820	15,500	32,200
20		169	348	708	1,240	1,760	3,750	6,750	10,600	22,200
30		135	279	568	993	1,410	3,010	5,420	8,550	17,800
40		116	239	486	850	1,210	2,580	4,640	7,310	15,200
50		103	212	431	754	1,070	2,280	4,110	6,480	13,500
60		93	192	391	683	969	2,070	3,730	5,870	12,200
70		86	177	359	628	891	1,900	3,430	5,400	11,300
80		80	164	334	584	829	1,770	3,190	5,030	10,500
90		75	154	314	548	778	1,660	2,990	4,720	9,820
100		71	146	296	518	735	1,570	2,830	4,450	9,280
125		63	129	263	459	651	1,390	2,500	3,950	8,220
150		57	117	238	416	590	1,260	2,270	3,580	7,450
175		52	108	219	383	543	1,160	2,090	3,290	6,850
200		49	100	204	356	505	1,080	1,940	3,060	6,380
250		43	89	181	315	448	956	1,720	2,710	5,650
300		39	80	164	286	406	866	1,560	2,460	5,120
350		36	74	150	263	373	797	1,430	2,260	4,710
400		33	69	140	245	347	741	1,330	2,100	4,380
450		31	65	131	230	326	696	1,250	1,970	4,110
500		30	61	124	217	308	657	1,180	1,870	3,880
550		28	58	118	206	292	624	1,120	1,770	3,690
600		27	55	112	196	279	595	1,070	1,690	3,520
650		26	53	108	188	267	570	1,030	1,620	3,370
700		25	51	103	181	256	548	986	1,550	3,240
750		24	49	100	174	247	528	950	1,500	3,120
800		23	47	96	168	239	510	917	1,450	3,010
850		22	46	93	163	231	493	888	1,400	2,920
900		22	44	90	158	224	478	861	1,360	2,830
950		21	43	88	153	217	464	836	1,320	2,740
1,000		20	42	85	149	211	452	813	1,280	2,670
1,100		19	40	81	142	201	429	772	1,220	2,540
1,200		18	38	77	135	192	409	737	1,160	2,420
1,300		18	36	74	129	183	392	705	1,110	2,320
1,400		17	35	71	124	176	376	678	1,070	2,230
1,500		16	34	68	120	170	363	653	1,030	2,140
1,600		16	33	66	116	164	350	630	994	2,070
1,700		15	31	64	112	159	339	610	962	2,000
1,800		15	30	62	108	154	329	592	933	1,940
1,900		14	30	60	105	149	319	575	906	1,890
2,000		14	29	59	102	145	310	559	881	1,830

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

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

Table 6.2.1(m) Semirigid Copper Tubing

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

INTENDED USE: Pipe Sizing Between Point of Delivery and the House Line Regulator. Total Load Supplied by a Single House Line Regulator Not Exceeding 150 Cubic Feet per Hour.*

		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:†		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		303	625	1,270	2,220	3,150	6,740	12,100	19,100	39,800
20		208	430	874	1,530	2,170	4,630	8,330	13,100	27,400
30		167	345	702	1,230	1,740	3,720	6,690	10,600	22,000
40		143	295	601	1,050	1,490	3,180	5,730	9,030	18,800
50		127	262	532	931	1,320	2,820	5,080	8,000	16,700
60		115	237	482	843	1,200	2,560	4,600	7,250	15,100
70		106	218	444	776	1,100	2,350	4,230	6,670	13,900
80		98	203	413	722	1,020	2,190	3,940	6,210	12,900
90		92	190	387	677	961	2,050	3,690	5,820	12,100
100		87	180	366	640	907	1,940	3,490	5,500	11,500
125		77	159	324	567	804	1,720	3,090	4,880	10,200
150		70	144	294	514	729	1,560	2,800	4,420	9,200
175		64	133	270	472	670	1,430	2,580	4,060	8,460
200		60	124	252	440	624	1,330	2,400	3,780	7,870
250		53	110	223	390	553	1,180	2,130	3,350	6,980
300		48	99	202	353	501	1,070	1,930	3,040	6,320
350		44	91	186	325	461	984	1,770	2,790	5,820
400		41	85	173	302	429	916	1,650	2,600	5,410
450		39	80	162	283	402	859	1,550	2,440	5,080
500		36	75	153	268	380	811	1,460	2,300	4,800
550		35	72	146	254	361	771	1,390	2,190	4,560
600		33	68	139	243	344	735	1,320	2,090	4,350
650		32	65	133	232	330	704	1,270	2,000	4,160
700		30	63	128	223	317	676	1,220	1,920	4,000
750		29	60	123	215	305	652	1,170	1,850	3,850
800		28	58	119	208	295	629	1,130	1,790	3,720
850		27	57	115	201	285	609	1,100	1,730	3,600
900		27	55	111	195	276	590	1,060	1,680	3,490
950		26	53	108	189	268	573	1,030	1,630	3,390
1,000		25	52	105	184	261	558	1,000	1,580	3,300
1,100		24	49	100	175	248	530	954	1,500	3,130
1,200		23	47	95	167	237	505	910	1,430	2,990
1,300		22	45	91	160	227	484	871	1,370	2,860
1,400		21	43	88	153	218	465	837	1,320	2,750
1,500		20	42	85	148	210	448	806	1,270	2,650
1,600		19	40	82	143	202	432	779	1,230	2,560
1,700		19	39	79	138	196	419	753	1,190	2,470
1,800		18	38	77	134	190	406	731	1,150	2,400
1,900		18	37	74	130	184	394	709	1,120	2,330
2,000		17	36	72	126	179	383	690	1,090	2,270

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

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

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

Table 6.2.1(n) Semirigid Copper Tubing

							Gas:	Natural		
							Inlet Pressure:	5.0 psi		
							Pressure Drop:	3.5 psi		
							Specific Gravity:	0.60		
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		511	1,050	2,140	3,750	5,320	11,400	20,400	32,200	67,100
20		351	724	1,470	2,580	3,650	7,800	14,000	22,200	46,100
30		282	582	1,180	2,070	2,930	6,270	11,300	17,800	37,000
40		241	498	1,010	1,770	2,510	5,360	9,660	15,200	31,700
50		214	441	898	1,570	2,230	4,750	8,560	13,500	28,100
60		194	400	813	1,420	2,020	4,310	7,750	12,200	25,500
70		178	368	748	1,310	1,860	3,960	7,130	11,200	23,400
80		166	342	696	1,220	1,730	3,690	6,640	10,500	21,800
90		156	321	653	1,140	1,620	3,460	6,230	9,820	20,400
100		147	303	617	1,080	1,530	3,270	5,880	9,270	19,300
125		130	269	547	955	1,360	2,900	5,210	8,220	17,100
150		118	243	495	866	1,230	2,620	4,720	7,450	15,500
175		109	224	456	796	1,130	2,410	4,350	6,850	14,300
200		101	208	424	741	1,050	2,250	4,040	6,370	13,300
250		90	185	376	657	932	1,990	3,580	5,650	11,800
300		81	167	340	595	844	1,800	3,250	5,120	10,700
350		75	154	313	547	777	1,660	2,990	4,710	9,810
400		69	143	291	509	722	1,540	2,780	4,380	9,120
450		65	134	273	478	678	1,450	2,610	4,110	8,560
500		62	127	258	451	640	1,370	2,460	3,880	8,090
550		58	121	245	429	608	1,300	2,340	3,690	7,680
600		56	115	234	409	580	1,240	2,230	3,520	7,330
650		53	110	224	392	556	1,190	2,140	3,370	7,020
700		51	106	215	376	534	1,140	2,050	3,240	6,740
750		49	102	207	362	514	1,100	1,980	3,120	6,490
800		48	98	200	350	497	1,060	1,910	3,010	6,270
850		46	95	194	339	481	1,030	1,850	2,910	6,070
900		45	92	188	328	466	1,000	1,790	2,820	5,880
950		43	90	182	319	452	967	1,740	2,740	5,710
1,000		42	87	177	310	440	940	1,690	2,670	5,560
1,100		40	83	169	295	418	893	1,610	2,530	5,280
1,200		38	79	161	281	399	852	1,530	2,420	5,040
1,300		37	76	154	269	382	816	1,470	2,320	4,820
1,400		35	73	148	259	367	784	1,410	2,220	4,630
1,500		34	70	143	249	353	755	1,360	2,140	4,460
1,600		33	68	138	241	341	729	1,310	2,070	4,310
1,700		32	65	133	233	330	705	1,270	2,000	4,170
1,800		31	63	129	226	320	684	1,230	1,940	4,040
1,900		30	62	125	219	311	664	1,200	1,890	3,930
2,000		29	60	122	213	302	646	1,160	1,830	3,820

