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NATIONAL FUEL GAS CODE

An American National Standard

Secretariats

American Gas Association
(Administrative)
1515 Wilson Boulevard, Arlington, VA 22209

National Fire Protection Association, Inc.
Batterymarch Park, Quincy, MA 02269

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NOTICE

All questions or other communications relating to this document should be sent to the American Gas Association Laboratories and the National Fire Protection Association Headquarters addressed to the attention of the committee responsible for the document.

For information on obtaining Formal Interpretations of the document, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Chairman, American National Standards Committee Z223, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131 and the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement written or oral that is not processed in accordance with the interpretation procedure of the Z223 Committee or with Section 16 of the NFPA Regulations Governing Committee Projects shall not be considered the position respectively of the Z223 Committee or the NFPA, and shall not be considered nor relied upon as a Formal Interpretation.

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Third Edition — 1984

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NATIONAL FUEL GAS CODE

ANSI Z223.1-1984

NFPA 54-1984

1984 Edition of ANSI Z223.1—NFPA 54

This 1984 edition incorporates changes to the 1980 edition. It was adopted by the National Fire Protection Association (NFPA) on May 23, 1984 and approved by the American National Standards Institute, Inc. (ANSI) on July 24, 1984. The ANSI designation is Z223.1-1984. The NFPA designation is 54-1984.

Changes, other than editorial, are denoted by a vertical line in the margin except as follows:

a. The three figures delineating the suggested dimensions for draft hoods have been deleted.

PREFACE

(This Preface is informative and is not part of the Code.)

This Code offers general criteria for the installation, operation and maintenance 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 guidelines for the safety and more satisfactory utilization of gas.

Changes in this Code may become necessary from time to time. When any revision is deemed advisable, recommendations should be forwarded to the Chairman, American National Standards Committee Z223, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131 and the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

HISTORY OF DEVELOPMENT OF NATIONAL FUEL GAS CODE

(This History is informative and is not part of the Code.)

As a result of the expressed need within the gas industry, among public safety authorities, insurance groups, architects, designers and builders, for one Code that would cover all facets of fuel gas piping and appliance installation downstream from meter set assemblies or other facilities comprising the gas service entrance to consumers' premises, a meeting of a Conference Group on Piping and Installation Standards, consisting of representatives from the American Gas Association, the American Society of Mechanical Engineers and the National Fire Protection Association, was held on October 25, 1967, to consider the development of a National Fuel Gas Code.

At a January 1968 meeting, a working group of this conference group developed the objectives and scope of a proposed National Standards Committee which envisioned the combining of American National Standards Z21.30 (NFPA No. 54), Installation of Gas Appliances and Gas Piping; Z83.1 (NFPA No. 54A), Installation of Gas Piping and Gas Equipment on Industrial Premises and Certain Other Premises; and B31.2, Fuel Gas Piping, into a National Fuel Gas Code. The proposed scope ultimately agreed on limited coverage of piping systems to a maximum operating pressure of 60 psig. National Standards Committees Z21, Z83 and B31 agreed to relinquish, respectively, Z21.30, Z83.1 and that portion of B31.2 covering piping systems at pressures up to and including 60 psig.

On August 13, 1971, the American National Standards Institute approved the scope of activities and the formation of a National Standards Committee on National Fuel Gas Code, Z223, co-sponsored by the American Gas Association, the American Society of Mechanical Engineers and the National Fire Protection Association.

In order to establish a National Fuel Gas Code to satisfy the immediate needs of the gas industry for a single installation code, the Z223

Committee, at its organizational meeting on December 6, 1972, combined NFPA No. 54-1969 and Z83.1-1972 with only those editorial revisions necessary to accomplish the combination and to reflect the new scope of the standard. It had been recognized that further revisions of the Code would be necessary to incorporate the pertinent coverage for fuel gas piping from B31.2-1968.

The first edition of the Code, which combined NFPA No. 54-1969 and Z83.1-1972, together with amendments to paragraphs 1.4.5.5, 1.4.5.6 and 1.4.5.7, was approved as American National Standard by the American National Standards Institute, Inc., on June 4, 1974, and by the National Fire Protection Association on May 23, 1974. Subsequent to publication of the first edition of the National Fuel Gas Code, the American Society of Mechanical Engineers relinquished its role as co-sponsor of the Code as of April 1, 1980.

The second edition of the Code, which was a consolidation and reorganization of Parts 1 and 2 of the previous edition of the Code plus pertinent portions of ANSI B31.2, Fuel Gas Piping, eliminated the need to differentiate between residential, commercial and industrial installations and generally updated the coverage of the Code in line with current installation practices. It was approved as American National Standard by the American National Standards Institute, Inc., on December 31, 1980, and adopted by the National Fire Protection Association, Inc., on November 20, 1980.

This, the third edition of the Code, which includes revisions drafted in line with industry developments and current installation practices, was approved as American National Standard by the American National Standards Institute, Inc., on July 24, 1984. It was adopted by the National Fire Protection Association, Inc., at its May 21-24, 1984 annual meeting and issued by the NFPA Standards Council on June 14, 1984. The NFPA effective date for this edition of the Code is July 5, 1984.

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The National Fuel Gas Code Committee is a Committee functioning jointly under the procedures of the American National Standards Institute and the National Fire Protection Association and, accordingly, the National Fuel Gas Code bears two designations, ANSI Z223.1 and NFPA No. 54. In the ANSI context, the Code is prepared by the American National Standards Committee on National Fuel Gas Code, Z223, co-sponsored by the American Gas Association (Administrative Secretariat) and the National Fire Protection Association. In the NFPA context the Committee is an NFPA Technical Committee. The personnel on both Committees is identical except as noted in the Committee roster with respect to Messrs. Dockum, Snyder, Streisel and Walls.

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

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Notice: Information on referenced documents may be found in Appendix A.

PART 1

GENERAL

1.1 Scope.

1.1.1 Applicability:

a. This Code is a safety code which applies to the installation of fuel gas piping systems, fuel gas utilization equipment and related accessories as follows:

1. Fuel 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.

2. Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than undiluted liquefied petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no meter is provided. For undiluted liquefied petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator.

3. The maximum operating pressure is 60 psig, except that piping systems for gas-air mixtures within the flammable range are limited to a maximum pressure of 10 psig.

4. Coverage of piping systems includes design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance.

5. Coverage of gas utilization equipment and related accessories includes installation, combustion and ventilation air, and venting.

b. This Code does not apply to the following (reference standards for some of which appear in Appendix A):

1. Portable LP-gas equipment of all types which are not connected to a fixed fuel piping system.

2. Installation of farm equipment such as brooders, dehydrators, dryers and irrigation equipment.
3. Raw material (feed stock) 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 power and atomic energy plants.
11. Proprietory 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 which is not to become part of the permanent building piping system, i.e., 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.

1.1.2 **Other Standards:** In applying this Code, reference should also be made to the manufacturer's instructions and the serving gas supplier regulations. For a list of standards specifically referenced in applying this Code and other standards which may be used, see Appendix A.

1.2 Alternate Materials, Equipment and Procedures.

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 alternate 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 alternates.

1.3 Retroactivity.

Unless otherwise stated, it is not intended that the provisions of this Code be retroactive to existing systems in compliance with the provisions of the code in effect at the time of installation.

1.4 Qualified Agency.

Installation and replacement of gas piping, gas utilization equipment or accessories and repair and servicing of equipment shall be performed only by a qualified agency. The term "qualified agency" means any individual, firm, corporation or company which either in person or through a representative is engaged in and is responsible for (a) the installation or replacement of gas piping or (b) the connection, installation, repair, or servicing of equipment, who is experienced in such work, familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction.

1.5 Interruption of Service.

1.5.1 **Notification of Interrupted Service:** Except in the case of an emergency, it shall be the duty of the qualified agency, when the gas supply is to be turned off, to notify all affected users.

When two or more users are served from the same supply system, precautions shall be exercised to assure that only service to the proper user is turned off.

1.5.2 **Before Turning Gas Off:** Before turning off the gas to the premises, or section of piping to be serviced, for the purpose of installation, repair, replacement or maintenance of gas piping or gas utilization equipment, all equipment valves shall be turned off.

A leakage test shall be made, as specified in Appendix D, to determine that all equipment is turned off in the piping section to be affected.

1.5.3 **Turn Gas Off:** All gas piping installations, equipment installations and modifications to existing systems shall normally be

performed with the gas turned off to eliminate hazards from leakage of gas, except as outlined in "b" below.

a. Reduce gas pressure and purge section to be worked on as specified in 4.3.

b. Hot taps may be made if they are installed by trained and experienced crews utilizing equipment specifically designed for such purpose.

1.5.4 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 safe condition, such as by not leaving any open-ended piping.

1.6 Prevention of Accidental Ignition.

1.6.1 Potential Ignition Sources: When working on piping which contains or has contained gas:

a. Provisions for electrical continuity shall be made before alterations are made in a metallic piping system.

b. Smoking, open flames, lanterns, welding or other sources of ignition shall not be permitted.

c. A metallic electrical bond shall be installed around the location of cuts in metallic gas pipes made by other than cutting torches. If cutting torches, welding or other sources of ignition are unavoidable, 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 4.3 before welding or cutting with a torch is attempted.

d. Artificial illumination shall be restricted to listed safety type flashlights and safety lamps. Electric switches shall not be operated, on or off.

1.6.2 Handling of Flammable Liquids:

a. Drip Liquids: Liquid which is removed from a drip in existing gas piping shall be handled cautiously to avoid spillage or ignition and the gas supplier shall be notified.

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

PART 2

GAS PIPING SYSTEM DESIGN, MATERIALS AND COMPONENTS

2.1 Piping Plan.

2.1.1. Installation of Piping System: When required by the authority having jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. This plan shall show the proposed location of piping, the size of different branches, the various load demands and the location of the point of delivery.

2.1.2 Addition to Existing System: When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity (see 2.4.3). If inadequate, the existing system shall be enlarged as required or separate gas piping of adequate capacity shall be provided.

2.2 Provision for Location of Point of Delivery.

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

2.3 Interconnections Between Gas Piping Systems.

2.3.1 Interconnections Supplying Separate Users: When two or more meters, or two or more service regulators when 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.

2.3.2 Interconnections for Stand-By Fuels: When a supplementary gas for stand-by use is connected downstream from a meter or a service regulator when a meter is not provided, a suitable device to prevent backflow shall be installed. A three-way valve installed to admit the stand-by supply and at the same time shut off the regular supply may be used for this purpose.

2.4 Sizing of Gas Piping Systems.

2.4.1 General Considerations: Gas piping shall be of such size and so installed as to provide a supply of gas sufficient to meet the max-

imum demand without undue loss of pressure between the point of delivery and the gas utilization equipment. The size of gas piping depends upon the following factors:

a. Allowable loss in pressure (see 2.4.4) from point of delivery to equipment.

b. Maximum gas demand.

c. Length of piping and number of fittings.

d. Specify gravity of the gas.

e. Diversity factor.

f. Foreseeable future demand.

2.4.2 **Maximum Gas Demand:** The volume of gas to be provided (in cubic feet per hour) shall be determined directly from the manufacturer's input ratings of the gas utilization equipment served. When input rating is not indicated, the gas supplier, equipment manufacturer, or a qualified agency shall be contacted for estimating the volume of gas to be supplied.

NOTE: To obtain the cubic feet per hour of gas required, divide the Btu per hour rating by the Btu per cubic foot heating value of the gas supplied. The heating value of the gas may be obtained from the local gas supplier.

The total connected hourly load shall be used as the basis for piping sizing since all equipment may be operating at full capacity simultaneously. If, however, a diversity of load can be established, smaller sized piping may be used.

In case the ratings of the equipment to be installed are not known, Table C-1 of Appendix C shows the approximate demand of typical appliances by types.

2.4.3 **Gas Piping Size:** The gas-carrying capacities for different sizes and lengths of iron pipe, or equivalent rigid pipe, and semi-rigid tubing are shown in the capacity tables given in Appendix C.

Tables C-3 to C-14 in Appendix C indicate approximate capacities for single runs of piping. If the specific gravity of the gas is other than 0.60, correction factors shall be applied. Correction factors for use with these tables are given in Table C-15..

For any gas piping system, for special gas utilization equipment or for conditions other than those covered by the capacity tables in Appendix C, such as longer runs, greater gas demands, or greater pressure drops, the size of each gas piping system shall be determined

by standard engineering methods acceptable to the authority having jurisdiction.

A suggested procedure with an example of using tables to size a gas piping system is presented in Appendix C.

2.4.4 **Allowable Pressure Drop:** The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the gas utilization equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

2.5 Piping System Operating Pressure Limitations.

2.5.1 **Maximum Design Operating Pressure:** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 psig unless approved by the authority having jurisdiction and one or more of the following conditions are met:

a. The piping system is welded.

