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ANSI Z223.1

National Fuel Gas Code

2018

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ANSI Z223.1–2018

National Fuel Gas Code

2018 Edition

This edition of NFPA 54, *National Fuel Gas Code*, was prepared by the Technical Committee on National Fuel Gas Code and acted on by NFPA at its June Association Technical Meeting held June 4–7, 2017, in Boston, MA. It was issued by the Standards Council on August 17, 2017, with an effective date of September 6, 2017, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See "Codes & Standards" at www.nfpa.org for more information.

This edition of ANSI Z223.1/NFPA 54 was approved as an American National Standard on September 6, 2017. The ANSI designation is Z223.1-2018 approved on August 3, 2017. The NFPA designation is NFPA 54-2018.

Origin and Development of ANSI Z223.1/NFPA 54

This code offers criteria for the installation and operation of gas piping and gas equipment on consumers' premises. It is the cumulative result of years of experience of many individuals and many organizations acquainted with the installation of gas piping and equipment designed for utilization of gaseous fuels. It is intended to promote public safety by providing requirements for the safe and satisfactory utilization of gas.

Changes in this code can become necessary from time to time. When any revision is deemed advisable, recommendations should be forwarded to the Secretary, Accredited Standards Committee Z223, 400 N. Capitol St. NW, Washington, DC 20001, and the Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Prior to 1974, the following three codes covered the installation of gas piping and appliances:

(1) *American National Standard Installation of Gas Appliances and Gas Piping*, ANSI Z21.30 (NFPA 54)
(2) *Installation of Gas Piping and Gas Equipment on Industrial Premises and Certain Other Premises*, ANSI Z83.1 (NFPA 54A)
(3) *Fuel Gas Piping*, ASME B31.2

The first edition of the code was issued in 1974. It combined the requirements of the three predecessor documents. The American Gas Association and the National Fire Protection Association have continued co-sponsorship of the code following the first edition.

The second edition of the code, incorporating pertinent portions of B31.2, was issued in 1980, and reorganized the code to the current format. Subsequent editions were issued in 1984, 1988, 1992, 1996, 1999, and 2002, respectively. The scope of the code was expanded in 1988 to include piping systems up to and including 125 psi (862 kPa). Revision highlights from subsequent editions include:

The 2006 edition incorporated expanded steel, copper, and polyethylene pipe sizing tables. Requirements for appliance shutoff valves were revised to allow manifold systems with all shutoff valves in one location up to 50 ft (15 m) from the most remote appliance, and the chapters were reorganized by application.

The 2009 edition included allowing press-connect fittings for gas tubing systems, new requirements for bonding of CSST piping systems, expanded CSST sizing tables to recognize additional available sizes, new coverage of outdoor decorative appliances, and a new requirement to seal the annular space around the side wall vent penetrations.

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The 2012 edition included revised fuel gas piping purging procedures that require outdoor purging of piping with larger pipe sizes or higher operating pressures and allows smaller or lower operating pressure piping to be purged indoors under specific conditions.

The 2015 edition revised the bonding requirements for CSST so that the bonding connection can be placed on any metallic fitting in the piping system as long as the bonding jumper does not exceed 75 ft (22 m) in length. Overpressure protection requirements were rewritten and overpressure protection is required on any system containing an appliance with a maximum inlet pressure of 14 in. w.c. (3.5 kPa) that is supplied with gas at the point of delivery at a pressure greater than 2 psig (14 kPa). Annex G, Recommended Procedure for Safety Inspection of an Existing Appliance Installation, was expanded and revised to reflect modern appliances and test methods.

In the 2018 edition, revisions to piping include allowing listed arc-resistant jacket or coated CSST to use the appliance's electrical grounding connector as the bonding means and recognizing stainless steel smooth wall pipe and tubing products as acceptable piping materials. The minimum allowed wall thickness of carbon and stainless steel pipe has been revised to Schedule 10 but joints on Schedule 10 pipe cannot be made with screwed fittings. Press-connect fittings have been added as an acceptable joining method for pipe.

Revisions to the venting requirements include requiring listing to the appropriate UL standards for plastic venting materials, factory-built chimneys, Type B and BW vents, chimney lining systems, and special gas vents. Direct vent clearances to building openings for appliances with an input above 150,000 Btu (44 kW) are to be in accordance with the appliance manufacturer's installation instructions.