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

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

Table 6.2.1(o) Corrugated Stainless Steel Tubing (CSST)

											Gas:	Natural		
											Inlet Pressure:	Less than 2 psi		
											Pressure Drop:	0.5 in. w.c.		
											Specific Gravity:	0.60		
	Tube Size (EHD)													
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
5	46	63	115	134	225	270	471	546	895	1,037	1,790	2,070	3,660	4,140
10	32	44	82	95	161	192	330	383	639	746	1,260	1,470	2,600	2,930
15	25	35	66	77	132	157	267	310	524	615	1,030	1,200	2,140	2,400
20	22	31	58	67	116	137	231	269	456	536	888	1,050	1,850	2,080
25	19	27	52	60	104	122	206	240	409	482	793	936	1,660	1,860
30	18	25	47	55	96	112	188	218	374	442	723	856	1,520	1,700
40	15	21	41	47	83	97	162	188	325	386	625	742	1,320	1,470
50	13	19	37	42	75	87	144	168	292	347	559	665	1,180	1,320
60	12	17	34	38	68	80	131	153	267	318	509	608	1,080	1,200
70	11	16	31	36	63	74	121	141	248	295	471	563	1,000	1,110
80	10	15	29	33	60	69	113	132	232	277	440	527	940	1,040
90	10	14	28	32	57	65	107	125	219	262	415	498	887	983
100	9	13	26	30	54	62	101	118	208	249	393	472	843	933
150	7	10	20	23	42	48	78	91	171	205	320	387	691	762
200	6	9	18	21	38	44	71	82	148	179	277	336	600	661
250	5	8	16	19	34	39	63	74	133	161	247	301	538	591
300	5	7	15	17	32	36	57	67	95	148	226	275	492	540

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

Table 6.2.1(p) Corrugated Stainless Steel Tubing (CSST)

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.

	Tube Size (EHD)													
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
5	120	160	277	327	529	649	1,180	1,370	2,140	2423	4,430	5,010	8,800	10,100
10	83	112	197	231	380	462	828	958	1,530	1740	3,200	3,560	6,270	7,160
15	67	90	161	189	313	379	673	778	1,250	1433	2,540	2,910	5,140	5,850
20	57	78	140	164	273	329	580	672	1,090	1249	2,200	2,530	4,460	5,070
25	51	69	125	147	245	295	518	599	978	1123	1,960	2,270	4,000	4,540
30	46	63	115	134	225	270	471	546	895	1029	1,790	2,070	3,660	4,140
40	39	54	100	116	196	234	407	471	778	897	1,550	1,800	3,180	3,590
50	35	48	89	104	176	210	363	421	698	806	1,380	1,610	2,850	3,210
60	32	44	82	95	161	192	330	383	639	739	1,260	1,470	2,600	2,930
70	29	41	76	88	150	178	306	355	593	686	1,170	1,360	2,420	2,720
80	27	38	71	82	141	167	285	331	555	644	1,090	1,280	2,260	2,540
90	26	36	67	77	133	157	268	311	524	609	1,030	1,200	2,140	2,400
100	24	34	63	73	126	149	254	295	498	579	974	1,140	2,030	2,280
150	19	27	52	60	104	122	206	240	409	477	793	936	1,660	1,860
200	17	23	45	52	91	106	178	207	355	415	686	812	1,440	1,610
250	15	21	40	46	82	95	159	184	319	373	613	728	1,290	1,440
300	13	19	37	42	75	87	144	168	234	342	559	665	1,180	1,320

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

Table 6.2.1(q) Corrugated Stainless Steel Tubing (CSST)

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.

	Tube Size (EHD)													
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
5	173	229	389	461	737	911	1,690	1,950	3,000	3375	6,280	7,050	12,400	14,260
10	120	160	277	327	529	649	1,180	1,370	2,140	2423	4,430	5,010	8,800	10,100
15	96	130	227	267	436	532	960	1,110	1,760	1996	3,610	4,100	7,210	8,260
20	83	112	197	231	380	462	828	958	1,530	1740	3,120	3,560	6,270	7,160
25	74	99	176	207	342	414	739	855	1,370	1564	2,790	3,190	5,620	6,400
30	67	90	161	189	313	379	673	778	1,250	1433	2,540	2,910	5,140	5,850
40	57	78	140	164	273	329	580	672	1,090	1249	2,200	2,530	4,460	5,070
50	51	69	125	147	245	295	518	599	978	1123	1,960	2,270	4,000	4,540
60	46	63	115	134	225	270	471	546	895	1029	1,790	2,070	3,660	4,140
70	42	58	106	124	209	250	435	505	830	956	1,660	1,920	3,390	3,840
80	39	54	100	116	196	234	407	471	778	897	1,550	1,800	3,180	3,590
90	37	51	94	109	185	221	383	444	735	848	1,460	1,700	3,000	3,390
100	35	48	89	104	176	210	363	421	698	806	1,380	1,610	2,850	3,210
150	28	39	73	85	145	172	294	342	573	664	1,130	1,320	2,340	2,630
200	24	34	63	73	126	149	254	295	498	579	974	1,140	2,030	2,280
250	21	30	57	66	114	134	226	263	447	520	870	1,020	1,820	2,040
300	19	27	52	60	104	122	206	240	409	477	793	936	1,660	1,860

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

Table 6.2.1(r) Corrugated Stainless Steel Tubing (CSST)

											Gas:	Natural		
											Inlet Pressure:	2.0 psi		
											Pressure Drop:	1.0 psi		
											Specific Gravity:	0.60		
	Tube Size (EHD)													
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Cubic Feet of Gas per Hour													
10	270	353	587	700	1,100	1,370	2,590	2,990	4,510	5,037	9,600	10,700	18,600	21,600
25	166	220	374	444	709	876	1,620	1,870	2,890	3,258	6,040	6,780	11,900	13,700
30	151	200	342	405	650	801	1,480	1,700	2,640	2,987	5,510	6,200	10,900	12,500
40	129	172	297	351	567	696	1,270	1,470	2,300	2,605	4,760	5,380	9,440	10,900
50	115	154	266	314	510	624	1,140	1,310	2,060	2,343	4,260	4,820	8,470	9,720
75	93	124	218	257	420	512	922	1,070	1,690	1,932	3,470	3,950	6,940	7,940
80	89	120	211	249	407	496	892	1,030	1,640	1,874	3,360	3,820	6,730	7,690
100	79	107	189	222	366	445	795	920	1,470	1,685	3,000	3,420	6,030	6,880
150	64	87	155	182	302	364	646	748	1,210	1,389	2,440	2,800	4,940	5,620
200	55	75	135	157	263	317	557	645	1,050	1,212	2,110	2,430	4,290	4,870
250	49	67	121	141	236	284	497	576	941	1,090	1,890	2,180	3,850	4,360
300	44	61	110	129	217	260	453	525	862	999	1,720	1,990	3,520	3,980
400	38	52	96	111	189	225	390	453	749	871	1,490	1,730	3,060	3,450
500	34	46	86	100	170	202	348	404	552	783	1,330	1,550	2,740	3,090