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

c. The piping is located inside buildings or separate areas of buildings used exclusively for:

1. Industrial processing or heating;
2. Research;
3. Warehousing; or
4. Boiler or mechanical equipment rooms.

d. The piping is a temporary installation for buildings under construction.

2.5.2 **Gas-Air Mixture Systems:** Piping systems for gas-air mixtures within the flammable range are limited to a maximum pressure of 10 psig.

2.5.3 **Liquefied Petroleum Gas Systems:** In no case shall the maximum design operating pressure for undiluted LP-gas systems exceed 20 psig, except for buildings, or separate areas of buildings, constructed in accordance with Chapter 7 of the Standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58, and used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

2.6 Acceptable Piping Materials and Joining Methods.

2.6.1 General:

a. **Material Application:** Materials and components conforming to nationally recognized standards or specifications listed herein and/or acceptable to the authority having jurisdiction may be used for appropriate applications, as prescribed and limited by this Code.

b. **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.

c. **Other Materials:** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service, and, in addition, shall be recommended for that service by the manufacturer and shall be acceptable to the authority having jurisdiction.

2.6.2 Metallic Pipe:

a. Cast-iron pipe shall not be used.

b. Steel and wrought-iron pipe shall be at least of standard weight (Schedule 40) and shall comply with one of the following standards:

1. The Standard for Welded and Seamless Wrought-Steel Pipe, ANSI B36.10;
2. Specification for Black and Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe, ASTM A53;
3. Specification for Seamless Carbon Steel Pipe for High-Temperature Service, ASTM A106; or
4. Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM A120.

c. Nodular (ductile) iron pipe shall comply with one of the following standards:

1. The Standard for Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Gas, ANSI A21.52; or
2. Specification for Gray Iron and Ductile Iron Pressure Pipe, ASTM A377.

Such pipe shall be not less than 3-inch size, shall not be welded and shall be used only underground outside building foundation

boundaries, or aboveground, provided that joints are properly restrained against movement and separation.

d. Copper and brass pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas. This is equivalent to a trace as determined by the following applicable standard: Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate-Iodometric Titration Method), ANSI/ASTM D2385, or Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method), ANSI/ASTM D2420.

Threaded copper, brass or aluminum alloy pipe in iron pipe sizes may be used with gases not corrosive to such material.

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

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

2.6.3 **Metallic Tubing:** Seamless copper, aluminum alloy or steel tubing may be used with gases not corrosive to such material.

a. Steel tubing shall comply with the Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines, ANSI/ASTM A539, or the Standard Specification for Copper Brazed Steel Tubing, ANSI/ASTM A254.

b. Copper tubing shall comply with standard Type K or L, of the Specification for Seamless Copper Water Tube, ASTM B88 or the Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service, ASTM B280.

Copper and brass tubing and fittings (except tin-lined copper tubing) shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas. This is equivalent to a trace as determined by the following applicable standard: Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate-Iodometric Titration Method), ANSI/ASTM D2385, or Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method), ANSI/ASTM D2420.

c. Aluminum alloy tubing shall comply with the Specification for Aluminum-Alloy Drawn Seamless Tubes, ASTM B210, or the Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube, ASTM B241. Aluminum-alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster or insulation or is subject to repeated wettings by such liquids as water, detergents or sewage.

Aluminum-alloy tubing shall not be used in exterior locations or underground.

2.6.4 **Plastic Pipe, Tubing and Fittings:** Plastic pipe or tubing and compatible fittings shall be used outside underground only and shall conform with the Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings, ASTM D2513, or the Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings, ASTM D2517.

For use of plastic pipe, tubing and fittings in undiluted liquefied petroleum gas piping systems, see the Standard for Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.6.5 **Workmanship and Defects:** Gas pipe or tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading and shall be thoroughly brushed, and chip and scale blown.

Defects in pipe or tubing or fittings shall not be repaired. When defective pipe, tubing or fittings are located in a system, the defective material shall be replaced.

2.6.6 **Protective Coating:** When in contact with material or atmosphere exerting a corrosive action, metallic piping and fittings coated with a corrosion-resistant material shall be used.

External or internal coatings or linings used on piping or components shall not be considered as adding strength.

2.6.7 **Metallic Pipe Threads:**

a. Specifications for Pipe Threads: Metallic pipe and fitting threads shall be taper pipe threads and shall comply with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

b. Damaged Threads: Pipe with threads which are stripped, chipped, corroded or otherwise damaged shall not be used. If a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

c. Number of Threads: Table I may be used as a guide for field threading of metallic pipe.

d. Threaded Pipe Sizes: Threaded pipe in sizes larger than 4 inch shall not be used unless acceptable to the authority having jurisdiction.

Table I

Specifications for Threading Metallic Pipe

Iron Pipe Size (Inches)	Approximate Length of Threaded Portion (Inches)	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

2.6.8 **Metallic Piping Joints and Fittings:** The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue or to the weight of the pipe and its contents.

a. Pipe Joints: Pipe joints shall be threaded, flanged or welded, and nonferrous pipe may also be brazed with materials having a melting point in excess of 1,000 F. Brazing alloys shall not contain phosphorous.

Threaded joints shall not be used in annealed, tempered aluminum pipe.

b. Tubing Joints: Tubing joints shall either be made with approved gas tubing fittings or be brazed with a material having a melting point in excess of 1,000 F. Brazing alloys shall not con-

tain phosphorous. Metallic ball sleeve compression type tubing fittings shall not be used for this purpose.

c. **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 adequate provisions are made in the design to prevent separation of the joints.

d. **Couplings and Proprietary Joints:** Approved couplings and proprietary type joints may be used within the manufacturer's pressure-temperature recommendations, provided adequate provision is made to prevent separation of the joint due to vibration, fatigue and thermal expansion or contraction.

e. **Metallic Fittings:** Metallic fittings (except valves, strainers or filters) shall be steel, brass or malleable and cast iron or ductile iron when used with steel or wrought-iron pipe; shall be copper or brass when used with copper or brass pipe; and shall be aluminum alloy when used with aluminum alloy pipe.

1. When approved by the authority having jurisdiction, special fittings, such as saddle tees and gland-type compression couplings, may be used to connect steel or wrought-iron pipe if adequately braced so that neither the gas pressure nor external physical damage will force the joint apart.
2. Cast-iron fittings (including valves, strainers and filters) in sizes 6 inches and larger may be used to connect steel and wrought-iron pipe when approved by the authority having jurisdiction.
3. Cast-iron fittings in sizes 4 inches and larger shall not be used indoors unless approved by the authority having jurisdiction.
4. Cast-iron fittings and zinc-aluminum valves and fittings shall not be used in systems containing flammable gas-air mixtures.
5. Cast-iron flanges may be used.
6. Fittings in copper or brass piping systems, if exposed to soil, shall be made of bronze, copper or brass containing not less than 80 percent copper.
7. Approved flared, flareless or compression (other than metallic ball sleeve) type tubing fittings may be used provided they meet the manufacturer's pressure-temperature recommendations for the fittings and the service conditions anticipated, such as vibration, fatigue and thermal expansion or contraction.

f. **Bushings:** Cast-iron or plastic bushings, orange-peel bull plugs, orange-peel swages and fish tails shall not be used.

g. **Joint Compounds:** Joint compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gases to be conducted through the piping.

2.6.9 **Plastic Piping Joints and Fittings:** Plastic pipe, tubing and fittings shall be joined by either the solvent cement method, adhesive method, heat-fusion method, or by means of compression couplings or flanges. The joining method used shall be compatible with the materials being joined and the recommendations of the manufacturer. The following shall be observed when making such joints:

a. Plastic pipe or tubing shall not be threaded.

b. The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material.

c. Solvent cement joints, adhesive joints and heat-fusion joints shall be made in accordance with qualified procedures which have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined.

d. Solvent cement or heat-fusion joints shall not be made between different kinds of plastics.

e. Heat-fusion or mechanical joints shall be used when joining polyethylene pipe, tubing or fittings.

f. Flanges or special joints may be used providing they are properly qualified and utilized.

g. When 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, and the stiffener shall be flush with the end of the pipe or tubing and 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. A split tubular stiffener shall not be used.

h. For plastic piping joints and fittings for use in liquefied petroleum gas piping systems, see the Standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.6.10 Flanges: All flanges shall comply with nationally recognized standards and specifications as listed in Appendix A. The pressure-temperature ratings shall equal or exceed that required by the application.

a. Flange Facings: Standard facings are suitable for use under this Code. When 150-pound steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed.

b. Lapped Flanges: Lapped flanges may be used only aboveground or in exposed locations accessible for inspection.

2.6.11 Flange Gaskets: Material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system, and the chemical constituents of the gas being conducted, without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing material.

a. Acceptable materials include:
   1. Metal or metal-jacketed asbestos (plain or corrugated);
   2. Asbestos; and
   3. Aluminum "O" rings and spiral wound metal gaskets.

b. When a flanged joint is opened, the gasket shall be replaced.

c. Full-face gaskets shall be used with all bronze and cast-iron flanges.

2.7 Gas Meters.

2.7.1 Capacity: Gas meters shall be properly selected for the maximum expected pressure and permissible pressure drop.

2.7.2 Location:

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

b. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, coal bins, or where they will be subject to excessive corrosion or vibration.

c. Gas meters shall be located at least 3 feet from sources of ignition.

d. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in tem-

perature. Meter manufacturers shall furnish information regarding safe temperature limits.

2.7.3 **Supports:** Gas meters shall be securely supported or connected to rigid piping so as not to exert a strain on the meters. When 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 other means providing equivalent support.

2.7.4 **Meter Protection:** Meters shall be protected against overpressure, backpressure and vacuum, if necessary.

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

2.8 **Gas Pressure Regulators.**

2.8.1 **When Required:** When the gas supply pressure is higher than that at which the branch supply line or gas utilization equipment is designed to operate or varies beyond design pressure limits, a line gas pressure regulator or gas equipment pressure regulator, as applicable, shall be installed.

2.8.2 **Location:** The gas pressure regulator location shall be such that the connections are readily accessible for servicing.

2.8.3 **Regulator Protection:** Pressure regulators shall be protected against physical damage.

2.8.4 **Venting:**

a. **Line Gas Pressure Regulators, Including Second Stage LP-Gas Regulators:**

1. An adequately sized independent vent to the outside of the building shall be provided when the location of a regulator is such that a ruptured diaphragm will cause a hazard. When there is more than one regulator at a location, each regulator shall have a separate vent to the outside. See 2.9.7 for properly locating the vent.

2. The vent shall be designed to prevent the entry of water, insects or other foreign materials that could cause blockage.

3. At locations where regulators might be submerged during floods, a special anti-flood type breather vent fitting

shall be installed, or the vent line shall be extended above the height of the expected flood waters.

4. A regulator shall not be vented to the gas equipment flue or exhaust system.

b. Gas Appliance Pressure Regulators: For venting of gas appliance pressure regulators, see 5.1.18.

2.8.5 **Bypass Piping:** Suitably valved and regulated bypasses may be placed around gas line pressure regulators where continuity of service is imperative.

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

2.8.7 **Second Stage LP-Gas Regulators:** Second stage regulators on undiluted liquefied petroleum gas piping systems shall comply with the Standard for Pressure Regulating Valves for LP-Gas, ANSI/UL 144, and shall be installed in accordance with the Standard for Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.9 **Overpressure Protection Devices.**

2.9.1 **General:** Overpressure protection devices shall be provided to prevent the pressure in the piping system from exceeding that value which would cause unsafe operation of any connected and properly adjusted gas utilization equipment. (See 2.9.5.)

a. The requirements of this section shall be met and a piping system deemed to have adequate overpressure protection when there are two acceptable devices (a service or line pressure regulator plus one other device), each limiting the pressure to a value that does not exceed the maximum working pressure of the downstream system, both of which must fail simultaneously in order to overpressure the downstream system. The pressure regulating, limiting and relieving devices shall be properly maintained and inspection procedures shall be devised or suitable instrumentation installed to detect failures or malfunctions of such devices and replacements or repairs shall be promptly made.

b. No pressure relieving or limiting device is required if the gas does not contain materials that could seriously interfere with

the operation of the service or line pressure regulator and if the service or line pressure regulator has all of the following design features or characteristics:

1. Pipe connections to the service or line regulator do not exceed 2 inches nominal diameter;
2. It is self-contained with no external static or control piping;
3. It has a single port valve with an orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet;
4. The valve seat is made of resilient material designed to withstand abrasion of the gas, impurities in the gas and cutting by the valve and to resist permanent deformation when it is pressed against the valve port; and
5. It is capable, under normal operating conditions, of regulating the downstream pressure within the necessary limits of accuracy and of limiting the discharge pressure under no-flow conditions to not more than 150 percent of the discharge pressure maintained under flow conditions.