Finally, in Chapter 9 a requirement has been added that an existing gas appliance installation be inspected for combustion air and venting code compliance when the building structure that it is installed in is modified with specific air infiltration-reducing changes.

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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.

Documents
Document Sharing Hub
Full document details: NFPA 54 2018

Contents

Chapter 1 Administration 54– 7
1.1 Scope. 54– 7
1.2 Purpose. 54– 8
1.3 Retroactivity. 54– 8
1.4 Equivalency. 54– 8
1.5 Enforcement. 54– 8

Chapter 2 Referenced Publications 54– 8
2.1 General. 54– 8
2.2 NFPA Publications. 54– 8
2.3 Other Publications. 54– 8
2.4 References for Extracts in Mandatory Sections. ... 54– 9

Chapter 3 Definitions 54– 9
3.1 General. 54– 9
3.2 NFPA Official Definitions. 54– 9
3.3 General Definitions. 54– 10

Chapter 4 General 54– 17
4.1 Qualified Agency. 54– 17
4.2 Interruption of Service. 54– 17
4.3 Prevention of Accidental Ignition. 54– 17
4.4 Noncombustible Material. 54– 17

Chapter 5 Gas Piping System Design, Materials, and Components 54– 17
5.1 Piping Plan. 54– 17
5.2 Provision for Location of Point of Delivery. 54– 17
5.3 Interconnections Between Gas Piping Systems. 54– 17
5.4 Sizing of Gas Piping Systems. 54– 18
5.5 Operating Pressure. 54– 18
5.6 Acceptable Piping Materials and Joining Methods. 54– 18
5.7 Gas Meters. 54– 21
5.8 Gas Pressure Regulators. 54– 21
5.9 Overpressure Protection Devices. 54– 22
5.10 Back Pressure Protection. 54– 23
5.11 Low-Pressure Protection. 54– 23
5.12 Shutoff Valves. 54– 23
5.13 Excess Flow Valve(s). 54– 23
5.14 Expansion and Flexibility. 54– 23

Chapter 6 Pipe Sizing 54– 23
6.1 Pipe Sizing Methods. 54– 23
6.2 Sizing Natural Gas Piping Systems. 54– 23
6.3 Sizing Propane Piping Systems. 54– 23
6.4 Sizing Equations. 54– 23

Chapter 7 Gas Piping Installation 54– 59
7.1 Installation of Underground Piping. 54– 59
7.2 Installation of Aboveground Piping. 54– 61
7.3 Concealed Piping in Buildings. 54– 61
7.4 Piping in Vertical Chases. 54– 62
7.5 Gas Pipe Turns. 54– 62
7.6 Drips and Sediment Traps. 54– 62
7.7 Outlets. 54– 62
7.8 Manual Gas Shutoff Valves. 54– 63
7.9 Prohibited Devices. 54– 63
7.10 Systems Containing Gas–Air Mixtures Outside the Flammable Range. 54– 63
7.11 Systems Containing Flammable Gas–Air Mixtures. 54– 63
7.12 Electrical Bonding and Grounding. 54– 64
7.13 Electrical Circuits. 54– 64
7.14 Electrical Connections. 54– 64

Chapter 8 Inspection, Testing, and Purging 54– 64
8.1 Pressure Testing and Inspection. 54– 64
8.2 Piping System Leak Check. 54– 65
8.3 Purging Requirements. 54– 65

Chapter 9 Appliance, Equipment, and Accessory Installation 54– 66
9.1 General. 54– 66
9.2 Accessibility and Clearance. 54– 68
9.3 Air for Combustion and Ventilation. 54– 69
9.4 Appliances on Roofs. 54– 70
9.5 Appliances in Attics. 54– 71
9.6 Appliance and Equipment Connections to Building Piping. 54– 71
9.7 Electrical. 54– 73
9.8 Room Temperature Thermostats. 54– 73