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds ¾ psi, do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

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

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

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

Table 6.2.1(s) Corrugated Stainless Steel Tubing (CSST)

											Gas:	Natural		
											Inlet Pressure:	5.0 psi		
											Pressure Drop:	3.5 psi		
											Specific Gravity:	0.60		
	Tube Size (EHD)													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (ft)	**Capacity in Cubic Feet of Gas per Hour**													
10	523	674	1,080	1,300	2,000	2,530	4,920	5,660	8,300	9,140	18,100	19,800	34,400	40,400
25	322	420	691	827	1,290	1,620	3,080	3,540	5,310	5,911	11,400	12,600	22,000	25,600
30	292	382	632	755	1,180	1,480	2,800	3,230	4,860	5,420	10,400	11,500	20,100	23,400
40	251	329	549	654	1,030	1,280	2,420	2,790	4,230	4,727	8,970	10,000	17,400	20,200
50	223	293	492	586	926	1,150	2,160	2,490	3,790	4,251	8,020	8,930	15,600	18,100
75	180	238	403	479	763	944	1,750	2,020	3,110	3,506	6,530	7,320	12,800	14,800
80	174	230	391	463	740	915	1,690	1,960	3,020	3,400	6,320	7,090	12,400	14,300
100	154	205	350	415	665	820	1,510	1,740	2,710	3,057	5,650	6,350	11,100	12,800
150	124	166	287	339	548	672	1,230	1,420	2,220	2,521	4,600	5,200	9,130	10,500
200	107	143	249	294	478	584	1,060	1,220	1,930	2,199	3,980	4,510	7,930	9,090
250	95	128	223	263	430	524	945	1,090	1,730	1,977	3,550	4,040	7,110	8,140
300	86	116	204	240	394	479	860	995	1,590	1,813	3,240	3,690	6,500	7,430
400	74	100	177	208	343	416	742	858	1,380	1,581	2,800	3,210	5,650	6,440
500	66	89	159	186	309	373	662	766	1,040	1,422	2,500	2,870	5,060	5,760

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

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

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

Table 6.2.1(t) Polyethylene Plastic Pipe

					Gas:	Natural		
					Inlet Pressure:	Less than 2 psi		
					Pressure Drop:	0.3 in. w.c.		
					Specific Gravity:	0.60		
	Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	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 (ft)	Capacity in Cubic Feet of Gas per Hour							
10	153	305	551	955	1,440	2,590	7,170	13,900
20	105	210	379	656	991	1,780	4,920	9,520
30	84	169	304	527	796	1,430	3,950	7,640
40	72	144	260	451	681	1,220	3,380	6,540
50	64	128	231	400	604	1,080	3,000	5,800
60	58	116	209	362	547	983	2,720	5,250
70	53	107	192	333	503	904	2,500	4,830
80	50	99	179	310	468	841	2,330	4,500
90	46	93	168	291	439	789	2,180	4,220
100	44	88	159	275	415	745	2,060	3,990
125	39	78	141	243	368	661	1,830	3,530
150	35	71	127	221	333	598	1,660	3,200
175	32	65	117	203	306	551	1,520	2,940
200	30	60	109	189	285	512	1,420	2,740
250	27	54	97	167	253	454	1,260	2,430
300	24	48	88	152	229	411	1,140	2,200
350	22	45	81	139	211	378	1,050	2,020
400	21	42	75	130	196	352	974	1,880
450	19	39	70	122	184	330	914	1,770
500	18	37	66	115	174	312	863	1,670

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

Table 6.2.1(u) Polyethylene Plastic Pipe

					Gas:	Natural		
					Inlet Pressure:	Less than 2 psi		
					Pressure Drop:	0.5 in. w.c.		
					Specific Gravity:	0.60		
	Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	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 (ft)	Capacity in Cubic Feet of Gas per Hour							
10	201	403	726	1,260	1,900	3,410	9,450	18,260
20	138	277	499	865	1,310	2,350	6,490	12,550
30	111	222	401	695	1,050	1,880	5,210	10,080
40	95	190	343	594	898	1,610	4,460	8,630
50	84	169	304	527	796	1,430	3,950	7,640
60	76	153	276	477	721	1,300	3,580	6,930
70	70	140	254	439	663	1,190	3,300	6,370
80	65	131	236	409	617	1,110	3,070	5,930
90	61	123	221	383	579	1,040	2,880	5,560
100	58	116	209	362	547	983	2,720	5,250
125	51	103	185	321	485	871	2,410	4,660
150	46	93	168	291	439	789	2,180	4,220
175	43	86	154	268	404	726	2,010	3,880
200	40	80	144	249	376	675	1,870	3,610
250	35	71	127	221	333	598	1,660	3,200
300	32	64	115	200	302	542	1,500	2,900
350	29	59	106	184	278	499	1,380	2,670
400	27	55	99	171	258	464	1,280	2,480
450	26	51	93	160	242	435	1,200	2,330
500	24	48	88	152	229	411	1,140	2,200

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

Table 6.2.1(v) Polyethylene Plastic Pipe

					Gas:	Natural		
					Inlet Pressure:	2.0 psi		
					Pressure Drop:	1.0 psi		
					Specific Gravity:	0.60		
	Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	2	3	3
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 (ft)	Capacity in Cubic Feet of Gas per Hour							
10	1,860	3,720	6,710	11,600	17,600	31,600	87,300	169,000
20	1,280	2,560	4,610	7,990	12,100	21,700	60,000	116,000
30	1,030	2,050	3,710	6,420	9,690	17,400	48,200	93,200
40	878	1,760	3,170	5,490	8,300	14,900	41,200	79,700
50	778	1,560	2,810	4,870	7,350	13,200	36,600	70,700
60	705	1,410	2,550	4,410	6,660	12,000	33,100	64,000
70	649	1,300	2,340	4,060	6,130	11,000	30,500	58,900
80	603	1,210	2,180	3,780	5,700	10,200	28,300	54,800
90	566	1,130	2,050	3,540	5,350	9,610	26,600	51,400
100	535	1,070	1,930	3,350	5,050	9,080	25,100	48,600
125	474	949	1,710	2,970	4,480	8,050	22,300	43,000
150	429	860	1,550	2,690	4,060	7,290	20,200	39,000
175	395	791	1,430	2,470	3,730	6,710	18,600	35,900
200	368	736	1,330	2,300	3,470	6,240	17,300	33,400
250	326	652	1,180	2,040	3,080	5,530	15,300	29,600
300	295	591	1,070	1,850	2,790	5,010	13,900	26,800
350	272	544	981	1,700	2,570	4,610	12,800	24,700
400	253	506	913	1,580	2,390	4,290	11,900	22,900
450	237	475	856	1,480	2,240	4,020	11,100	21,500
500	224	448	809	1,400	2,120	3,800	10,500	20,300
550	213	426	768	1,330	2,010	3,610	9,990	19,300
600	203	406	733	1,270	1,920	3,440	9,530	18,400
650	194	389	702	1,220	1,840	3,300	9,130	17,600
700	187	374	674	1,170	1,760	3,170	8,770	16,900
750	180	360	649	1,130	1,700	3,050	8,450	16,300
800	174	348	627	1,090	1,640	2,950	8,160	15,800
850	168	336	607	1,050	1,590	2,850	7,890	15,300
900	163	326	588	1,020	1,540	2,770	7,650	14,800
950	158	317	572	990	1,500	2,690	7,430	14,400
1,000	154	308	556	963	1,450	2,610	7,230	14,000
1,100	146	293	528	915	1,380	2,480	6,870	13,300
1,200	139	279	504	873	1,320	2,370	6,550	12,700
1,300	134	267	482	836	1,260	2,270	6,270	12,100
1,400	128	257	463	803	1,210	2,180	6,030	11,600
1,500	124	247	446	773	1,170	2,100	5,810	11,200
1,600	119	239	431	747	1,130	2,030	5,610	10,800
1,700	115	231	417	723	1,090	1,960	5,430	10,500
1,800	112	224	404	701	1,060	1,900	5,260	10,200
1,900	109	218	393	680	1,030	1,850	5,110	9,900
2,000	106	212	382	662	1,000	1,800	4,970	9,600