2.9.2 Devices: Any of the following pressure relieving or pressure limiting devices may be used:

a. Spring loaded relief device.

b. Pilot loaded backpressure regulator used as a relief valve so designed that failure of the pilot system or external control piping will cause the regulator relief valve to open.

c. A monitoring regulator installed in series with the service or line pressure regulator.

d. A series regulator installed upstream from the service or line regulator and set to continuously limit the pressure on the inlet of the service or line regulator to the maximum working pressure of the downstream piping system.

e. An automatic shutoff device installed in series with the service or line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum working pressure or some other predetermined pressure less than the maximum working pressure. This device shall be designed so that it will remain closed until manually reset.

f. A liquid seal relief device that can be set to open accurately and consistently at the desired pressure.

The above devices may be installed as an integral part of the service or line pressure regulator or as separate units. If separate pressure relieving or pressure limiting devices are installed, they shall comply with 2.9.3 through 2.9.8.

2.9.3 **Construction and Installation:** All pressure relief or pressure limiting devices shall:

a. Be constructed of materials so that the operation of the device will not normally be impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.

b. Be designed and installed so they can be readily operated to determine if the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they will operate and examined for leakage when in the closed position.

2.9.4 **External Control Piping:** External control piping shall be reasonably protected from falling objects, excavations or other causes of damage and shall be designed and installed so that damage to any control piping shall not render both the regulator and the overpressure protective device inoperative.

2.9.5 **Setting:** Each pressure limiting or pressure relieving device shall be set so that the pressure shall not exceed a safe level beyond the maximum allowable working pressure for the piping and appliances connected.

2.9.6 **Unauthorized Operation:** Precautions shall be taken to prevent unauthorized operation of any shutoff valve which will make a pressure relief valve or pressure limiting device inoperative. Acceptable methods for complying with this provision are:

a. Lock the valve in the open position. Instruct authorized personnel of 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.

b. Install duplicate relief valves, each having adequate capacity to protect the system, and arrange the isolating valves or 3-way valve so that only one safety device can be rendered inoperative at a time.

2.9.7 **Vents:** The discharge stacks, vents or outlet parts of all pressure relief and pressure limiting devices shall be located so that gas is discharged into the atmosphere without undue hazard. Discharge stacks or vents shall be designed to prevent the entry of water, insects or other foreign material that could cause blockage. The dis-

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

2.9.8 **Size of Fittings, Pipe and Openings:** The openings, pipe and fittings located between the system to be protected and the pressure relieving device shall be of adequate size to prevent hammering of the valve and to prevent impairment of relief capacity.

2.10 Back Pressure Protection.

2.10.1 **When to Install:** When the design of utilization equipment connected is such that air, oxygen or stand-by gases may be forced into the gas supply system, suitable protective devices shall be installed as close to the utilization equipment as practical. Gas and air combustion mixers incorporating double diaphragm "zero" or "atmosphere" governors or regulators require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psig or more.

2.10.2 **Suitable Devices:** Suitable protective devices include but are not limited to the following:

a. Check valves;

b. Three-way valves (of the type that completely closes one side before starting to open the other side);

c. Reverse flow indicators controlling positive shutoff valves; and

d. Normally closed air-actuated positive-shutoff pressure regulators.

2.11 Low Pressure Protection.

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

2.12 Shutoff Valves.

Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use and reliability of operation.

2.13 Expansion and Flexibility.

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

Flexibility shall be provided by the use of bends, loops, offsets or couplings of the slip type. Provision shall be made to absorb thermal changes by the use of expansion joints of the bellows type, or by the use of "ball" or "swivel" joints. Expansion joints of the slip type shall not be used inside buildings or for thermal expansion. If expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes.

Pipe alignment guides shall be used with expansion joints according to the recommended practice of the joint manufacturer.

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

PART 3

GAS PIPING INSTALLATION

3.1 Piping Underground.

3.1.1 **Clearances:** Underground gas piping shall be installed with enough clearance from any other underground structure to avoid contact therewith, to allow proper maintenance and to protect against damage that might result from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance, or shall be insulated, from any source of heat so as to prevent the heat from impairing the serviceability of the pipe.

3.1.2 **Protection Against Damage:** Where soil conditions are unstable and settling of piping or foundation walls or heavy vehicular traffic may occur, adequate measures shall be provided to prevent excessive stressing of the piping. Piping shall be buried a sufficient depth or covered in a manner so as to protect the piping from physical damage.

Consideration should be given to protecting the piping from physical damage when it passes through flower beds, shrub beds and other such cultivated areas.

a. **Cover Requirements:** Underground piping systems shall be installed with at least 18 inches of cover. The cover may be reduced to 12 inches if external damage to the pipe is not likely to result. If a minimum of 12 inches of cover cannot be maintained, the pipe shall be installed in conduit or bridged (shielded).

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

c. **Backfilling:** Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom.

3.1.3 **Protection Against Corrosion:** Gas piping in contact with earth, or other material which may corrode the piping, shall be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

Uncoated threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion may occur.

3.1.4 **Protection Against Freezing:** Where the formation of hydrates or ice is a problem, piping shall be protected against freezing.

NOTE: The gas supplier may be consulted for recommendations.

3.1.5 **Connection of Plastic Piping:** Connections between metallic and plastic piping shall be made only outside, underground and with approved transition fittings.

3.1.6 **Piping Through Foundation Wall:** Underground piping, when installed below grade through the outer foundation or basement wall of a building, shall be encased in a protective pipe. The annular space between the gas piping and the sleeve shall be sealed at the foundation or basement wall to prevent entry of gas or water.

3.1.7 **Piping Underground Beneath Buildings:** When the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in an approved conduit designed to withstand the superimposed loads. The conduit shall extend into a normally usable and accessible portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. If the end sealing is of a type that will retain the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend at least 4 inches outside the building, be vented above grade to the outside and be installed so as to prevent the entrance of water and insects.

3.2 Aboveground Piping Outside.

Piping installed aboveground shall be securely supported and located where it will be protected from physical damage. (Also see 3.1.4.) When passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. When piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve shall be sealed at the wall to prevent the entry of water, insects or rodents.

3.3 **Piping in Buildings.**

3.3.1 **Building Structure:**

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

b. Before any beams or joists are cut or notched, permission shall be obtained from the authority having jurisdiction.

3.3.2 **Other Than Dry Gas:** Drips, sloping, protection from freezing, and branch pipe connections, as provided for in 3.1.4, 3.3.3, 3.7.1 and 3.9-a, shall apply only when other than dry gas is distributed and climatic conditions make such provisions necessary.

3.3.3 **Gas Piping to be Sloped:** Piping for other than dry gas conditions shall be sloped not less than ¼ inch in 15 feet to prevent traps. Horizontal lines shall slope upward to risers and from the risers to the meter, or service regulator when a meter is not provided, or to the equipment.

3.3.4 **Above-Ceiling Locations:** Gas piping may be installed in accessible above-ceiling spaces, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.

3.3.5 **Prohibited Locations:** Gas piping inside any building shall not be run in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This provision shall not apply to ducts used to provide combustion and ventilation air in accordance with 5.3 or to above-ceiling spaces as covered in 3.3.4.

3.3.6 **Hangers, Supports and Anchors:**

a. Piping shall be supported in a substantial and workmanlike manner with pipe hooks, metal pipe straps, bands, brackets or hangers suitable for the size of piping, of adequate strength and quality, and located at proper intervals so as to prevent or damp out excessive vibration. Piping shall be anchored sufficiently to prevent undue strains on connected equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of Standard Practice for Pipe Hangers and Supports—Materials, Design and Manufacture, ANSI/MSS SP-58.

b. Spacings of supports in gas piping installations shall not be greater than shown in Table II.

c. Supports, hangers and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. Suitable spring hangers, sway bracing, etc., shall be provided where necessary. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.

3.3.7 **Removal of Pipe:** If piping containing gas is to be removed, the line shall be first disconnected from all sources of gas and then thoroughly purged with air, water or with inert gas before any cutting or welding is done. (See 4.3.)

Table II

Support of Piping

Steel Pipe, Nominal Size of Pipe (Inches)	Spacing of Supports (Feet)	Nominal Size of Tubing (Inch O.D.)	Spacing of Supports (Feet)
½	6	½	4
¾ or 1	8	⅝ or ¾	6
1¼ or larger (horizontal)	10	⅞ or 1	8
1¼ or larger (vertical)	every floor level		

3.4 **Concealed Piping in Buildings.**

3.4.1 **General:** Gas piping may be installed in concealed locations in accordance with this section.

3.4.2 **Piping in Partitions:** Concealed gas piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This provision does not apply to tubing which passes through walls or partitions.

3.4.3 **Piping in Floors:**

a. Except as provided in "b," gas piping in solid floors such as concrete shall be laid in channels in the floor suitably covered to permit access to the piping with a minimum of damage to the building. When piping in floor channels may be exposed to excessive moisture or corrosive substances, it shall be suitably protected.

b. In other than industrial occupancies and when approved by the authority having jurisdiction, gas piping may be embedded in concrete floor slabs constructed with portland cement. Piping shall be surrounded with a minimum of 1½ inches of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings and risers shall be protected against corrosion in accordance with 2.6.6. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate.

3.4.4 **Connections in Original Installations:** When installing gas piping which is to be concealed, unions, tubing fittings, running threads, right and left couplings, bushings, and swing joints made by combinations of fittings shall not be used.

3.4.5 **Reconnections:** When necessary to insert fittings in gas pipe which has been installed in a concealed location, the pipe may be reconnected by welding, flanges, or the use of a ground joint union with the nut center-punched to prevent loosening by vibration. Reconnection of tubing in a concealed location is prohibited.

3.5 **Piping in Vertical Chases.**

3.5.1 **Pressure Reduction:** If pressure reduction is needed in branch connections for compliance with 2.5.1, such reduction shall take place either inside the chase or immediately adjacent to the outside wall of the chase. Regulator venting and downstream overpressure protection shall comply with 2.8.4 and 2.9. The regulator shall be accessible for service and repair.

a. Regulators equipped with a vent limiting means may be vented into the chase.

b. Regulators not equipped with a vent limiting means shall be vented directly to the outdoors or to a point within the top one foot of the chase.

3.5.2 **Construction:** Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings.

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

NOTE: Only vertical chases are recognized by the coverage. It is believed that welded joints for a horizontal gas line would be preferable to a horizontal chase.

3.6 **Gas Pipe Turns.**

Changes in direction of gas pipe may be made by the use of fittings, factory bends or field bends.

3.6.1 **Metallic Pipe:**

a. Bends shall be made only with bending equipment and procedures especially intended for that purpose.

b. All bends shall be smooth and free from buckling, cracks or other evidence of mechanical damage.

c. The longitudinal weld of the pipe shall be near the neutral axis of the bend.

d. Pipe shall not be bent through an arc of more than 90 degrees.

e. The inside radius of a bend shall be not less than 6 times the outside diameter of the pipe.

3.6.2 **Plastic Pipe:**

a. Plastic pipe may be bent provided that the pipe is not damaged and the internal diameter of the pipe is not effectively reduced.

b. The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.

c. When the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

3.6.3 **Mitered Bends:** Mitered bends are permitted subject to the following limitations:

a. Miters shall not be used in systems having a design pressure greater than 50 psig. Deflections caused by misalignments up to 3 degrees are not considered as miters.

b. The total deflection angle at each miter shall not exceed 90 degrees.

c. Care shall be taken in making mitered joints to provide proper root opening and alignment and full weld penetration.

3.6.4 **Elbows:** Factory made welding elbows or transverse segments cut therefrom may be used for changes in direction provided that the arc length measured along the crotch is at least one inch in pipe sizes 2 inches and larger.

3.7 **Drips and Sediment Traps.**

3.7.1 **Provide Drips Where Necessary:** A drip shall be provided at any point in the line of pipe where condensate may collect. When condensation is excessive, a drip should be provided at the outlet of the meter. This drip should be so installed as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before it will run back into the meter.

3.7.2 **Location of Drips:** All drips shall be installed only in such location that they will be readily accessible to permit cleaning or emptying. A drip shall not be located where the condensate is likely to freeze.

3.7.3 **Sediment Traps:** See 5.5.6.

3.8 **Outlets.**

3.8.1 **Location and Installation:**

a. The outlet fittings or piping shall be securely fastened in place.

b. Outlets shall not be located behind doors.

c. Outlets shall be located far enough from floors, walls, patios, slabs and ceilings to permit the use of proper wrenches without straining, bending or damaging the piping.

d. The unthreaded portion of gas piping outlets shall extend not less than one inch through finished ceilings or indoor or outdoor walls.

e. The unthreaded portion of gas piping outlets shall extend not less than 2 inches above the surface of floors or outdoor patios or slabs.

f. The provisions of 3.8.1-d and -e do not apply to listed quick-disconnect devices of the flush-mounted type. Such devices shall be installed in accordance with the manufacturer's installation instructions.