Chapter 10 Installation of Specific Appliances 54– 73
10.1 General. 54– 73
10.2 Air-Conditioning Appliances (Gas-Fired Air Conditioners and Heat Pumps). 54– 73
10.3 Central Heating Boilers and Furnaces. 54– 75
10.4 Clothes Dryers. 54– 77
10.5 Conversion Burners. 54– 77
10.6 Decorative Appliances for Installation in Vented Fireplaces. 54– 77
10.7 Gas Fireplaces, Vented. 54– 78
10.8 Non-Recirculating Direct Gas-Fired Industrial Air Heaters. 54– 78
10.9 Recirculating Direct Gas-Fired Industrial Air Heaters. 54– 79
10.10 Duct Furnaces. 54– 79
10.11 Floor Furnaces. 54– 80
10.12 Food Service Appliance, Floor-Mounted. 54– 81
10.13 Food Service Appliances, Counter Appliances. 54– 82
10.14 Household Cooking Appliances. 54– 82
10.15 Illuminating Appliances. 54– 82
10.16 Incinerators, Commercial-Industrial. 54– 83
10.17 Infrared Heaters. 54– 83
10.18 Open-Top Broiler Units. 54– 83
10.19 Outdoor Cooking Appliances. 54– 83
10.20 Pool Heaters. 54– 83
10.21 Refrigerators. 54– 84
10.22 Room Heaters. 54– 84
10.23 Stationary Gas Engines. 54– 84
10.24 Gas-Fired Toilets. 54– 84
10.25 Unit Heaters. 54– 84
10.26 Wall Furnaces. 54– 85
10.27 Water Heaters. 54– 85
10.28 Compressed Natural Gas (CNG) Vehicular Fuel Systems. 54– 86
10.29 Appliances for Installation in Manufactured Housing. 54– 86
10.30 Fuel Cell Power Plants. 54– 86
10.31 Outdoor Open Flame Decorative Appliances. 54– 86

Chapter 11 Procedures to Be Followed to Place Appliance in Operation 54– 86
11.1 Adjusting the Burner Input. 54– 86
11.2 Primary Air Adjustment. 54– 86
11.3 Safety Shutoff Devices. 54– 86
11.4 Automatic Ignition. 54– 86
11.5 Protective Devices. 54– 86
11.6 Checking the Draft. 54– 87
11.7 Operating Instructions. 54– 87

Documents 2018 Edition Document Sharing Hub

Full document details: NFPA 54 2018

Chapter 12 Venting of Appliances **54–** 87
12.1 Minimum Safe Performance. **54–** 87
12.2 General. **54–** 87
12.3 Specification for Venting. **54–** 87
12.4 Design and Construction. **54–** 87
12.5 Type of Venting System to Be Used. **54–** 88
12.6 Masonry, Metal, and Factory-Built Chimneys. **54–** 88
12.7 Gas Vents. **54–** 90
12.8 Single-Wall Metal Pipe. **54–** 91
12.9 Through-the-Wall Vent Termination. **54–** 93
12.10 Condensation Drain. **54–** 93
12.11 Vent Connectors for Category I Appliances. **54–** 93
12.12 Vent Connectors for Category II, Category III, and Category IV Appliances. **54–** 95
12.13 Draft Hoods and Draft Controls. **54–** 95
12.14 Manually Operated Dampers. **54–** 95
12.15 Automatically Operated Vent Dampers. **54–** 96
12.16 Obstructions. **54–** 96

Chapter 13 Sizing of Category I Venting Systems **54–** 96
13.1 Additional Requirements to Single Appliance Vent. **54–** 96
13.2 Additional Requirements to Multiple-Appliance Vent. **54–** 104

Annex A Explanatory Material **54–** 116

Annex B Sizing and Capacities of Gas Piping **54–** 129

Annex C Suggested Method of Checking for Leakage **54–** 138

Annex D Suggested Emergency Procedure for Gas Leaks **54–** 139

Annex E Flow of Gas Through Fixed Orifices **54–** 140

Annex F Sizing of Venting Systems Serving Appliances Equipped with Draft Hoods, Category I Appliances, and Appliances Listed for Use with Type B Vents **54–** 145

Annex G Recommended Procedure for Safety Inspection of an Existing Appliance Installation **54–** 153

Annex H Indoor Combustion Air Calculation Examples **54–** 158

Annex I Example of Combination of Indoor and Outdoor Combustion and Ventilation Opening Design **54–** 159

Annex J Enforcement **54–** 160

Annex K Informational References **54–** 161

Index **54–** 164

Documents
Document Sharing Hub
Full document details: NFPA 54 2018

NFPA 54

ANSI Z223.1–2018

National Fuel Gas Code

2018 Edition

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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.