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

Table 6.2.1(w) Polyethylene Plastic Tubing

	Gas:	Natural
	Inlet Pressure:	Less than 2.0 psi
	Pressure Drop:	0.3 in. w.c.
	Specific Gravity:	0.60
	Plastic Tubing Size (CTS) (in.)	
Nominal OD:	½	1
Designation:	SDR 7	SDR 11
Actual ID:	0.445	0.927
Length (ft)	Capacity in Cubic Feet of Gas per Hour	
10	54	372
20	37	256
30	30	205
40	26	176
50	23	156
60	21	141
70	19	130
80	18	121
90	17	113
100	16	107
125	14	95
150	13	86
175	12	79
200	11	74
225	10	69
250	NA	65
275	NA	62
300	NA	59
350	NA	54
400	NA	51
450	NA	47
500	NA	45

CTS: Copper tube size.
NA: A flow of less than 10 cfh.
Note: All table entries are rounded to 3 significant digits.

Table 6.2.1(x) Polyethylene Plastic Tubing

	Gas:	Natural
	Inlet Pressure:	Less than 2.0 psi
	Pressure Drop:	0.5 in. w.c.
	Specific Gravity:	0.60
	Plastic Tubing Size (CTS) (in.)	
Nominal OD:	½	1
Designation:	SDR 7	SDR 11
Actual ID:	0.445	0.927
Length (ft)	Capacity in Cubic Feet of Gas per Hour	
10	72	490
20	49	337
30	39	271
40	34	232
50	30	205
60	27	186
70	25	171
80	23	159
90	22	149
100	21	141
125	18	125
150	17	113
175	15	104
200	14	97
225	13	91
250	12	86
275	11	82
300	11	78
350	10	72
400	NA	67
450	NA	63
500	NA	59

CTS: Copper tube size.
NA: A flow of less than 10 cfh.
Note: All table entries are rounded to 3 significant digits.

Table 6.3.1(a) Schedule 40 Metallic Pipe

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

INTENDED USE: Pipe Sizing Between First-Stage (High-Pressure) Regulator and Second-Stage (Low-Pressure) Regulator.

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

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

Table 6.3.1(b) Schedule 40 Metallic Pipe

Gas:	Undiluted Propane
Inlet Pressure:	10.0 psi
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 (in.)								
Nominal Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	5,890	12,300	23,200	47,600	71,300	137,000	219,000	387,000	789,000
20	4,050	8,460	15,900	32,700	49,000	94,400	150,000	266,000	543,000
30	3,250	6,790	12,800	26,300	39,400	75,800	121,000	214,000	436,000
40	2,780	5,810	11,000	22,500	33,700	64,900	103,000	183,000	373,000
50	2,460	5,150	9,710	19,900	29,900	57,500	91,600	162,000	330,000
60	2,230	4,670	8,790	18,100	27,100	52,100	83,000	147,000	299,000
70	2,050	4,300	8,090	16,600	24,900	47,900	76,400	135,000	275,000
80	1,910	4,000	7,530	15,500	23,200	44,600	71,100	126,000	256,000
90	1,790	3,750	7,060	14,500	21,700	41,800	66,700	118,000	240,000
100	1,690	3,540	6,670	13,700	20,500	39,500	63,000	111,000	227,000
125	1,500	3,140	5,910	12,100	18,200	35,000	55,800	98,700	201,000
150	1,360	2,840	5,360	11,000	16,500	31,700	50,600	89,400	182,000
175	1,250	2,620	4,930	10,100	15,200	29,200	46,500	82,300	167,800
200	1,160	2,430	4,580	9,410	14,100	27,200	43,300	76,500	156,100
250	1,030	2,160	4,060	8,340	12,500	24,100	38,400	67,800	138,400
300	935	1,950	3,680	7,560	11,300	21,800	34,800	61,500	125,400
350	860	1,800	3,390	6,950	10,400	20,100	32,000	56,500	115,300
400	800	1,670	3,150	6,470	9,690	18,700	29,800	52,600	107,300
450	751	1,570	2,960	6,070	9,090	17,500	27,900	49,400	100,700
500	709	1,480	2,790	5,730	8,590	16,500	26,400	46,600	95,100
550	673	1,410	2,650	5,450	8,160	15,700	25,000	44,300	90,300
600	642	1,340	2,530	5,200	7,780	15,000	23,900	42,200	86,200
650	615	1,290	2,420	4,980	7,450	14,400	22,900	40,500	82,500
700	591	1,240	2,330	4,780	7,160	13,800	22,000	38,900	79,300
750	569	1,190	2,240	4,600	6,900	13,300	21,200	37,400	76,400
800	550	1,150	2,170	4,450	6,660	12,800	20,500	36,200	73,700
850	532	1,110	2,100	4,300	6,450	12,400	19,800	35,000	71,400
900	516	1,080	2,030	4,170	6,250	12,000	19,200	33,900	69,200
950	501	1,050	1,970	4,050	6,070	11,700	18,600	32,900	67,200
1,000	487	1,020	1,920	3,940	5,900	11,400	18,100	32,000	65,400
1,100	463	968	1,820	3,740	5,610	10,800	17,200	30,400	62,100
1,200	442	923	1,740	3,570	5,350	10,300	16,400	29,000	59,200
1,300	423	884	1,670	3,420	5,120	9,870	15,700	27,800	56,700
1,400	406	849	1,600	3,280	4,920	9,480	15,100	26,700	54,500
1,500	391	818	1,540	3,160	4,740	9,130	14,600	25,700	52,500
1,600	378	790	1,490	3,060	4,580	8,820	14,100	24,800	50,700
1,700	366	765	1,440	2,960	4,430	8,530	13,600	24,000	49,000
1,800	355	741	1,400	2,870	4,300	8,270	13,200	23,300	47,600
1,900	344	720	1,360	2,780	4,170	8,040	12,800	22,600	46,200
2,000	335	700	1,320	2,710	4,060	7,820	12,500	22,000	44,900

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

Table 6.3.1(c) Schedule 40 Metallic Pipe

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

INTENDED USE: Pipe Sizing Between 2 psig Service and Line Pressure Regulator.