3.8.2 **Cap All Outlets:**

a. Each outlet, including a valve or cock outlet, shall be securely closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. Likewise, when the equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be securely closed gastight. The outlet shall not be closed with tin caps, wooden plugs, corks, or by other improvised methods.

b. The above provision does not prohibit the normal use of a listed quick-disconnect device.

3.9 **Branch Pipe Connection.**

a. Except on undiluted liquefied petroleum gas supply systems, all branch outlet pipes shall be taken from the top or sides of horizontal lines and not from the bottom.

b. When a branch outlet is placed on a main supply line before it is known what size pipe will be connected to it, the outlet shall be of the same size as the line which supplies it.

3.10 **Manual Gas Shutoff Valves (Also see 5.5.4).**

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

3.10.2 **Valves Controlling Multiple Systems:**

a. **Accessibility of Gas Valves:** Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They shall be plainly marked with a metal tag attached by the installing agency so that the gas piping systems supplied through them can be readily identified.

b. Shutoff Valves for Multiple House Lines: In multiple tenant buildings supplied through a master meter, or one service regulator when a meter is not provided, or where meters or service regulators are not readily accessible from the equipment location, an individual shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility.

In a common system serving a number of individual buildings, shutoff valves shall be installed at each building.

3.10.3 Emergency Shutoff Valves: An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted at appropriate points.

3.11 Prohibited Devices.

No device shall be placed inside the gas piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas, except when proper allowance in the piping system design has been made for such a device and when approved by the authority having jurisdiction.

3.12 Systems Containing Gas-Air Mixtures Outside the Flammable Range.

When gas-air mixing machines are employed to produce mixtures above or below the flammable range, they shall be provided with suitable stops to prevent adjustment of the mixture to within or approaching the flammable range.

3.13 Systems Containing Flammable Gas-Air Mixtures.

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

a. Gas-mixing machine in the form of an automatic gas-air proportioning device combined with a downstream blower or compressor.

b. Flammable mixture piping, minimum Schedule 40 NPS.

c. Automatic firecheck(s).

d. Safety blowout(s) or backfire preventers for systems utilizing flammable mixture lines above 2½ inches nominal pipe size or the equivalent.

3.13.2 **Optional Components:** The following components may also be utilized in any type central premix system:

a. Flowmeter(s).

b. Flame arrester(s).

3.13.3 **Additional Requirements:** Gas-mixing machines shall have nonsparking blowers and shall be so constructed that a flashback will not rupture machine casings.

3.13.4 **Limitations:** A mixing blower system shall be limited to applications with minimum practical lengths of mixture piping, limited to a maximum mixture pressure of 10 inches water column, and limited to gases containing no more than 10 percent hydrogen.

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

NOTE: The mixing blower is acknowledged as a special case because of its inability to tolerate control valves or comparable restrictions between mixing blower and burner(s). With these limitations, mixing blower installations are not required to utilize safety blowouts, backfire preventers, explosion heads, flame arresters or automatic firechecks which introduce pressure losses.

3.13.5 **Installation of Gas-Mixing Machines:**

a. The machine shall be located in a large, well-ventilated area or in a small detached building or cut-off room provided with room construction and explosion vents in accordance with the Guide for Explosion Venting, ANSI/NFPA 68. Such rooms or below-grade installations shall have adequate positive ventilation.

b. When gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be governed by the National Electrical Code, ANSI/NFPA 70, for general service conditions unless other hazards in the area prevail.

When gas-mixing machines are installed in small detached buildings or cut-off rooms, the electrical equipment and wiring shall be installed in accordance with the National Electrical Code, ANSI/NFPA 70, for hazardous locations (Article 500, Sections 501-1 through 501-17, Class I, Division 2).

c. Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical.

d. Controls for gas-mixing machines shall include interlocks and a safety shutoff valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, this shall be interlocked so that the blower or compressor will stop operating following a gas supply failure. When a system employs pressure air, suitable means shall be provided to shut off the gas supply in the event of air failure.

NOTE: Additional interlocks may be necessary for safe operation of equipment supplied by the gas-mixing machine.

e. Centrifugal gas-mixing machines in parallel can cause troublesome downstream pulsation or equipment overload. Such systems shall be carefully reviewed by user and equipment manufacturer before installation and means or plans for minimizing these effects shall be prepared and utilized as required.

3.13.6 **Use of Automatic Firechecks, Safety Blowouts or Backfire Preventers:** Automatic firechecks and safety blowouts or backfire preventers shall be provided in piping systems distributing flammable air-gas mixtures from gas-mixing machines to protect the piping and the machines in event of flashback in accordance with the following recommendations:

a. Approved automatic firechecks shall be installed upstream as close as practicable to the burner inlets following the firecheck manufacturer's instructions.

NOTE 1: Two basic methods are generally used. One calls for a separate firecheck at each burner; the other a firecheck at each group of burners. The second method is generally more practical if a system consists of many closely spaced burners.

NOTE 2: An approved automatic firecheck shall be installed as near as practicable upstream from a flame

arrester used for local protection where test burners or lighting torches are employed.

b. A separate manually operated gas valve shall be provided at each automatic firecheck for shutting off the flow of the gas-air mixture through the firecheck after a flashback has occurred. The valve shall be located upstream as close as practicable to the inlet of the automatic firecheck.

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

c. A safety blowout or backfiring preventer shall be provided in the mixture line near the outlet of each gas-mixing machine where the size of the piping is larger than 2½ inches NPS or equivalent, to protect the mixing equipment in the event of an explosion passing through an automatic firecheck. The manufacturer's instructions shall be followed when installing these devices, particularly after a disc has burst.

The discharge from the safety blowout or backfire preventer shall be located or shielded so that particles from the ruptured disc cannot be directed toward personnel. Whenever there are interconnected installations of gas-mixing machines with safety blowouts or backfire preventers, provision shall be made to keep the mixture from other machines from reaching any ruptured disc opening. Check valves shall not be used for this purpose.

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

3.14 **Electrical Bonding and Grounding.**

a. Each aboveground portion of a gas piping system upstream from the equipment shutoff valve shall be electrically continuous and bonded to any grounding electrode, as defined by the National Electrical Code, ANSI/NFPA 70.

b. Gas piping shall not be used as a grounding electrode.

3.15 Electrical Circuits.

Electrical circuits shall not utilize gas piping or components except that low-voltage (50 volts or less) control circuits, ignition circuits, and electronic flame detection device circuits may make use of piping or components for a part of an electric circuit.

3.16 Electrical Connections.

a. All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of the National Electrical Code, ANSI/NFPA 70 (see 3.14).

b. Any essential safety control depending upon electric current as the operating medium shall be of a type which will shut off (fail safe) the flow of gas in the event of current failure.

PART 4

INSPECTION, TESTING AND PURGING

4.1 Pressure Testing and Inspection.

4.1.1 General:

a. Prior to acceptance and initial operation, all piping installations shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with the requirements of this Code.

b. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of nondestructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc., although desirable, are not required unless specifically listed herein or in the engineering design.

c. In the event repairs or additions are made following the pressure test, the affected piping shall be tested, except that in the case of minor repairs or additions testing may be omitted when precautionary measures are taken to assure sound construction.

d. Because it is sometimes necessary to divide a piping system into test sections and install test heads, connecting piping, and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be pressure tested. Tie-in connections, however, shall be tested with soap solution after gas has been introduced and the pressure has been increased sufficiently to give some indications should leaks exist. (See caution following 4.1.5-b.)

e. The test procedure used shall be capable of disclosing all leaks in the section being tested and shall be selected after giving due consideration to the volumetric content of the section and to its location.

f. A piping system may be tested as a complete unit or in sections as the construction progresses. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless two valves are installed in series with a valved "telltale" located between these valves. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve closing mechanism, is designed to safely withstand the test pressure.

g. Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed may be tested with inert gas at the time of fabrication.

4.1.2 Test Medium:

a. Except as provided in 4.1.2-b, the test medium shall be air or inert gas (e.g., nitrogen, carbon dioxide). OXYGEN SHALL NEVER BE USED.

b. Fuel gas may be used in piping systems operating at pressures of ½ pound per square inch or less.

4.1.3 Test Preparation:

a. Whenever possible, pipe joints, including welds, shall be left uninsulated and exposed for examination during the test. If the pipe end joints have been previously tested in accordance with this Code, they may be insulated, covered or concealed.

b. Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test.

c. Equipment which is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test need not be tested.

d. When the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment and their individual shutoff valves shall be isolated from the piping system by disconnecting them and capping the outlet(s).

e. When the piping system is connected to equipment or components designed for operating pressures equal to or greater than the test pressure, such equipment shall be isolated from the piping system by closing their individual manual shutoff valve(s).

f. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleared of all foreign material.

4.1.4 Test Pressure:

a. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

b. The test pressure to be used shall be no less than 1½ times the proposed maximum working pressure, but not less than 3 psig, irrespective of design pressure. When the test pressure exceeds 125 psig, the test pressure shall not exceed a value which produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

c. Systems for undiluted liquefied petroleum gases shall withstand the pressure test in accordance with "b" above, or, for systems operating at a pressure of ½ psig or less when appliances are connected to the piping system, shall withstand a pressure of not less than 10.0 inches nor more than 14.0 inches water column for a period of not less than 10 minutes without showing any drop in pressure. The source of pressure shall be isolated before the pressure tests are made.

d. Test duration shall be not less than one-half hour for each 500 cubic feet of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet or a system in a single-family dwelling, the test duration may be reduced to 10 minutes. For piping systems having a volume of more than 24,000 cubic feet, the duration of the test need not exceed 24 hours.

4.1.5 **Detection of Leaks and Defects:**

a. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gages shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

b. The leakage shall be located by means of an approved combustible gas detector, soap and water, or an equivalent nonflammable solution, as applicable. **Matches, candles, open flames, or other methods which could provide a source of ignition shall not be used.**

CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping shall be rinsed with water after testing, unless it has been determined the leak test solution is noncorrosive.

When leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. (See 4.1.1-c.)

4.1.6 **Test Records:** Records shall be made of inspection and all tests performed. These records shall indicate which portions of the piping system conform to this Code or were pressure tested.

4.2 **System and Equipment Check.**

4.2.1 **Before Turning Gas On:** Before gas is introduced into a system of new gas piping, or back into an existing system after being shut off, the entire system shall be checked to determine that there are no open fittings or ends and that all manual valves on equipment are closed and all unused valves at outlets are closed and plugged or capped.

4.2.2 **Check for Leakage:** Immediately after turning on the gas, the piping system shall be checked to ascertain that no gas is escaping. (See Appendix D for suggested method.)

If leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

4.2.3 **Placing Equipment in Operation:** Gas utilization equipment may be placed in operation after the piping system has been tested and determined to be free of leakage and purged in accordance with 4.3.2.

4.3 **Purging.**

The processes of voiding a gas pipe line of fuel gas and replacing the fuel gas with air, or charging a gas pipe line that is full of air with fuel gas, require that a significant amount of combustible mixture not be developed within the pipe line or released within a confined space.

4.3.1 **Removal from Service:** When gas piping is to be opened for servicing, addition or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors.

If this section exceeds the lengths shown in Table III, the remaining gas shall be displaced with an inert gas.

4.3.2 **Placing in Operation:** When piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, provided the piping does not exceed the length shown in Table IV. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow should be continued without interruption until the vented gas is free of air.

The point of discharge shall not be left unattended during purging. The vent shall then be closed.

If the piping exceeds the lengths shown in Table IV, the air in the piping shall be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas.

4.3.3 **Discharge of Purged Gases:** The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions.

4.3.4 **Placing Equipment in Operation:** After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary.

Table III

Length of Gas Line Requiring Purging for Servicing or Modification

Nominal Pipe Size, Inches	Min. Length of Piping Requiring Purging
2½	50 feet
3	30 feet
4	15 feet
6	10 feet
8 or larger	Any length

Table IV

Length of Piping Requiring Purging Before Placing in Operation

Nominal Pipe Size, Inches	Min. Length of Piping Requiring Purging
3	30 feet
4	15 feet
6	10 feet
8 or larger	Any length

PART 5

EQUIPMENT INSTALLATION

5.1 General.

5.1.1 Appliances, Accessories and Equipment To Be "Approved": Gas appliances, accessories, and gas utilization equipment shall be "Approved." "Approved" shall mean "acceptable to the authority having jurisdiction."

Acceptance of unlisted gas utilization equipment and accessories shall be on the basis of a sound engineering evaluation. In such cases, the equipment shall be safe and suitable for the proposed service and be recommended for the service by the manufacturer.