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

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

N **(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.

Δ **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

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Full document details: NFPA 54 2018

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.

1.4 Equivalency. The provisions of this code are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this code, provided 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,* 2018 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,* 2016 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2017 edition.

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

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.

NFPA 88A, *Standard for Parking Structures,* 2015 edition.

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

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2018 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2017 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2016 edition.

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

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2017 edition.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems,* 2015 edition.

NFPA 1192, *Standard on Recreational Vehicles,* 2018 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,* 2010.

ANSI/ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard,* 2013.

ANSI/ASME B16.20, *Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound and Jacketed,* 2012.

ANSI/ASME B16.21, *Nonmetallic Flat Gaskets for Pipe Flanges,* 2011.

ANSI/ASME B16.24, *Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500,* 2011.

ANSI/ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300,* 2011.

ANSI/ASME B16.47, *Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard,* 2011.

ANSI/ASME B36.10M, *Welded and Seamless Wrought Steel Pipe,* 2015.

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,* 2012.

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service,* 2014.

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.

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

ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes,* 2015.

ASTM B88, *Standard Specification for Seamless Copper Water Tube,* 2014.

ASTM B210, *Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes,* 2012.

ASTM B241, *Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube,* 2012.

ASTM B280, *Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service,* 2013.

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings,* 2014.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2012.

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 °C,* 2012.

Documents Document Sharing Hub
Full document details: NFPA 54 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.

ASTM F2509, *Standard Specification for Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing,* 2012.

ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings,* 2015.

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

ANSI/CSA NGV 5.1, *Residential Fueling Appliances*, 2015.

ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST),* 2014.

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

ANSI Z21.8, *Installation of Domestic Gas Conversion Burners,* 1994, reaffirmed 2012.

ANSI Z21.11.2, *Gas-Fired Room Heaters — Volume II, Unvented Room Heaters,* 2013.

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

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

ANSI Z21.54/CSA 8.4, *Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances,* 2014.

ANSI Z21.69/CSA 6.16, *Connectors for Movable Gas Appliances,* 2009.

ANSI Z21.75/CSA 6.27, *Connectors for Outdoor Gas Appliances and Manufactured Homes,* 2007, reaffirmed 2012.

ANSI Z21.80/CSA 6.22, *Line Pressure Regulators,* 2011.

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,* 2013.

ANSI Z83.4/CSA 3.7, *Non-Recirculating Direct Gas-Fired Industrial Air Heaters,* 2015.

ANSI Z83.18, *Recirculating Direct Gas-Fired Industrial Air Heaters,* 2015.

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,* 2009.

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

ANSI/UL 103, *Chimneys, Factory-Built, Residential Type and Building Heating Appliances*, 2010, reapproved 2012.

ANSI/UL 441, *Gas Vents*, 2010, reapproved 2014.

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

ANSI/UL 641, *Type L Low-Temperature Venting Systems*, 2010, reapproved 2013.

ANSI/UL 651, *Schedule 40 and 80 Rigid PVC Conduit and Fittings,* 2011, reapproved 2014.

ANSI/UL 959, *Medium Heat Appliance Factory-Built Chimneys*, 2010, reapproved 2014.

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

ANSI/UL 1777, *Chimney Liners*, 2015.

ANSI/UL 2158A, *Clothes Dryer Transition Ducts,* 2013.

ANSI/UL 2561, *1400 Degree Fahrenheit Factory-Built Chimneys*, 2009, reapproved 2013.

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

2.3.6 U.S. Government Publications. U.S. Government Publishing Office, 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.

Δ 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,* 2015 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

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

NFPA 5000®, Building Construction and Safety Code®, 2015 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.

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Full document details: NFPA 54 2018

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.

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.

3.3.3 Air Conditioning. The treatment of air so as to control simultaneously its temperature, humidity, cleanness, and distribution to meet the requirements of a conditioned space.

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

3.3.5 Appliance. Any device that utilizes a fuel to produce light, heat, power, refrigeration, or air conditioning.

3.3.5.1 ***Automatically Controlled Appliance.*** Appliance equipped with an automatic burner ignition and safety shutoff device and other automatic devices.

3.3.5.2 ***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.

3.3.5.3 ***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.