	Pipe Size (in.)								
Nominal:	½	¾	1	1¼	1½	2	2½	3	4
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	2,680	5,590	10,500	21,600	32,400	62,400	99,500	176,000	359,000
20	1,840	3,850	7,240	14,900	22,300	42,900	68,400	121,000	247,000
30	1,480	3,090	5,820	11,900	17,900	34,500	54,900	97,100	198,000
40	1,260	2,640	4,980	10,200	15,300	29,500	47,000	83,100	170,000
50	1,120	2,340	4,410	9,060	13,600	26,100	41,700	73,700	150,000
60	1,010	2,120	4,000	8,210	12,300	23,700	37,700	66,700	136,000
70	934	1,950	3,680	7,550	11,300	21,800	34,700	61,400	125,000
80	869	1,820	3,420	7,020	10,500	20,300	32,300	57,100	116,000
90	815	1,700	3,210	6,590	9,880	19,000	30,300	53,600	109,000
100	770	1,610	3,030	6,230	9,330	18,000	28,600	50,600	103,000
125	682	1,430	2,690	5,520	8,270	15,900	25,400	44,900	91,500
150	618	1,290	2,440	5,000	7,490	14,400	23,000	40,700	82,900
175	569	1,190	2,240	4,600	6,890	13,300	21,200	37,400	76,300
200	529	1,110	2,080	4,280	6,410	12,300	19,700	34,800	71,000
250	469	981	1,850	3,790	5,680	10,900	17,400	30,800	62,900
300	425	889	1,670	3,440	5,150	9,920	15,800	27,900	57,000
350	391	817	1,540	3,160	4,740	9,120	14,500	25,700	52,400
400	364	760	1,430	2,940	4,410	8,490	13,500	23,900	48,800
450	341	714	1,340	2,760	4,130	7,960	12,700	22,400	45,800
500	322	674	1,270	2,610	3,910	7,520	12,000	21,200	43,200
550	306	640	1,210	2,480	3,710	7,140	11,400	20,100	41,100
600	292	611	1,150	2,360	3,540	6,820	10,900	19,200	39,200
650	280	585	1,100	2,260	3,390	6,530	10,400	18,400	37,500
700	269	562	1,060	2,170	3,260	6,270	9,990	17,700	36,000
750	259	541	1,020	2,090	3,140	6,040	9,630	17,000	34,700
800	250	523	985	2,020	3,030	5,830	9,300	16,400	33,500
850	242	506	953	1,960	2,930	5,640	9,000	15,900	32,400
900	235	490	924	1,900	2,840	5,470	8,720	15,400	31,500
950	228	476	897	1,840	2,760	5,310	8,470	15,000	30,500
1,000	222	463	873	1,790	2,680	5,170	8,240	14,600	29,700
1,100	210	440	829	1,700	2,550	4,910	7,830	13,800	28,200
1,200	201	420	791	1,620	2,430	4,680	7,470	13,200	26,900
1,300	192	402	757	1,550	2,330	4,490	7,150	12,600	25,800
1,400	185	386	727	1,490	2,240	4,310	6,870	12,100	24,800
1,500	178	372	701	1,440	2,160	4,150	6,620	11,700	23,900
1,600	172	359	677	1,390	2,080	4,010	6,390	11,300	23,000
1,700	166	348	655	1,340	2,010	3,880	6,180	10,900	22,300
1,800	161	337	635	1,300	1,950	3,760	6,000	10,600	21,600
1,900	157	327	617	1,270	1,900	3,650	5,820	10,300	21,000
2,000	152	318	600	1,230	1,840	3,550	5,660	10,000	20,400

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

Δ Table 6.3.1(d) Schedule 40 Metallic Pipe

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

INTENDED USE: Pipe Sizing Between Single- or Second-Stage (Low-Pressure) Regulator and Appliance.

	Pipe Size (in.)								
Nominal Inside:	½	¾	1	1¼	1½	2	2½	3	4
Actual:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Capacity in Thousands of Btu per Hour								
10	291	608	1,150	2,350	3,520	6,790	10,800	19,100	39,000
20	200	418	787	1,620	2,420	4,660	7,430	13,100	26,800
30	160	336	632	1,300	1,940	3,750	5,970	10,600	21,500
40	137	287	541	1,110	1,660	3,210	5,110	9,030	18,400
50	122	255	480	985	1,480	2,840	4,530	8,000	16,300
60	110	231	434	892	1,340	2,570	4,100	7,250	14,800
70	101	212	400	821	1,230	2,370	3,770	6,670	13,600
80	94	197	372	763	1,140	2,200	3,510	6,210	12,700
90	89	185	349	716	1,070	2,070	3,290	5,820	11,900
100	84	175	330	677	1,010	1,950	3,110	5,500	11,200
125	74	155	292	600	899	1,730	2,760	4,880	9,950
150	67	140	265	543	814	1,570	2,500	4,420	9,010
175	62	129	243	500	749	1,440	2,300	4,060	8,290
200	58	120	227	465	697	1,340	2,140	3,780	7,710
250	51	107	201	412	618	1,190	1,900	3,350	6,840
300	46	97	182	373	560	1,080	1,720	3,040	6,190
350	42	89	167	344	515	991	1,580	2,790	5,700
400	40	83	156	320	479	922	1,470	2,600	5,300
450	37	78	146	300	449	865	1,380	2,440	4,970
500	35	73	138	283	424	817	1,300	2,300	4,700
550	33	70	131	269	403	776	1,240	2,190	4,460
600	32	66	125	257	385	741	1,180	2,090	4,260
650	30	64	120	246	368	709	1,130	2,000	4,080
700	29	61	115	236	354	681	1,090	1,920	3,920
750	28	59	111	227	341	656	1,050	1,850	3,770
800	27	57	107	220	329	634	1,010	1,790	3,640
850	26	55	104	213	319	613	978	1,730	3,530
900	25	53	100	206	309	595	948	1,680	3,420
950	25	52	97	200	300	578	921	1,630	3,320
1,000	24	50	95	195	292	562	895	1,580	3,230
1,100	23	48	90	185	277	534	850	1,500	3,070
1,200	22	46	86	176	264	509	811	1,430	2,930
1,300	21	44	82	169	253	487	777	1,370	2,800
1,400	20	42	79	162	243	468	746	1,320	2,690
1,500	19	40	76	156	234	451	719	1,270	2,590
1,600	19	39	74	151	226	436	694	1,230	2,500
1,700	18	38	71	146	219	422	672	1,190	2,420
1,800	18	37	69	142	212	409	652	1,150	2,350
1,900	17	36	67	138	206	397	633	1120	2280
2,000	17	35	65	134	200	386	615	1090	2220

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

Table 6.3.1(e) Semirigid Copper Tubing

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

INTENDED USE: Tube Sizing Between First-Stage (High-Pressure) Regulator and Second-Stage (Low-Pressure) Regulator.