> NOTE: The National Fire Protection Association, the American National Standards Institute and the American Society of Mechanical Engineers do not approve, inspect or certify any installations, procedures, equipment or materials, nor do they approve or evaluate testing laboratories. In determining acceptability of installations or procedures, the authority having jurisdiction may base acceptance on compliance with NFPA, ANSI, ASME, or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices (see Part 10, Definitions) of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

5.1.2 Assignment and Coordination of Gas Equipment Design, Construction and Maintenance: Because industrial gas applications are so varied in nature, many agencies are jointly involved with their safe and satisfactory use. See Appendix B for suggested guidelines and check list.

5.1.3 Type of Gas(es): It shall be determined whether the gas utilization equipment has been designed for use with the gas to which it will be connected. No attempt shall be made to convert the equipment from the gas specified on the rating plate for use with a different gas without consulting the serving gas supplier or the equipment manufacturer for complete instructions.

5.1.4 Safety Shutoff Devices for Unlisted LP-Gas Equipment Used Indoors: Unlisted gas utilization equipment for use with undiluted liquefied petroleum gases and installed indoors, shall be equipped with safety shutoff devices of the complete shutoff type.

5.1.5 Use of Air or Oxygen Under Pressure: When air or oxygen under pressure is used in connection with the gas supply, effective means such as a backpressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. The serving gas supplier shall be consulted for details. When oxygen is used, see the Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes, ANSI/NFPA 51.

5.1.6 Protection of Gas Equipment from Fumes or Gases Other than Products of Combustion: When corrosive or flammable process fumes are present, suitable means for their safe disposal shall be provided. Such fumes include, among others, carbon monoxide, hydrogen sulfide, ammonia, chlorine and halogenated hydrocarbons.

NOTE: Halogenated hydrocarbons are particularly injurious and corrosive after contact with flames or hot surfaces.

5.1.7 Building Structural Members:

a. Structural members of a building shall not pass through gas utilization equipment having an operating temperature in excess of 500 F.

b. Structural members passing through gas utilization equipment having an operating temperature of 500 F or less shall be of noncombustible material. Building columns, girders, beams or trusses shall not be included within equipment, unless appropriate insulation and ventilation are provided to avoid all deterioration in strength, and linear expansion of the building structure in either a vertical or horizontal direction.

c. Gas utilization equipment shall be furnished either with load distributing bases or with a sufficient number of adequate supports to prevent damage to either the building structure or equipment.

d. At the locations selected for installation of gas utilization equipment, the dynamic and static load carrying capacities of the building structure shall be checked to determine if they are adequate to carry the additional loads. The equipment shall be adequately supported and shall be connected to the piping so as not to exert undue stress on the connections.

5.1.8 **Flammable Vapors:** Gas appliances shall not be installed in any location where flammable vapors are likely to be present, unless the design, operation and installation are such to eliminate the probable ignition of the flammable vapors. Gas utilization equipment installed in compliance with 5.1.9, 5.1.10 and 5.1.11 shall be considered to comply with the intent of this provision.

5.1.9 **Installation in Residential Garages:**

a. Gas utilization equipment in residential garages shall be installed so that all burners and burner ignition devices are located not less than 18 inches above the floor.

b. Such equipment shall be located, or protected, so it is not subject to physical damage by a moving vehicle.

5.1.10 **Installation in Commercial Garages:**

a. **Parking Structures:** Gas utilization equipment may be installed in enclosed, basement and underground parking structures (see Part 10, Definitions) when there is no dispensing or transferring of liquefied petroleum gas or Class I or Class II flammable liquids (as defined in the Flammable and Combustible Liquids Code, ANSI/NFPA 30), provided all burners, burner flames and burner ignition devices are located not less than 18 inches above the floor, or the equipment is enclosed by a partition not less than 18 inches high, and provided continuous mechanical ventilation is supplied at a rate of not less than six air changes per hour. Gas utilization equipment shall be located or protected so it is not subject to physical damage by a moving vehicle.

Overhead heaters shall be installed at least 8 feet above the floor. Overhead radiant type heaters shall be located at a sufficient height to avoid overheating vehicles parked underneath.

For installations in parking structures which have facilities for dispensing fuel, see the Standard for Parking Structures, NFPA 88A.

b. **Repair Garages:** Gas utilization equipment may be installed in a repair garage (see Part 10, Definitions) when there is no dispensing or transferring of liquefied petroleum gas or Class I or II flammable liquids (as defined in the Flammable and Combustible Liquids Code, ANSI/NFPA 30), provided all burners, burner flames and burner ignition devices are located not less than 18 inches above the floor, and provided continuous mechanical ventilation is supplied at a rate of not less than 0.75 cubic foot per minute per square foot of floor area. For installations in below

grade areas, an approved means shall be provided for introducing an equal amount of outdoor air. The equipment and the ventilation system shall be interlocked so the equipment will not operate unless the ventilation system is in operation. Gas utilization equipment shall be located or protected so it is not subject to physical damage by a moving vehicle.

Overhead heaters shall be installed at least 8 feet above the floor. Overhead radiant type heaters shall be located at a sufficient height to avoid overheating vehicles parked underneath.

For installations in repair garages which have facilities for dispensing fuel, see the Standard for Repair Garages, NFPA 88B.

5.1.11 Installation in Aircraft Hangars: Heaters in aircraft hangars shall be installed in accordance with the Standard on Aircraft Hangars, ANSI/NFPA 409.

5.1.12 Gas Equipment Physical Protection: When it is necessary to locate gas utilization equipment close to a passageway traveled by trucks or cranes, suitable guard rails or bumper plates shall be installed to protect the equipment from damage.

5.1.13 Venting of Flue Gases: Gas utilization equipment shall be vented in accordance with the provisions of Part 7, Venting of Equipment.

5.1.14 Extra Device or Attachment: No device or attachment shall be installed on any gas utilization equipment which may in any way impair the combustion of gas.

5.1.15 Adequate Capacity of Piping: When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity (see 2.4). If inadequate, the existing system shall be enlarged as necessary or separate gas piping of adequate capacity shall be run from the point of delivery to the equipment.

5.1.16 Avoid Strain on Gas Piping: Gas utilization equipment shall be adequately supported and so connected to the piping as not to exert undue strain on the connections.

5.1.17 Gas Appliance Pressure Regulators: When the gas supply pressure is higher than that at which the gas utilization equipment is designed to operate or varies beyond the design pressure limits of the equipment, a gas appliance pressure regulator shall be installed.

5.1.18 Venting of Gas Appliance Pressure Regulators:

a. Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the equipment, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure.

b. Vent limiting means shall be employed on listed gas appliance pressure regulators only.

c. In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent stoppage of it by insects and foreign matter.

d. Under no circumstances shall a regulator be vented to the gas utilization equipment flue or exhaust system.

e. In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined.

f. A vent line(s) from a gas appliance pressure regulator and a bleed line(s) from a diaphragm type valve shall not be connected to a common manifold terminating in a combustion chamber.

5.1.19 Bleed Lines for Diaphragm Type Valves:

a. Diaphragm type valves shall be equipped to convey bleed gas to the outside atmosphere or into the combustion chamber adjacent to a continuous pilot.

b. In the case of bleed lines leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent stoppage of it by insects and foreign matter.

c. Under no circumstances shall bleed lines terminate in the gas utilization equipment flue or exhaust system.

d. In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed

position relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined.

e. A bleed line(s) from a diaphragm type valve and a vent line(s) from a gas appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber.

5.1.20 Combination of Equipment: Any combination of gas utilization equipment, attachments or devices used together in any manner shall comply with the standards which apply to the individual equipment.

5.1.21 Installation Instructions: The installing agency shall conform with the equipment manufacturer's specific recommendations in completing an installation that will provide satisfactory performance and serviceability. The installing agency shall also leave the manufacturer's installation, operating and maintenance instructions in a location on the premises where they will be readily available for reference and guidance of the authority having jurisdiction, servicemen and the owner or operator.

5.1.22 Protection of Outdoor Equipment: Gas utilization equipment not listed for outdoor installation but installed outdoors shall be provided with protection to the degree that the environment requires. Equipment listed for outdoor installation may be installed without protection in accordance with the provisions of their listing. (See 5.2.1.)

5.2 Accessibility and Clearance.

5.2.1 Accessibility for Service: All gas utilization equipment shall be located with respect to building construction and other equipment so as to permit access to the gas utilization equipment. Sufficient clearance shall be maintained to permit cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and, the proper functioning of explosion vents, if provided. For attic installation the passageway and servicing area adjacent to the equipment shall be floored.

5.2.2 Clearance to Combustible Materials: Gas utilization equipment and their vent connectors shall be installed with clearances from combustible material so their operation will not create a hazard to persons or property.

Minimum clearances between combustible walls and the back and sides of various conventional types of equipment and their vent connectors are specified in Part 6, Installation of Specific Equipment, and Part 7, Venting of Equipment. (Reference may also be made to the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.)

Equipment shall not be installed on carpeting, unless the equipment is listed for such installation.

5.3 Air for Combustion and Ventilation.

5.3.1 General:

a. The provisions of 5.3 apply to gas utilization equipment installed in buildings and which require air for combustion, ventilation and dilution of flue gases from within the building. They do not apply to (1) direct vent equipment which is constructed and installed so that all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere, or (2) enclosed furnaces which incorporate an integral total enclosure and use only outside air for combustion and dilution of flue gases.

b. Equipment shall be installed in a location in which the facilities for ventilation permit satisfactory combustion of gas, proper venting and the maintenance of ambient temperature at safe limits under normal conditions of use. Equipment shall be located so as not to interfere with proper circulation of air. When normal infiltration does not provide the necessary air, outside air shall be introduced.

c. In addition to air needed for combustion, process air shall be provided as required for: cooling of equipment or material, controlling dew point, heating, drying, oxidation or dilution, safety exhaust, odor control, and air for compressors.

d. In addition to air needed for combustion, air shall be supplied for ventilation, including all air required for comfort and proper working conditions for personnel.

e. A draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

f. While all forms of building construction cannot be covered in detail, air for combustion, ventilation and dilution of flue gases

for gas utilization equipment vented by natural draft normally may be obtained by application of one of the methods covered in 5.3.3 and 5.3.4.

g. Air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces shall be considered in determining the adequacy of a space to provide combustion air requirements. See Appendix H for one method of determining adequate air for equipment operation.

5.3.2 **Equipment Located in Unconfined Spaces:** In unconfined spaces (see Part 10, Definitions) in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided using the methods described in 5.3.3-b or 5.3.4.

5.3.3 **Equipment Located in Confined Spaces:**

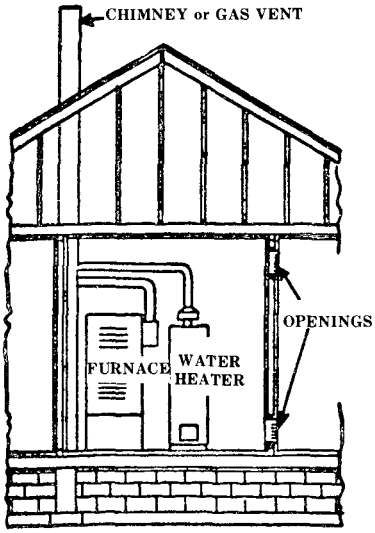
a. **All Air from Inside the Building:** The confined space shall be provided with two permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. The total input of all gas utilization equipment installed in the combined space shall be considered in making this determination. Each opening shall have a minimum free area of 1 square inch per 1,000 Btu per hour of the total input rating of all gas utilization equipment in the confined space, but not less than 100 square inches. One opening shall be within 12 inches of the top and one within 12 inches of the bottom of the enclosure. (See Figure 1.)

b. **All Air From Outdoors:** The confined space shall be provided with two permanent openings, one commencing within 12 inches of the top and one commencing within 12 inches of the bottom of the enclosure. The openings shall communicate directly, or by ducts, with the outdoors or spaces (crawl or attic) that freely communicate with the outdoors.

1. When directly communicating with the outdoors, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 2.)

2. When communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all

equipment in the enclosure. (See Figure 3.)
3. When communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 square inch per 2,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 4.)
4. When ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches.



NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu per hour of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

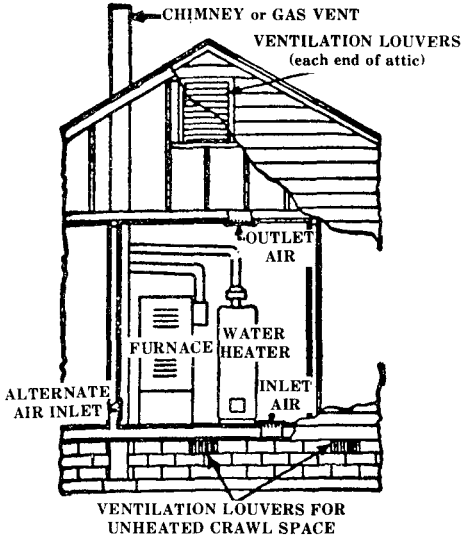
Fig. 1. Equipment Located in Confined Spaces; All Air from Inside the Building. See 5.3.3-a.