3.3.5.4 ***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.

3.3.5.5 ***Food Service Appliance.***

3.3.5.5.1 ***Baking and Roasting Gas 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.

3.3.5.5.2 ***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.

3.3.5.5.3 ***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.

3.3.5.5.4 ***Gas Range.*** A self-contained gas range providing for cooking, roasting, baking, or broiling, or any combination of these functions, and not designed specifically for domestic use.

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

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

3.3.5.5.7 ***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.

3.3.5.6 ***Gas Counter Appliances.*** See 3.3.5.5.2.

3.3.5.7 ***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.

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

3.3.5.7.2 ***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.

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

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Full document details: NFPA 54 2018

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

3.3.5.10 ***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.

3.3.5.11 ***Vented Appliance.***

3.3.5.11.1* ***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.

3.3.5.11.2 ***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.

3.3.5.11.3 ***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.

3.3.5.11.4 ***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.

3.3.6 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.

3.3.7 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.

3.3.8 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.

3.3.9 Backfire Preventer. See 3.3.86, Safety Blowout.

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

3.3.11 Boiler.

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

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

3.3.11.3 ***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]

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

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

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

3.3.14 Breeching. See 3.3.101, Vent Connector.

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

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

3.3.16 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).

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

3.3.17.1 ***Forced-Draft Burner.*** See 3.3.17.5, Power Burner.

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

3.3.17.3 ***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.

3.3.17.4 ***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.

3.3.17.5 ***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.

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

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

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

3.3.18.2 ***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.

3.3.18.3 ***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.

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

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

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Full document details: NFPA 54 2018

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

3.3.19.2 ***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.

3.3.20 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,** 2015]

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

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

3.3.23 Condensate (Condensation). The liquid that separates from a gas (including flue gas) due to a reduction in temperature or an increase in pressure.

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

3.3.24.1 ***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.

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

3.3.26 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. w.c. (7.5 kPa).

3.3.27 Deep Fat Fryer. See 3.3.5.5.3, Gas Deep Fat Fryer.

3.3.28 Device.

3.3.28.1 ***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.

3.3.28.2 ***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.

3.3.28.3 ***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.

3.3.28.4 ***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.

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

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

3.3.30.1 ***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.

Δ **3.3.30.2** ***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]

3.3.31 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.

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

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

Δ **3.3.34 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]

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 appli-

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ance 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.

Δ **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.

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Full document details: NFPA 54 2018

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 ***Direct Gas-Fired Nonrecirculating Industrial Air Heater.*** A nonrecirculating industrial air heater in which all the products of combustion generated by the appliance are released into the outdoor airstream being heated.

3.3.56.2 ***Direct Gas-Fired Recirculating Industrial Air Heater.*** An air recirculating heater in which all of the products of combustion generated by the appliance are released into the airstream being heated.

3.3.56.3 ***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.

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

3.3.56.5 ***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 3.3.5.5.2, Gas Counter Appliance.

3.3.58.1 ***Domestic Hot Plate.*** A fuel gas–burning appliance consisting of one or more open-top-type burners mounted 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./ft^2/°F/hr (0.14 W/m/°K).

3.3.61 Kettle. See 3.3.5.5.7.

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 ft^2 (29.7 m^2) 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.

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.

Δ **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.

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Full document details: NFPA 54 2018

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,** 2015]

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,** 2015]

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.

3.3.72 Oven, Gas Baking and Roasting. See 3.3.5.5.1, Baking and Roasting Gas Oven.

3.3.73 Parking Structure. A building, structure, or portion thereof used for the parking, storage, or both, of motor vehicles. [**88A,** 2015]

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,** 2015]

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

3.3.78.1 ***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.

3.3.78.2 ***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.

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

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

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

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

3.3.81 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 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.

3.3.82 Range. See 3.3.5.5.4, Gas Range.

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.

N **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 prod-

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Full document details: NFPA 54 2018

ucts 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.

Δ **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 piping and fittings installed by the serving gas supplier to connect the inlet side of the meter to the gas service and to connect the outlet side of the meter to the customer's house or yard piping.