		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Thousands of Btu per Hour								
10		513	1,060	2,150	3,760	5,330	11,400	20,500	32,300	67,400
20		352	727	1,480	2,580	3,670	7,830	14,100	22,200	46,300
30		283	584	1,190	2,080	2,940	6,290	11,300	17,900	37,200
40		242	500	1,020	1,780	2,520	5,380	9,690	15,300	31,800
50		215	443	901	1,570	2,230	4,770	8,590	13,500	28,200
60		194	401	816	1,430	2,020	4,320	7,780	12,300	25,600
70		179	369	751	1,310	1,860	3,980	7,160	11,300	23,500
80		166	343	699	1,220	1,730	3,700	6,660	10,500	21,900
90		156	322	655	1,150	1,630	3,470	6,250	9,850	20,500
100		147	304	619	1,080	1,540	3,280	5,900	9,310	19,400
125		131	270	549	959	1,360	2,910	5,230	8,250	17,200
150		118	244	497	869	1,230	2,630	4,740	7,470	15,600
175		109	225	457	799	1,130	2,420	4,360	6,880	14,300
200		101	209	426	744	1,060	2,250	4,060	6,400	13,300
250		90	185	377	659	935	2,000	3,600	5,670	11,800
300		81	168	342	597	847	1,810	3,260	5,140	10,700
350		75	155	314	549	779	1,660	3,000	4,730	9,840
400		70	144	292	511	725	1,550	2,790	4,400	9,160
450		65	135	274	480	680	1,450	2,620	4,130	8,590
500		62	127	259	453	643	1,370	2,470	3,900	8,120
550		59	121	246	430	610	1,300	2,350	3,700	7,710
600		56	115	235	410	582	1,240	2,240	3,530	7,350
650		54	111	225	393	558	1,190	2,140	3,380	7,040
700		51	106	216	378	536	1,140	2,060	3,250	6,770
750		50	102	208	364	516	1,100	1,980	3,130	6,520
800		48	99	201	351	498	1,060	1,920	3,020	6,290
850		46	96	195	340	482	1,030	1,850	2,920	6,090
900		45	93	189	330	468	1,000	1,800	2,840	5,910
950		44	90	183	320	454	970	1,750	2,750	5,730
1,000		42	88	178	311	442	944	1,700	2,680	5,580
1,100		40	83	169	296	420	896	1,610	2,540	5,300
1,200		38	79	161	282	400	855	1,540	2,430	5,050
1,300		37	76	155	270	383	819	1,470	2,320	4,840
1,400		35	73	148	260	368	787	1,420	2,230	4,650
1,500		34	70	143	250	355	758	1,360	2,150	4,480
1,600		33	68	138	241	343	732	1,320	2,080	4,330
1,700		32	66	134	234	331	708	1,270	2,010	4,190
1,800		31	64	130	227	321	687	1,240	1,950	4,060
1,900		30	62	126	220	312	667	1,200	1,890	3,940
2,000		29	60	122	214	304	648	1,170	1,840	3,830

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

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

Table 6.3.1(f) Semirigid Copper Tubing

							Gas:	Undiluted Propane		
							Inlet Pressure:	11.0 in. w.c.		
							Pressure Drop:	0.5 in. w.c.		
							Specific Gravity:	1.50		
INTENDED USE: Tube Sizing Between Single- or Second-Stage (Low-Pressure) Regulator and Appliance.										
		Tube Size (in.)								
Nominal:	K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
	ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Thousands of Btu per Hour								
10		45	93	188	329	467	997	1,800	2,830	5,890
20		31	64	129	226	321	685	1,230	1,950	4,050
30		25	51	104	182	258	550	991	1,560	3,250
40		21	44	89	155	220	471	848	1,340	2,780
50		19	39	79	138	195	417	752	1,180	2,470
60		17	35	71	125	177	378	681	1,070	2,240
70		16	32	66	115	163	348	626	988	2,060
80		15	30	61	107	152	324	583	919	1,910
90		14	28	57	100	142	304	547	862	1,800
100		13	27	54	95	134	287	517	814	1,700
125		11	24	48	84	119	254	458	722	1,500
150		10	21	44	76	108	230	415	654	1,360
175		NA	20	40	70	99	212	382	602	1,250
200		NA	18	37	65	92	197	355	560	1,170
250		NA	16	33	58	82	175	315	496	1,030
300		NA	15	30	52	74	158	285	449	936
350		NA	14	28	48	68	146	262	414	861
400		NA	13	26	45	63	136	244	385	801
450		NA	12	24	42	60	127	229	361	752
500		NA	11	23	40	56	120	216	341	710
550		NA	11	22	38	53	114	205	324	674
600		NA	10	21	36	51	109	196	309	643
650		NA	NA	20	34	49	104	188	296	616
700		NA	NA	19	33	47	100	180	284	592
750		NA	NA	18	32	45	96	174	274	570
800		NA	NA	18	31	44	93	168	264	551
850		NA	NA	17	30	42	90	162	256	533
900		NA	NA	17	29	41	87	157	248	517
950		NA	NA	16	28	40	85	153	241	502
1,000		NA	NA	16	27	39	83	149	234	488
1,100		NA	NA	15	26	37	78	141	223	464
1,200		NA	NA	14	25	35	75	135	212	442
1,300		NA	NA	14	24	34	72	129	203	423
1,400		NA	NA	13	23	32	69	124	195	407
1,500		NA	NA	13	22	31	66	119	188	392
1,600		NA	NA	12	21	30	64	115	182	378
1,700		NA	NA	12	20	29	62	112	176	366
1,800		NA	NA	11	20	28	60	108	170	355
1,900		NA	NA	11	19	27	58	105	166	345
2,000		NA	NA	11	19	27	57	102	161	335

NA: A flow of less than 10,000 Btu/hr.

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

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

Δ Table 6.3.1(g) Semirigid Copper Tubing

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

INTENDED USE: Tube Sizing Between 2 psig Service and Line Pressure Regulator.

Nominal:	Tube Size (in.)								
K & L:	¼	⅜	½	⅝	¾	1	1¼	1½	2
ACR:	⅜	½	⅝	¾	⅞	1⅛	1⅜	—	—
Outside:	0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside:*	0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)	Capacity in Thousands of Btu per Hour								
10	413	852	1,730	3,030	4,300	9,170	16,500	26,000	54,200
20	284	585	1,190	2,080	2,950	6,310	11,400	17,900	37,300
30	228	470	956	1,670	2,370	5,060	9,120	14,400	29,900
40	195	402	818	1,430	2,030	4,330	7,800	12,300	25,600
50	173	356	725	1,270	1,800	3,840	6,920	10,900	22,700
60	157	323	657	1,150	1,630	3,480	6,270	9,880	20,600
70	144	297	605	1,060	1,500	3,200	5,760	9,090	18,900
80	134	276	562	983	1,390	2,980	5,360	8,450	17,600
90	126	259	528	922	1,310	2,790	5,030	7,930	16,500
100	119	245	498	871	1,240	2,640	4,750	7,490	15,600
125	105	217	442	772	1,100	2,340	4,210	6,640	13,800
150	95	197	400	700	992	2,120	3,820	6,020	12,500
175	88	181	368	644	913	1,950	3,510	5,540	11,500
200	82	168	343	599	849	1,810	3,270	5,150	10,700
250	72	149	304	531	753	1,610	2,900	4,560	9,510
300	66	135	275	481	682	1,460	2,620	4,140	8,610
350	60	124	253	442	628	1,340	2,410	3,800	7,920
400	56	116	235	411	584	1,250	2,250	3,540	7,370
450	53	109	221	386	548	1,170	2,110	3,320	6,920
500	50	103	209	365	517	1,110	1,990	3,140	6,530
550	47	97	198	346	491	1,050	1,890	2,980	6,210
600	45	93	189	330	469	1,000	1,800	2,840	5,920
650	43	89	181	316	449	959	1,730	2,720	5,670
700	41	86	174	304	431	921	1,660	2,620	5,450
750	40	82	168	293	415	888	1,600	2,520	5,250
800	39	80	162	283	401	857	1,540	2,430	5,070
850	37	77	157	274	388	829	1,490	2,350	4,900
900	36	75	152	265	376	804	1,450	2,280	4,750
950	35	72	147	258	366	781	1,410	2,220	4,620
1,000	34	71	143	251	356	760	1,370	2,160	4,490
1,100	32	67	136	238	338	721	1,300	2,050	4,270
1,200	31	64	130	227	322	688	1,240	1,950	4,070
1,300	30	61	124	217	309	659	1,190	1,870	3,900
1,400	28	59	120	209	296	633	1,140	1,800	3,740
1,500	27	57	115	201	286	610	1,100	1,730	3,610
1,600	26	55	111	194	276	589	1,060	1,670	3,480
1,700	26	53	108	188	267	570	1,030	1,620	3,370
1,800	25	51	104	182	259	553	1,000	1,570	3,270
1,900	24	50	101	177	251	537	966	1,520	3,170
2,000	23	48	99	172	244	522	940	1,480	3,090