5.3.4 **Specially Engineered Installations:** The requirements of 5.3.3 shall not necessarily govern when special engineering, approved by the authority having jurisdiction, provides an adequate supply of air for combustion, ventilation, and dilution of flue gases.

5.3.5 **Louvers and Grilles:** In calculating free area in 5.3.3, consideration shall be given to the blocking effect of louvers, grilles or screens protecting openings. Screens used shall not be smaller than ¼ inch mesh. If the free area through a design of louver or grille is

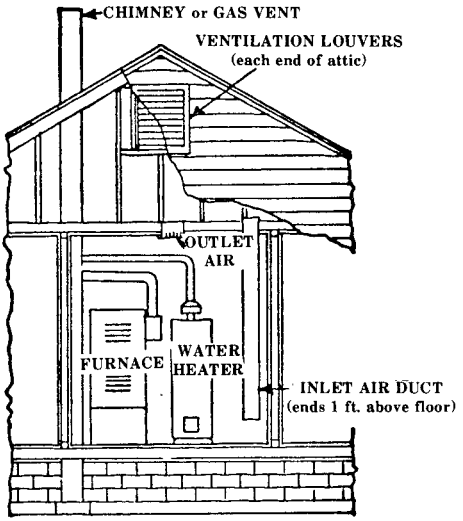
known, it should be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it may be assumed that wood louvers will have 20-25 percent free area and metal louvers and grilles will have 60-75 percent free area. Louvers and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically during equipment operation.

5.3.6 **Special Conditions Created by Mechanical Exhausting or Fireplaces:** Operation of exhaust fans, ventilation systems, clothes dryers or fireplaces may create conditions requiring special attention to avoid unsatisfactory operation of installed gas utilization equipment.



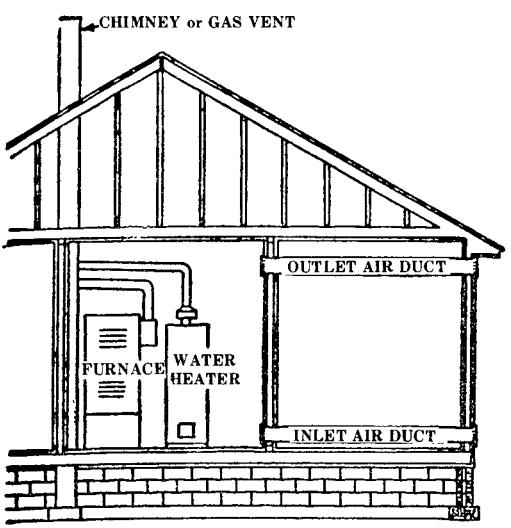
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 2. Equipment Located in Confined Spaces; All Air from Outdoors — Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic. See 5.3.3-b.



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 3. Equipment Located in Confined Spaces; All Air from Outdoors Through Ventilated Attic. See 5.3.3-b.



NOTE: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu per hour of the total input rating of all equipment in the enclosure.*

* If the equipment room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 4. Equipment Located in Confined Spaces; All Air from Outdoors. See 5.3.3-b.

5.4 Equipment on Roofs.

5.4.1 General:

a. Gas utilization equipment on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which they are installed. If enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least 30-inch clearance between the entire service access panel(s) of the equipment and the wall of the enclosure.

b. Roofs on which equipment is to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load.

c. All access locks, screws and bolts shall be of corrosion-resistant material.

5.4.2 Installation of Equipment on Roofs:

a. Gas utilization equipment shall be installed in accordance with its listing and the manufacturer's installation instructions.

b. Equipment shall be installed on a well-drained surface of the roof. At least 6 feet clearance shall be available between any part of the equipment and the edge of a roof or similar hazard, or rigidly fixed rails or guards at least 42 inches in height shall be provided on the exposed side except that parapets or other building structure at least 42 inches in height may be utilized in lieu of rails or guards.

c. All equipment requiring an external source of electrical power for its operation shall be provided with an accessible electrical disconnect means near the equipment, which will completely deenergize the equipment, and a 120-volt A-C grounding type convenience outlet on the roof adjacent to the equipment. The convenience outlet shall be on the supply side of the disconnect switch.

d. When water stands on the roof at the equipment or in the passageways to the equipment, or when the roof is of a design having a water seal, a suitable platform or walkway or both shall be provided above the water line. Such platform(s) or walkway(s) shall be located adjacent to the equipment and control panels so that the equipment can be safely serviced when water stands on the roof.

5.4.3 **Access to Equipment on Roofs:**

a. Gas utilization equipment located on roofs or other elevated locations shall be accessible.

b. Buildings of more than 15 feet in height shall have an inside means of access to the roof.

c. The inside means of access shall be a permanent, or fold-away, inside stairway or ladder, terminating in an enclosure, scuttle or trap door. Such scuttles or trap doors shall be at least 24 inches by 24 inches in size, shall open easily and safely under all conditions, especially snow, and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least 6 feet of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards at least 42 inches in height shall be provided on the exposed side; parapets or other building structure at least 42 inches in height may be utilized in lieu of guards or rails.

d. Proper permanent lighting shall be provided at the roof access. The switch for such lighting shall be located inside the building near the access means leading to the roof.

5.4.4 **Additional Provisions:** Also see 5.1.22, 5.2.1 and 7.14.3.

5.5 **Equipment Connections to Building Piping.**

5.5.1 **Connecting Gas Equipment:** Gas utilization equipment shall be connected to the building piping in compliance with 5.5.4 by one of the following:

a. Rigid metallic pipe and fittings.

b. Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

c. Listed gas appliance connectors used in accordance with the terms of their listing that are completely in the same room as the equipment.

d. Listed gas hose connectors in accordance with 5.5.2.

e. Gas-fired commercial cooking equipment listed for use with casters or otherwise subject to movement for cleaning, and other large and heavy gas utilization equipment that may be moved, shall be connected by a listed appliance connector complying with the Standard for Connectors for Movable Gas Appliances, ANSI Z21.69.

f. In "b" and "c" above, the connector or tubing shall be installed so as to be protected against physical and thermal damage. Aluminum-alloy tubing and connectors shall be coated to protect against external corrosion where they are in contact with masonry, plaster or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents or sewage.

5.5.2 **Use of Gas Hose Connectors:** Listed gas hose connectors shall be used in accordance with the terms of their listing as follows:

a. Indoor: Indoor gas hose connectors may be used with laboratory, shop or ironing equipment that requires mobility during operation. A shutoff valve shall be installed where the connector is attached to the building piping. The connector shall be of minimum length but shall not exceed 6 feet. The connector shall not be concealed and shall not extend from one room to another nor pass through wall partitions, ceilings or floors.

b. Outdoor: Outdoor gas hose connectors may be used to connect portable outdoor gas-fired equipment. A shutoff valve or a listed quick-disconnect device shall be installed where the connector is attached to the supply piping and in such a manner to prevent the accumulation of water or foreign matter. This connection shall only be made in the outdoor area where the equipment is to be used.

5.5.3 **Connection of Portable and Mobile Industrial Gas Equipment:**

a. Portable industrial gas utilization equipment or equipment requiring mobility or subject to vibration may be connected to the building gas piping system by the use of flexible hose suitable and safe for the conditions under which it may be used.

b. Industrial gas utilization equipment requiring mobility may be connected to the rigid piping by the use of swivel joints or couplings which are suitable for the service required. Where swivel joints or couplings are used, only the minimum number required shall be installed.

c. Industrial gas utilization equipment subject to vibration may be connected to the building piping system by the use of all metal flexible connectors suitable for the service required.

d. Where flexible connections are used, they shall be of the minimum practical length and shall not extend from one room to another nor pass through any walls, partitions, ceilings or floors. Flexible connections shall not be used in any concealed location.

They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections.

5.5.4 **Equipment Shutoff Valves and Connections:** Any gas utilization equipment connected to a piping system shall have an accessible, approved manual shutoff valve installed upstream of any connector and within 6 feet of the equipment it serves. A union or flanged connection shall be provided downstream from this valve to permit removal of controls.

5.5.5 **Quick-Disconnect Devices:** Gas utilization equipment connectors may be connected to the building piping by means of a listed quick-disconnect device, and when installed indoors, a manual shutoff valve shall be installed upstream of the quick-disconnect device.

5.5.6 **Sediment Trap:** If a sediment trap is not incorporated as a part of the gas utilization equipment and if dirt or other foreign material is a problem, a tee fitting with the bottom outlet plugged or capped shall be installed as close to the inlet of the equipment as practical (see Figure 5). Illuminating appliances and outdoor grills need not be so installed.

5.6 **Electrical.**

5.6.1 **Electrical Connections:** Electrical connections between gas utilization equipment and the building wiring, including the grounding of the equipment, shall conform to the National Electrical Code, ANSI/NFPA 70.

5.6.2 **Electric Ignition and Control Devices:** Electrical ignition, burner control and electrical vent damper devices shall not permit unsafe operation of the gas utilization equipment in the event of electrical power interruption or when the power is restored.

5.6.3 **Electrical Circuit:** The electrical circuit employed for operating the automatic main gas-control valve, automatic pilot, room temperature thermostat, limit control or other electrical devices used with the gas utilization equipment shall be in accordance with the wiring diagrams supplied with the equipment.

5.6.4 **Continuous Power:** All gas utilization equipment using electrical controls shall have the controls connected into a permanently live electric circuit, i.e., one that is not controlled by a light

switch. Central heating equipment shall be provided with a separate electrical circuit.

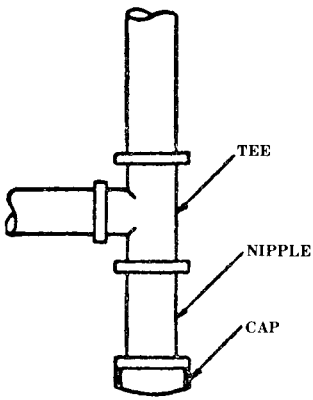


Fig. 5. A Method of Installing a Trap.

5.7 Room Temperature Thermostats.

5.7.1 Locations: Room temperature thermostats shall be installed in accordance with the manufacturer's instructions.

5.7.2 Drafts: Any hole in the plaster or panel through which the wires pass from the thermostat to the gas utilization equipment being controlled shall be sealed so as to prevent drafts from affecting the thermostat.

PART 6

INSTALLATION OF SPECIFIC EQUIPMENT

6.1 General.

a. This Part is primarily applicable to nonindustrial type gas utilization equipment and installations and, unless specifically indicated, does not apply to industrial type equipment and installations. Listed gas utilization equipment shall be installed in accordance with their listing and the manufacturer's instructions, or as elsewhere specified in this Part. Unlisted equipment shall be installed as specified in this Part as applicable to the equipment.

For additional information concerning particular gas equipment and accessories, including industrial types, reference can be made to the standards listed in Appendix A.

b. Gas utilization equipment shall not be installed so its combustion and ventilation air is obtained only from a bedroom or bathroom unless the bedroom or bathroom is an unconfined space (see 5.3.2 and Part 10, Definitions).

6.2 Air Conditioning Equipment.

6.2.1 **Independent Gas Piping:** Gas piping serving heating gas utilization equipment may also serve cooling equipment when heating and cooling equipment cannot be operated simultaneously. (See 2.4.)

6.2.2 **Connection of Gas Engine-Powered Air Conditioners:** To protect against the effects of normal vibration in service, gas engines shall not be rigidly connected to the gas supply piping.

6.2.3 **Clearances for Indoor Installation:**

a. Listed air conditioning equipment installed in rooms which are large in comparison with the size of the equipment shall be installed with clearances not less than those specified in Line I of Table V except as provided in "1," "2" and "3" below.

1. Air conditioning equipment listed for installation at lesser clearances than those specified in Table V may be installed in accordance with its listing and the manufacturer's instructions.

2. Air conditioning equipment listed for installation at greater clearances than those specified in Table V shall be installed in accordance with its listing and the manufacturer's instructions unless protected as specified in "3."

3. Air conditioning equipment installed in rooms large in comparison with the size of the equipment may be installed with reduced clearances to combustible material provided the combustible material or the equipment is protected as described in Table VI.

b. Air conditioning equipment installed in spaces such as alcoves and closets shall be specifically listed for such installation and installed in accordance with the terms of its listing. The installation clearances for air conditioning equipment in rooms not large in comparison with the size of equipment shall be as specified in the listing, regardless of whether the enclosure is of combustible or noncombustible material, and shall not be reduced by the protection methods described in Table VI.

c. Unlisted air conditioning equipment shall be installed with clearances from combustible material of not less than 18 inches above the equipment and at the sides, front and rear, and 9 inches from the draft hood.

d. When the plenum for an air conditioner which includes provisions for heating air is adjacent to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish when the clearance specified is 2 inches or less.

e. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. (See 5.2.1, 5.3 and 7.10.8.)