3.3.89 Service Regulator. See 3.3.84.5, Pressure Regulator; and 3.3.84.7, Service Regulator.

3.3.90 Shutoff. See 3.3.99, 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.

3.3.92 Steam Cooker. See 3.3.5.5.5, Gas Steam Cooker.

3.3.93 Steam Generator. See 3.3.5.5.6, Gas 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 ***Forced Mechanical Draft Venting System.*** A venting system in which a fan or other mechanical device is used to cause the flow of flue or vent gases under positive vent pressure.

3.3.95.7.2 ***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 Thread Joint Compounds. Nonhardening materials used on pipe threads to ensure a seal.

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

3.3.99 Valve. A device used in piping to control the gas supply to any section of a system of piping or to an appliance.

3.3.99.1 ***Appliance Shutoff Valve.*** A valve located in the piping system used to shut off individual equipment.

3.3.99.2 ***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.

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

3.3.99.4 ***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.

3.3.99.5 ***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.

3.3.99.5.1 ***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.

3.3.99.5.2 ***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.

3.3.99.5.3 ***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.

3.3.99.6 ***Service Shutoff Valve.*** A valve, installed by the serving gas supplier between the service meter or source of supply and the customer piping system, to shut off the entire piping system.

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Full document details: NFPA 54 2018

3.3.100 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.

3.3.100.1 ***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.

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

3.3.102 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.

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

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

3.3.105 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. Installation, testing, purging, and replacement of gas piping, appliances, or accessories, and repair and servicing of equipment, shall be performed only by a qualified agency.

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.

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. The gas supplier shall be notified when drip liquids are removed.

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*

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 Provision for Location of Point of Delivery. The location of the point of delivery shall be acceptable to the serving gas supplier.

5.3 Interconnections Between Gas Piping Systems.

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

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Full document details: NFPA 54 2018

5.3.2 Interconnections for Standby Fuels.

5.3.2.1 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.

5.3.2.2 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.

5.4 Sizing of Gas Piping Systems.

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

5.4.2* Maximum Gas Demand.

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

5.4.2.2 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).

5.4.2.3 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 **5.4.3* 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) Other approved engineering methods
(3) Sizing tables included in a listed piping system manufacturer's installation instructions

5.4.4 Allowable Pressure Drop. The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the appliance, shall be such that the supply pressure at the appliance is greater than or equal to the minimum pressure required by the appliance.

5.5 Operating Pressure.

Δ **5.5.1 Piping System Operating Pressure Limitations.** The maximum operating pressure for any piping system shall not exceed 125 psi (862 kPa).

N **5.5.2 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).

N **5.5.3 LP-Gas Piping Systems.** The maximum operating pressure for LP-Gas piping systems shall be 20 psi (140 kPa), except as provided in 5.5.4(7).

N **5.5.4 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 joints are flanged and all pipe-to-flange connections are made by welding or brazing.
(3) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
(4) 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
(5) The piping is a temporary installation for buildings under construction.
(6) The piping serves appliances or equipment used for agricultural purposes.
(7) The piping system is an LP-Gas piping system with an operating pressure greater than 20 psi (138 kPa) and complies with NFPA 58.

5.5.5 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.

5.6* Acceptable Piping Materials and Joining Methods.

5.6.1 General.

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

5.6.1.2 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.

5.6.1.3 Other Materials. Material not covered by the standards specifications listed herein shall meet the following criteria:

(1) Be investigated and tested to determine that it is safe and suitable for the proposed service
(2) Be recommended for that service by the manufacturer
(3) Be acceptable to the authority having jurisdiction

5.6.2 Metallic Pipe.

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

Δ **5.6.2.2 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*

5.6.2.3* 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).

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

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Full document details: NFPA 54 2018

5.6.2.5 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.

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

5.6.3 Metallic Tubing.

N **5.6.3.1** Tubing shall not be used with gases corrosive to the tubing material

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

N **5.6.3.3 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*

5.6.3.4* 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.*

5.6.3.5 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.

5.6.3.6 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.*

5.6.4 Plastic Pipe, Tubing, and Fittings.

5.6.4.1 Standard and Marking.

5.6.4.1.1 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."

Δ **5.6.4.1.2** 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."

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

5.6.4.2* Regulator Vent Piping. Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to ANSI/UL 651, *Schedule 40 and 80 Rigid PVC Conduit and Fittings.* PVC vent piping shall not be installed indoors.

Δ **5.6.4.3 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.

5.6.5 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.