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

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

Table 6.3.1(h) Corrugated Stainless Steel Tubing (CSST)

											Gas:	Undiluted Propane		
											Inlet Pressure:	11.0 in. w.c.		
											Pressure Drop:	0.5 in. w.c.		
											Specific Gravity:	1.50		
INTENDED USE: CSST Sizing Between Single- or Second-Stage (Low-Pressure) Regulator and Appliance Shutoff Valve.														
	Tube Size (EHD)													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (ft)	**Capacity in Thousands of Btu per Hour**													
5	72	99	181	211	355	426	744	863	1,420	1,638	2,830	3,270	5,780	6,550
10	50	69	129	150	254	303	521	605	971	1,179	1,990	2,320	4,110	4,640
15	39	55	104	121	208	248	422	490	775	972	1,620	1,900	3,370	3,790
20	34	49	91	106	183	216	365	425	661	847	1,400	1,650	2,930	3,290
25	30	42	82	94	164	192	325	379	583	762	1,250	1,480	2,630	2,940
30	28	39	74	87	151	177	297	344	528	698	1,140	1,350	2,400	2,680
40	23	33	64	74	131	153	256	297	449	610	988	1,170	2,090	2,330
50	20	30	58	66	118	137	227	265	397	548	884	1,050	1,870	2,080
60	19	26	53	60	107	126	207	241	359	502	805	961	1,710	1,900
70	17	25	49	57	99	117	191	222	330	466	745	890	1,590	1,760
80	15	23	45	52	94	109	178	208	307	438	696	833	1,490	1,650
90	15	22	44	50	90	102	169	197	286	414	656	787	1,400	1,550
100	14	20	41	47	85	98	159	186	270	393	621	746	1,330	1,480
150	11	15	31	36	66	75	123	143	217	324	506	611	1,090	1,210
200	9	14	28	33	60	69	112	129	183	283	438	531	948	1,050
250	8	12	25	30	53	61	99	117	163	254	390	476	850	934
300	8	11	23	26	50	57	90	107	147	234	357	434	777	854

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

Table 6.3.1(i) Corrugated Stainless Steel Tubing (CSST)

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

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

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

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

Table 6.3.1(j) Corrugated Stainless Steel Tubing (CSST)

											Gas:	Undiluted Propane		
											Inlet Pressure:	5.0 psi		
											Pressure Drop:	3.5 psi		
											Specific Gravity:	1.50		
	Tube Size (EHD)													
Flow Designation:	13	15	18	19	23	25	30	31	37	39	46	48	60	62
Length (ft)	Capacity in Thousands of Btu per Hour													
10	826	1,070	1,710	2,060	3,150	4,000	7,830	8,950	13,100	14,441	28,600	31,200	54,400	63,800
25	509	664	1,090	1,310	2,040	2,550	4,860	5,600	8,400	9,339	18,000	19,900	34,700	40,400
30	461	603	999	1,190	1,870	2,340	4,430	5,100	7,680	8,564	16,400	18,200	31,700	36,900
40	396	520	867	1,030	1,630	2,030	3,820	4,400	6,680	7,469	14,200	15,800	27,600	32,000
50	352	463	777	926	1,460	1,820	3,410	3,930	5,990	6,717	12,700	14,100	24,700	28,600
75	284	376	637	757	1,210	1,490	2,770	3,190	4,920	5,539	10,300	11,600	20,300	23,400
80	275	363	618	731	1,170	1,450	2,680	3,090	4,770	5,372	9,990	11,200	19,600	22,700
100	243	324	553	656	1,050	1,300	2,390	2,760	4,280	4,830	8,930	10,000	17,600	20,300
150	196	262	453	535	866	1,060	1,940	2,240	3,510	3,983	7,270	8,210	14,400	16,600
200	169	226	393	464	755	923	1,680	1,930	3,050	3,474	6,290	7,130	12,500	14,400
250	150	202	352	415	679	828	1,490	1,730	2,740	3,124	5,620	6,390	11,200	12,900
300	136	183	322	379	622	757	1,360	1,570	2,510	2,865	5,120	5,840	10,300	11,700
400	117	158	279	328	542	657	1,170	1,360	2,180	2,498	4,430	5,070	8,920	10,200
500	104	140	251	294	488	589	1,050	1,210	1,950	2,247	3,960	4,540	8,000	9,110

EHD: Equivalent hydraulic diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Notes:

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

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

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

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

Table 6.3.1(k) Polyethylene Plastic Pipe

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 at Tank or Second-Stage (Low-Pressure) Regulator and Building.

	Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	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 (ft)	Capacity in Thousands of Btu per Hour							
10	340	680	1,230	2,130	3,210	5,770	16,000	30,900
20	233	468	844	1,460	2,210	3,970	11,000	21,200
30	187	375	677	1,170	1,770	3,180	8,810	17,000
40	160	321	580	1,000	1,520	2,730	7,540	14,600
50	142	285	514	890	1,340	2,420	6,680	12,900
60	129	258	466	807	1,220	2,190	6,050	11,700
70	119	237	428	742	1,120	2,010	5,570	10,800
80	110	221	398	690	1,040	1,870	5,180	10,000
90	103	207	374	648	978	1,760	4,860	9,400
100	98	196	353	612	924	1,660	4,590	8,900
125	87	173	313	542	819	1,470	4,070	7,900
150	78	157	284	491	742	1,330	3,690	7,130
175	72	145	261	452	683	1,230	3,390	6,560
200	67	135	243	420	635	1,140	3,160	6,100
250	60	119	215	373	563	1,010	2,800	5,410
300	54	108	195	338	510	916	2,530	4,900
350	50	99	179	311	469	843	2,330	4,510
400	46	92	167	289	436	784	2,170	4,190
450	43	87	157	271	409	736	2,040	3,930
500	41	82	148	256	387	695	1,920	3,720