6.2.4 **Erection and Mounting:** Air conditioning equipment shall be erected in accordance with the manufacturer's instructions. Unless the equipment is listed for installation on a combustible surface such as a floor or roof, or unless the surface is protected in an approved manner,* it shall be installed on a surface of noncombustible construction with noncombustible material and surface finish and with no combustible material against the underside thereof.

6.2.5 **Plenum Chambers and Air Ducts:** A plenum chamber supplied as a part of the air conditioning equipment shall be installed in

*For details of protection, refer to Appendix E of the National Building Code (1976).

accordance with the manufacturer's instructions. When a plenum chamber is not supplied with the equipment, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. (Reference may be made to the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A, or the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.)

When the air conditioner is installed within a room not large in comparison with the size of the equipment, the air circulated by the equipment shall be handled by ducts which are sealed to the casing of the equipment and which separate the circulating air from the combustion and ventilation air.

6.2.6 **Refrigeration Coils:** (See 6.3.7 and 6.3.8.)

6.2.7 **Switches in Electrical Supply Line:** Means for interrupting the electrical supply to the air conditioning equipment and to its associated cooling tower (if supplied and installed in a location remote from the air conditioner) shall be provided within sight of and not over 50 feet from the air conditioner and cooling tower.

6.3 Central Heating Boilers and Furnaces.

6.3.1 **Clearance:**

a. Central heating boilers and furnaces installed in rooms large in comparison with the size of the equipment, shall be installed with clearances not less than specified in Table V except as provided in "1" and "2" below.

1. Central heating furnaces and boilers listed for installation at lesser clearances than specified in Table V may be installed in accordance with their listing and the manufacturer's instructions.

2. Central heating furnaces and boilers installed in rooms large in comparison with the size of the equipment may be installed with reduced clearances to combustible material provided the combustible material or the equipment is protected as described in Table VI.

b. Central heating furnaces and boilers installed in spaces such as alcoves and closets shall be specifically listed for such installation and installed in accordance with the terms of listing.

Table V

Clearances to Combustible Material for Furnaces and Boilers Installed in Rooms Which Are Large in Comparison With Size of Equipment, Except as Provided in 6.3.1-a (See Note 9)

	Minimum Clearance, Inches				
	Above and Sides of Bonnet or Plenum	Jacket Sides and Rear	Front (See Note 1)	Draft Hood and Barometric Draft Regulator	Vent Connector (See Note 2)
I. Listed automatically fired, forced air or gravity system, with 250 F temperature limit control.	2 (See Notes 3 and 4)	6	18	6	6 (See Note 10)
II. Unlisted automatically fired, forced air or gravity system, equipped with temperature limit control which cannot be set higher than 250 F.	6 (See Note 5)	6	18	18 (See Note 6)	18 (See Note 6)
III. Listed Automatically Fired Heating Boilers—Steam boilers operating at not over 15 psi gage pressure and hot water boilers operating at not in excess of 250 F.	6 (See Note 7)	6	18	6	6 (See Note 10)
IV. Unlisted Automatically Fired Heating Boilers—Steam boilers operating at not over 15 psi gage pressure and hot water boilers operating at not in excess of 250 F.	6 (See Note 7)	6	18	18 (See Note 6)	18 (See Note 6)
V. Central heating boilers and furnaces, other than above.	18 (See Note 8)	18	18	18 (See Note 6)	18 (See Note 6)

NOTES APPLICABLE TO TABLE V

1. Front clearance shall be sufficient for servicing the burner and furnace or boiler.

2. The vent connector clearance does not apply to listed Type B gas vents.

3. This clearance may be reduced to 1 inch for a listed forced air or gravity furnace equipped with:

   a. A limit control that cannot be set higher than 200 F, or

   b. A marking to indicate that the outlet air temperature cannot exceed 200 F.

4. Clearance from supply ducts within 3 feet of the plenum shall not be less than that specified from the bonnet or plenum. No clearance is necessary beyond this distance.

5. Clearance from supply ducts within 6 feet of the plenum shall not be less than 6 inches. No clearance is necessary beyond this distance.

6. For unlisted gas utilization equipment equipped with an approved draft hood, this clearance may be reduced to 9 inches.

7. This clearance is above top of boiler.

8. Clearance from supply ducts shall not be less than 18 inches out to 3 feet from the bonnet or plenum, not less than 6 inches from 3 feet to 6 feet, and not less than 1 inch beyond 6 feet.

9. Rooms which are large in comparison with the size of the equipment are rooms having a volume equal to at least 12 times the total volume of an air conditioning appliance or furnace and at least 16 times the total volume of a boiler or water heater. Total volume of an appliance is determined from exterior dimensions and is to include fan compartments and burner vestibules, when used. When the actual ceiling height of a room is greater than 8 feet, the volume of a room shall be figured on the basis of a ceiling height of 8 feet.

10. These clearances shall apply unless the listing of an appliance specifies different clearances, in which case the listed clearances shall apply.

Table VI

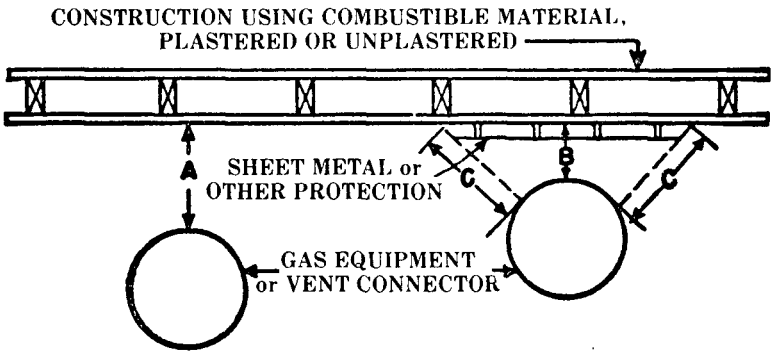
Clearances (Inches) With Specified Forms of Protection*

Type of Protection Applied to the combustible material unless otherwise specified and covering all surfaces within the distance specified as the required clearance with no protection. (See Fig. 6.) Thicknesses are minimum.	Where the required Clearance with no protection is:											
	36 inches			18 inches			12 inches		9 inches	6 inches		
	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector
(a) 1/4 in. insulating millboard** spaced out 1"† ...	30	18	30	15	9	12	9	6	6	3	2	3
(b) 28 gage sheet metal on 1/4" insulating millboard**	24	18	24	12	9	12	9	6	4	3	2	2
(c) 28 gage sheet metal spaced out 1"†	18	12	18	9	6	9	6	4	4	2	2	2
(d) 28 gage sheet metal on 1/8" insulating millboard** spaced out 1"†	18	12	18	9	6	9	6	4	4	2	2	2
(e) 1/4" insulating millboard** on 1" mineral wool bats reinforced with wire mesh or equivalent	18	12	18	6	6	6	4	4	4	2	2	2
(f) 22 gage sheet metal on 1" mineral wool bats reinforced with wire or equivalent	18	12	12	4	3	3	2	2	2	2	2	2
(g) 1/4" insulating millboard**	36	36	36	18	18	18	12	12	9	4	4	4

*All clearances shall be measured from the outer surface of the equipment to the combustible material disregarding any intervening protection applied to the combustible material.

**A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F, or less.

†Spacers shall be of noncombustible material.



A equals the clearance with no protection specified in Tables V and IX and in the sections applying to various types of equipment.
B equals the reduced clearance permitted in accordance with Table VI. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

Fig. 6. Extent of Protection Necessary to Reduce Clearances from Gas Equipment or Vent Connectors.

The installation clearances for furnaces and boilers in rooms not large in comparison with the size of the equipment shall be as specified in the listing, regardless of whether the enclosure is of combustible or noncombustible material, and shall not be reduced by the protection methods described in Table VI.

c. When the plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish when the clearance specified is 2 inches or less.

d. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. (See 5.2.1, 5.3 and 7.10.8.)

6.3.2 **Erection and Mounting:** A central heating boiler or furnace shall be erected in accordance with the manufacturer's instructions and shall be installed on a floor of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof or on fire-resistive slabs or arches having no combustible material against the underside thereof, unless listed for installation on a combustible floor or the floor is protected in an approved manner.*

6.3.3 **Temperature or Pressure Limiting Devices:** Steam and hot water boilers respectively shall be provided with approved automatic limiting devices for shutting down the burner(s) to prevent boiler steam pressure or boiler water temperature from exceeding the maximum allowable working pressure or temperature.

Safety limit controls shall not be used as operating controls.

6.3.4 **Low Water Cutoff:** Hot water boilers installed above the radiation level and all steam boilers shall be provided with an automatic means to shut off the fuel supply to the burner(s) if the boiler water level drops to the lowest safe water line.

6.3.5 **Steam Safety and Pressure Relief Valves:** Steam and hot water boilers shall be equipped, respectively, with listed or approved steam safety or pressure relief valves of appropriate discharge capacity and conforming with ASME requirements.†

*For details of protection, refer to Appendix E of the National Building Code (1976).

†For details of requirements on low-pressure heating boiler safety devices refer to ANSI/ASME Boiler and Pressure Vessel Code, 1983 Edition, Section IV, Heating Boilers.

6.3.6 Plenum Chambers and Air Ducts:

a. Plenum chambers and air ducts shall be installed in accordance with the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A, or the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.

b. A plenum chamber supplied as a part of a furnace shall be installed in accordance with the manufacturer's instructions.

c. When a plenum chamber is not supplied with the furnace, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. (Reference may be made to the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A and to the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.)

d. When a furnace is installed so supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

6.3.7 Refrigeration Coils:

a. A refrigeration coil shall not be installed in conjunction with a forced air furnace when circulation of cooled air is provided by the furnace blower, unless the blower has sufficient capacity to overcome the external static resistance imposed by the duct system and cooling coil at the air throughput necessary for heating or cooling, whichever is greater.

b. Furnaces shall not be located upstream from cooling units, unless the cooling unit is designed or equipped so as not to develop excessive temperature or pressure.

c. Refrigeration coils shall be installed in parallel with or on the downstream side of central furnaces to avoid condensation in the heating element, unless the furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control flow of air shall be sufficiently tight to prevent any circulation of cooled air through the furnace.

d. Means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element.

6.3.8 Cooling Units Used with Heating Boilers:

a. Boilers, when used in conjunction with refrigeration systems, shall be installed so that the chilled medium is piped in parallel with the heating boiler with appropriate valves to prevent the chilled medium from entering the heating boiler.

b. When hot water heating boilers are connected to heating coils located in air handling units where they may be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

6.4 Clothes Dryers.

6.4.1 Clearance:

a. Listed Type 1 clothes dryers shall be installed with a minimum clearance of 6 inches from adjacent combustible material, except that clothes dryers listed for installation at lesser clearances may be installed in accordance with their listing. Type 1 clothes dryers installed in closets shall be specifically listed for such installation.

b. Listed Type 2 clothes dryers shall be installed with clearances of not less than shown on the marking plate and in the manufacturer's instructions. Type 2 clothes dryers designed and marked "For use only in noncombustible locations" shall not be installed elsewhere.

c. Unlisted clothes dryers shall be installed with clearances to combustible material of not less than 18 inches. Combustible floors under unlisted clothes dryers shall be protected in an approved manner.*

6.4.2 Exhausting to the Outside Air:

a. Type 1 clothes dryers installed in closets shall be exhausted to the outside air, and no other fuel-burning appliance shall be installed in the same closet. Type 1 clothes dryers shall not be installed in bathrooms or bedrooms unless exhausted to the outside air.

b. Type 2 clothes dryers shall be exhausted to the outside air.

*For details of protection, refer to Appendix E of the National Building Code (1976).

6.4.3 Provisions for Make-Up Air:

a. When a Type 1 clothes dryer is exhausted to the outside, consideration shall be given to provision for make-up air. (See 5.3.6.) Provision for make-up air shall be provided for closet installed Type 1 clothes dryers in accordance with the manufacturer's installation instructions.

b. Provision for make-up air shall be provided for Type 2 clothes dryers, with a minimum free area (see 5.3.5) of one square inch for each 1,000 Btu per hour total input rating of the dryer(s) installed.

6.4.4 Exhaust Ducts for Type 1 Clothes Dryers:

a. A clothes dryer exhaust duct shall not be connected into any vent connector, gas vent, chimney, crawl space, attic or other similar concealed space.

b. Ducts for exhausting clothes dryers shall not be put together with sheet-metal screws or other fastening means which extend into the duct and which would catch lint and reduce the efficiency of the exhaust system.