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5.6.6 Metallic Pipe Threads.

5.6.6.1 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.*

5.6.6.2 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.

5.6.6.3 Number of Threads. Field threading of metallic pipe shall be in accordance with Table 5.6.6.3.

5.6.6.4* Thread Joint Compounds. Thread joint compounds shall be resistant to the action of LP-Gas or to any other chemi-

Δ **Table 5.6.6.3 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.

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Full document details: NFPA 54 2018

cal constituents of the gases to be conducted through the piping.

5.6.7 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.

5.6.7.1* 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*.

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

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

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

5.6.7.2 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.

N **5.6.7.3 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.

5.6.7.4 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.

Δ **5.6.7.5 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.

Δ **5.6.8 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. Heat fusion fittings shall be marked "ASTM D2513."
(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.

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Full document details: NFPA 54 2018

5.6.9 Flanges.

5.6.9.1 Flange Specifications.

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

5.6.9.1.2 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.*

5.6.9.1.3 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.*

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

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

5.6.9.3 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.

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

5.6.10 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.

5.6.10.1 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

5.6.10.2 Gasket Specifications.

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

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

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

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

5.7* Gas Meters.

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

5.7.2 Location.

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

5.7.2.2 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.

5.7.2.3 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.

5.7.3 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.

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

5.7.5 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.

5.8* Gas Pressure Regulators.

Δ **5.8.1 Where Required.** A line pressure regulator shall be installed where the gas supply pressure exceeds the maximum allowable inlet pressure of the appliance served.

5.8.2 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.

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

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

5.8.5 Venting.

5.8.5.1 Line Pressure Regulators. Line pressure regulators shall comply with all of the following:

(1) An independent vent to the exterior of the building, sized in accordance with the regulator manufacturer's instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard.
   (a) Where more than one regulator is at a location, each regulator shall have a separate vent to the outdoors or, if approved by the authority having jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize back pressure in the event of diaphragm failure.
   (b) Materials for vent piping shall be in accordance with Section 5.6.

Exception: A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22, Line Pressure

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Full document details: NFPA 54 2018

Regulators, shall be permitted to be used without a vent to the outdoors.

(2) The vent shall be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage.
(3) The regulator vent shall terminate at least 3 ft (0.9 m) from a source of ignition.
(4) At locations where regulators might be submerged during floods, a special antiflood-type breather vent fitting shall be installed, or the vent line shall be extended above the height of the expected flood waters.
(5) A regulator shall not be vented to the appliance flue or exhaust system.

5.8.5.2 Gas Appliance Pressure Regulators. For venting of gas appliance pressure regulators, see 9.1.19.

5.8.6 Bypass Piping. Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative.

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

5.9 Overpressure Protection Devices.

5.9.1 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.

5.9.2 Pressure Limitation Requirements.

5.9.2.1 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 5.9.1, 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.

5.9.2.2 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 5.9.1, 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.

5.9.2.3 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.

5.9.2.4 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.

5.9.2.5 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 5.9.2.1 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.

5.9.3 Overpressure Protection Devices.

5.9.3.1 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 5.9.2.1 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 5.9.2.1 or less. This device shall be designed so that it will remain closed until manually reset.

5.9.3.2 The devices in 5.9.3.1 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 5.9.4 through 5.9.9.

5.9.4 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.

5.9.5 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.

5.9.6 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 5.9.2.1 and 5.9.2.2.

5.9.7 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.

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Full document details: NFPA 54 2018

5.9.8 Vents.

5.9.8.1 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.

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

5.9.9 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.

5.10 Back Pressure Protection.

5.10.1 Where to Install.

5.10.1.1 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.

5.10.1.2 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.

5.10.2 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

5.11* 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.

5.12 Shutoff Valves. Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation. Shutoff valves of size 1 in. (25 mm) National Pipe Thread and smaller shall be listed.

5.13 Excess Flow Valve(s). Where automatic excess flow valves are installed, they shall be listed to 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.

5.14 Expansion and Flexibility.

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

5.14.2 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.

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.

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

N **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.

N **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.

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

N **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.

N **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.

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Full document details: NFPA 54 2018

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.

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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.

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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.

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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.

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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.

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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.

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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.

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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**

		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		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.

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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:	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		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.

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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.

		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		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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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	2 ½	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.

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