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

Table 6.3.1(l) Polyethylene Plastic Pipe

						Gas:	Undiluted Propane	
						Inlet Pressure:	2.0 psi	
						Pressure Drop:	1.0 psi	
						Specific Gravity:	1.50	
INTENDED USE: PE Pipe Sizing Between 2 psi Service Regulator and Line Pressure Regulator.								
	Pipe Size (in.)							
Nominal OD:	½	¾	1	1¼	1½	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 (ft)	**Capacity in Thousands of Btu per Hour**							
10	3,130	6,260	11,300	19,600	29,500	53,100	147,000	284,000
20	2,150	4,300	7,760	13,400	20,300	36,500	101,000	195,000
30	1,730	3,450	6,230	10,800	16,300	29,300	81,100	157,000
40	1,480	2,960	5,330	9,240	14,000	25,100	69,400	134,100
50	1,310	2,620	4,730	8,190	12,400	22,200	61,500	119,000
60	1,190	2,370	4,280	7,420	11,200	20,100	55,700	108,000
70	1,090	2,180	3,940	6,830	10,300	18,500	51,300	99,100
80	1,010	2,030	3,670	6,350	9,590	17,200	47,700	92,200
90	952	1,910	3,440	5,960	9,000	16,200	44,700	86,500
100	899	1,800	3,250	5,630	8,500	15,300	42,300	81,700
125	797	1,600	2,880	4,990	7,530	13,500	37,500	72,400
150	722	1,450	2,610	4,520	6,830	12,300	33,900	65,600
175	664	1,330	2,400	4,160	6,280	11,300	31,200	60,300
200	618	1,240	2,230	3,870	5,840	10,500	29,000	56,100
250	548	1,100	1,980	3,430	5,180	9,300	25,700	49,800
300	496	994	1,790	3,110	4,690	8,430	23,300	45,100
350	457	914	1,650	2,860	4,320	7,760	21,500	41,500
400	425	851	1,530	2,660	4,020	7,220	12,000	38,600
450	399	798	1,440	2,500	3,770	6,770	18,700	36,200
500	377	754	1,360	2,360	3,560	6,390	17,700	34,200
550	358	716	1,290	2,240	3,380	6,070	16,800	32,500
600	341	683	1,230	2,140	3,220	5,790	16,000	31,000
650	327	654	1,180	2,040	3,090	5,550	15,400	29,700
700	314	628	1,130	1,960	2,970	5,330	14,700	28,500
750	302	605	1,090	1,890	2,860	5,140	14,200	27,500
800	292	585	1,050	1,830	2,760	4,960	13,700	26,500
850	283	566	1,020	1,770	2,670	4,800	13,300	25,700
900	274	549	990	1,710	2,590	4,650	12,900	24,900
950	266	533	961	1,670	2,520	4,520	12,500	24,200
1,000	259	518	935	1,620	2,450	4,400	12,200	23,500
1,100	246	492	888	1,540	2,320	4,170	11,500	22,300
1,200	234	470	847	1,470	2,220	3,980	11,000	21,300
1,300	225	450	811	1,410	2,120	3,810	10,600	20,400
1,400	216	432	779	1,350	2,040	3,660	10,100	19,600
1,500	208	416	751	1,300	1,960	3,530	9,760	18,900
1,600	201	402	725	1,260	1,900	3,410	9,430	18,200
1,700	194	389	702	1,220	1,840	3,300	9,130	17,600
1,800	188	377	680	1,180	1,780	3,200	8,850	17,100
1,900	183	366	661	1,140	1,730	3,110	8,590	16,600
2,000	178	356	643	1,110	1,680	3,020	8,360	16,200

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

Table 6.3.1(m) Polyethylene Plastic Tubing

	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) (in.)		
Nominal OD:	½	1
Designation:	**SDR 7**	**SDR 11**
Actual ID:	**0.445**	**0.927**
Length (ft)	**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

CTS: Copper tube size.
Note: All table entries are rounded to 3 significant digits.

Table 6.4.2 *Cr* and *Y* for Natural Gas and Undiluted Propane at Standard Conditions

	Formula Factors	
Gas	***Cr***	***Y***
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.9910

Chapter 7 Gas Piping Installation

7.1 Installation of Underground Piping.

Δ 7.1.1 Clearances.

N **7.1.1.1** 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.

N **7.1.1.2** 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.

7.1.2 Protection Against Damage. Means shall be provided to prevent excessive stressing of the piping where vehicular traffic is heavy or soil conditions are unstable and settling of piping or foundation walls could occur. Piping shall be buried or covered in a manner so as to protect the piping from physical damage. Piping shall be protected from physical damage where it passes through flower beds, shrub beds, and other such cultivated areas where such damage is reasonably expected.

7.1.2.1 Cover Requirements. Underground piping systems shall be installed with a minimum of 12 in. (300 mm) of cover.

(A) The minimum cover shall be increased to 18 in. (460 mm) if external damage to the pipe or tubing from external forces is likely to result.

Δ **(B)*** Where a minimum of 12 in. (300 mm) of cover cannot be provided, the piping shall be installed in conduit.

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

7.1.2.3 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.

7.1.3* Corrosion Protection of Piping. Steel pipe and steel tubing installed underground shall be installed in accordance with the 7.1.3.1 through 7.1.3.9.

7.1.3.1 Zinc coating (galvanizing) shall not be deemed adequate protection for underground gas piping.

7.1.3.2 Underground piping shall comply with 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 7.1.3.3 or 7.1.3.6.

7.1.3.3 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 described in Appendix D of Title 49 of the Code of Federal Regulations, Part 192

7.1.3.4 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 (1) and (2), periodic follow-up testing shall be performed at intervals not to exceed 36 months

7.1.3.5 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 7.1.3.4(1) and 7.1.3.4(2), and the results shall comply with 7.1.3.3.

7.1.3.6 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.

7.1.3.7 Documentation of the results of the two most recent tests shall be retained.

7.1.3.8 Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used.

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

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

7.1.5 Piping Through Foundation Wall. Piping through a foundation wall shall comply with 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.

7.1.6 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 7.1.6.1 or 7.1.6.2

(2) A piping/encasement system listed for installation beneath buildings.

7.1.6.1 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 in. (100 mm) outside the building, be vented outdoors above finished ground level, and be installed so as to prevent the entrance of water and insects.

7.1.6.2 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.

7.1.7 Plastic Piping.

7.1.7.1 Connection of Plastic Piping. Plastic piping shall be installed outdoors, underground only.

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

Exception No. 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.

7.1.7.2 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, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, Category I transition fittings
(2) ASTM F1973, *Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA 12) Fuel Gas Distribution Systems*
(3) ASTM F2509, *Standard Specification for Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing*

7.1.7.3 Tracer Wire. An electrically continuous corrosion-resistant tracer shall be buried with the plastic pipe to facilitate locating.

7.1.7.3.1 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

7.1.7.3.2 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.

7.1.8 CSST piping systems shall be installed in accordance with this code and the manufacturer's installation instructions.

Δ 7.2 Installation of Aboveground Piping.

7.2.1 Piping installed aboveground shall comply with 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 in. (89 mm) above the ground.
(6) Sealing materials shall be compatible with the piping and sleeve.

7.2.2* 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.

7.2.3 Building Structure.

7.2.3.1 The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits.

7.2.3.2 Approval shall be obtained before any beams or joists are cut or notched.

7.2.4 Gas Piping to Be Sloped. Piping for other than dry gas conditions shall be sloped not less than ¼ in. in 15 ft (7 mm in 4.6 m) to prevent traps.

7.2.5* 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.

7.2.6 Hangers, Supports, and Anchors.

7.2.6.1 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 ANSI/MSS SP-58, *Pipe Hangers and Supports — Materials, Design Manufacture, Selection, Application, and Installation.*

7.2.6.2 Spacings of supports in gas piping installations shall not be greater than shown in Table 7.2.6.2. Spacing of supports of CSST shall be in accordance with the CSST manufacturer's instructions.

7.2.6.3 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.

Δ 7.2.6.4 Piping on Roofs.

***N* 7.2.6.4.1** Gas piping installed on the roof surfaces shall be supported in accordance with Table 7.2.6.2.

***N* 7.2.6.4.2** Gas piping shall be elevated not less than 3½ in. (89 mm) above the roof surface.