6.4.5 Exhaust Ducts for Type 2 Clothes Dryers:

a. Exhaust ducts for Type 2 clothes dryers shall comply with 6.4.4.

b. Exhaust ducts for Type 2 clothes dryers shall be constructed of sheet metal or other noncombustible material. Such ducts shall be equivalent in strength and corrosion resistance to ducts made of galvanized sheet steel not less than 0.0195 inch thick.†

c. Type 2 clothes dryers shall be equipped or installed with lint controlling means.

d. Exhaust ducts for Type 2 clothes dryers shall have a clearance of at least 6 inches to combustible material except as provided in "e."

e. Exhaust ducts for Type 2 clothes dryers may be installed with reduced clearances to combustible material provided the combustible material is protected as described in Table VI.

f. When ducts pass through walls, floors or partitions, the space around the duct shall be sealed with noncombustible material.

†This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

g. Multiple installations of Type 2 clothes dryers shall be made in a manner to prevent adverse operation due to back pressures that might be created in the exhaust systems.

6.4.6 **Multiple Family or Public Use:** All clothes dryers installed for multiple family or public use shall be equipped with approved safety shutoff devices and shall be installed as specified for a Type 2 clothes dryer under 6.4.5.

6.5 Commercial Cooking Equipment, Floor-Mounted.

6.5.1 **Clearance for Listed Equipment:** Listed floor-mounted commercial cooking equipment, such as hotel and restaurant ranges, deep fat fryers, unit broilers, gas-fired kettles, steam cookers, steam generators and commercial baking and roasting ovens, shall be installed at least 6 inches from combustible material except that at least a 2-inch clearance shall be maintained between a draft hood and combustible material. Floor-mounted commercial cooking equipment listed for installation at lesser clearances may be installed in accordance with its listing and the manufacturer's instructions. Equipment designed and marked "For use only in noncombustible locations" shall not be installed elsewhere.

6.5.2 **Clearance for Unlisted Equipment:**

a. Unlisted floor-mounted commercial cooking equipment, except as provided in "b" and "c" below, shall be installed to provide a clearance to combustible material of not less than 18 inches at the sides and rear of the equipment and from the vent connector and not less than 48 inches above cooking tops and at the front of the equipment.

b. Unlisted floor-mounted commercial cooking equipment may be installed in rooms, but not in partially enclosed areas such as alcoves, with reduced clearances to combustible material, provided the combustible material or the equipment is protected as described in Table VI.

c. Unlisted floor-mounted commercial cooking equipment may be installed in rooms, but not in partially enclosed areas such as alcoves, with reduced clearance of 6 inches to combustible material, provided the wall or combustible material is protected by sheet metal not less than 0.0152 inch thick,* fastened with noncombustible spacers that are spaced at not less than 2-foot vertical and horizontal intervals to provide a clearance of 1½ inches from such wall or material. Such protection shall extend at least

12 inches beyond the back, side, top or any other part of the equipment and the space between the sheet metal and wall or combustible material shall be open on both sides and top and bottom to permit circulation of air.

6.5.3 **Mounting On Combustible Floor:**

a. Listed floor-mounted commercial cooking equipment that is listed specifically for installation on floors constructed of combustible material may be mounted on combustible floors in accordance with its listing.

b. Listed floor-mounted commercial cooking equipment that is designed and marked "For use only in noncombustible locations" shall be mounted on floors of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall in all cases extend not less than 12 inches beyond the equipment on all sides.

c. Floor-mounted commercial cooking equipment which is not listed for mounting on a combustible floor shall be mounted in accordance with "b" above or be mounted in accordance with one of the following:

1. When the equipment is set on legs which provide not less than 18 inches open space under the base of the equipment, or where it has no burners and no portion of any oven or broiler within 18 inches of the floor, it may be mounted on a combustible floor without special floor protection, provided there is at least one sheet metal baffle between the burner and the floor.

2. When the equipment is set on legs which provide not less than 8 inches open space under the base of the equipment, it may be mounted on combustible floors provided the floor under the equipment is protected with not less than ⅜-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick.† The above specified floor protection shall extend not less than 6 inches beyond the equipment on all sides.

3. When the equipment is set on legs which provide not less than 4 inches under the base of the equipment, it may be mounted on combustible floors, provided the floor under the equipment is protected with hollow masonry not less than 4 inches in thickness covered with sheet metal not less than 0.0195 inch thick.* Such masonry courses shall be laid with

*This corresponds to No. 26 U.S. Standard gage sheet steel with all applicable minus tolerances included.

†This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

ends unsealed and joints matched in such a way as to provide for free circulation of air through the masonry.
4. When the equipment does not have legs at least 4 inches high, it may be mounted on combustible floors, provided the floor under the equipment is protected by two courses of 4-inch hollow clay tile, or equivalent, with courses laid at right angles and with ends unsealed and joints matched in such a way as to provide for free circulation of air through such masonry courses and covered with steel plate not less than 3/16 inch in thickness.

6.5.4 **Combustible Material Adjacent to Cooking Top:** Any portion of combustible material adjacent to a cooking top section of a hotel or restaurant range, even though listed for close-to-wall installation, which is not shielded from the wall by a high shelf, warming closet, etc., shall be protected as specified in 6.5.2 for a distance of at least 2 feet above the surface of the cooking top.

6.5.5 **For Use With Casters:** Floor-mounted equipment with casters shall be listed for such construction and shall be installed in accordance with their listing and the accompanying instructions for limiting the movement of the equipment to prevent strain on the connection.

6.5.6 **Install Level:** Floor-mounted commercial cooking equipment shall be installed level on a firm foundation.

6.5.7 **Ventilation:** Adequate means shall be provided to properly ventilate the space in which commercial cooking equipment is installed to permit proper combustion of the gas. When exhaust fans are used for ventilation, special precautions may be necessary to avoid interference with the operation of the equipment.

6.6 **Commercial Counter Appliances.**

6.6.1 **Vertical Clearance:** A vertical distance of not less than 48 inches shall be provided between the top of all commercial hot plates and griddles and combustible material.

6.6.2 **Clearance for Listed Appliances:** Listed commercial counter appliances such as hot plates and griddles, food and dish warmers, and coffee brewers and urns, when installed on combustible surfaces, shall be set on their own bases or legs and shall be installed with a minimum horizontal clearance of 6 inches from combustible material, except that at least a 2-inch clearance shall be maintained be-

tween a draft hood and combustible material. Commercial counter appliances listed for installation at lesser clearances may be installed in accordance with their listing and the manufacturer's instructions.

6.6.3 **Clearance for Unlisted Appliances:** Unlisted commercial hot plates and griddles shall be installed with a horizontal clearance from combustible material of not less than 18 inches. Unlisted gas commercial counter appliances such as coffee brewers and urns, waffle bakers and hot water immersion sterilizers shall be installed with a horizontal clearance from combustible material of not less than 12 inches. Gas commercial counter appliances may be installed with reduced clearances to combustible material provided the combustible material is protected as described in Table VI. Unlisted food and dish warmers shall be installed with a horizontal clearance from combustible material of not less than 6 inches.

6.6.4 **Mounting of Unlisted Appliances:** Unlisted commercial counter appliances shall not be set on combustible material unless they have legs which provide not less than 4 inches of open space below the burners, and the combustible surface is protected with insulating millboard at least ¼ inch thick covered with sheet metal not less than 0.0122 inch thick,* or with equivalent protection.

6.7 Conversion Burners.

Installation of conversion burners shall conform to the Standard for Installation of Domestic Gas Conversion Burners, ANSI Z21.8.

6.8 Decorative Appliances for Installation in Vented Fireplaces.

6.8.1 **Installation:** A decorative appliance for installation in a vented fireplace shall be installed only in a vented fireplace having a working chimney flue and constructed of noncombustible materials. These appliances shall not be thermostatically controlled.

a. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer's instructions.

b. An unlisted decorative appliance for installation in a vented fireplace shall be installed in a fireplace having a permanent

*This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

free opening, based on appliance input rating and chimney height, equal to or greater than that specified in Table VII.

6.8.2 **Fireplace Screens:** A fireplace screen shall be installed with a decorative appliance for installation in a vented fireplace in order to provide protection from inadvertent contact with the appliance.

6.9 **Decorative Appliances, Vented.**

6.9.1 **Installation:**

a. A listed vented decorative appliance shall be installed in accordance with its listing and the manufacturer's instructions. They may be installed in or attached to combustible material when so listed.

b. Unlisted vented decorative appliances shall not be installed in or attached to combustible material. They shall have a clearance at the sides and rear of not less than 18 inches, except that appliances which make use of metal, asbestos or ceramic material to direct radiation to the front of the appliance shall have a clearance of 36 inches in front and, if constructed with a double back of metal or ceramic, may be installed with a clearance of 18 inches at the sides and 12 inches at the rear. Combustible floors under unlisted vented decorative appliances shall be protected in an approved manner.* Such unlisted appliances shall be equipped with a draft hood and be properly vented in accordance with Part 7.

c. Panels, grilles and access doors which must be removed for normal servicing operations shall not be attached to the building.

6.9.2 **Combustion and Circulating Air:** Adequate combustion and circulating air shall be provided (see 5.3).

6.10 **Direct Make-Up Air Heaters.**

6.10.1 **Installation:** Direct make-up air heaters shall not be used to supply any area containing sleeping quarters.

6.10.2 **Clearance from Combustible Material:** The clearances specified below shall not interfere with combustion air, accessibility for operation and servicing.

*For details of protection, refer to mounting provisions for unlisted room heaters in Appendix E of the National Building Code (1976).

Table VII

Free Opening Area of Chimney Damper for Venting Flue Gases from Unlisted Decorative Appliances for Installation in Vented Fireplaces

Chimney Height, Feet	Minimum Permanent Free Opening, Square Inches*						
	8	13	20	29	39	51	64
	Appliance Input Rating, Btu Per Hour						
6	7,800	14,000	23,200	34,000	46,400	62,400	80,000
8	8,400	15,200	25,200	37,000	50,400	68,000	86,000
10	9,000	16,800	27,600	40,400	55,800	74,400	96,400
15	9,800	18,200	30,200	44,600	62,400	84,000	108,800
20	10,600	20,200	32,600	50,400	68,400	94,000	122,200
30	11,200	21,600	36,600	55,200	76,800	105,800	138,600

* The first six minimum permanent free openings (8 to 51 sq. in.) correspond approximately to the cross-sectional areas of chimneys having diameters of 3 through 8 inches, respectively. The 64 sq. in. opening corresponds to the cross-sectional area of standard 8 in. x 8 in. chimney tile.

a. Listed direct make-up air heaters shall be installed in accordance with their listings and the manufacturer's instructions.

b. Unlisted direct make-up air heaters shall be installed with clearances to combustible material of not less than 18 inches. Combustible floors under unlisted floor-mounted heaters shall be protected in an approved manner.†

6.10.3 Outside Air: All air handled by a direct make-up air heater, including combustion air, shall be brought in from outdoors. Indoor air may be added to the outdoor air stream after the outdoor air stream has passed the combustion zone.

6.10.4 Outside Louvers: If outside louvers of either the manual or automatic type are used, they shall be proved in the open position before the main burners can operate.

6.10.5 Controls:

a. Listed direct make-up air heaters shall be equipped with air-flow sensing devices, safety shutoff devices, operating temperature controls and thermally actuated temperature limit controls in accordance with the terms of their listings.

b. Unlisted direct make-up air heaters shall be equipped with:

1. Air-flow sensing devices so designed and installed as to shut off the gas to the main burners upon failure of either combustion air or main air supply. (Controls actuated by failure of the power supply to the blower motor do not meet the intent of this provision.)

2. Combustion safeguards, including manual reset safety shutoff devices.

3. Operating temperature controls and thermally actuated manual reset temperature limit controls, the latter of which shall not permit the discharge air temperature to exceed 150 F.

6.10.6 Input Ratings: Unlisted direct make-up air heaters shall have input ratings such that the ratio of gas input by volume to the total volume of gas-air mixture discharged will not exceed 0.2 percent.

6.10.7 Atmospheric Vents and Gas Relief or Bleeds: Direct make-up air heaters with enclosed valve trains shall be equipped with both

†For details of protection, refer to Appendix E of the National Building Code (1976).

atmospheric vent lines and gas reliefs or bleeds leading outdoors. Means shall be employed on these lines to prevent water from entering and to prevent stoppage by insects and foreign matter. An atmospheric vent line need not be provided on a valve train component equipped with a vent limiter.

6.10.8 Exhaust: The design of the installation shall include adequate provision to permit make-up air heaters to operate at rated capacity by providing properly designed relief openings or an interlocked power exhaust system.

6.10.9 Purging: The blower of an unlisted direct make-up air heater and the exhaust system shall be operated to effect at least four air changes of the combustion chamber before the gas to the main burners is ignited.

6.11 Duct Furnaces.

6.11.1 Clearances:

a. Listed duct furnaces shall be installed with clearances of at least 6 inches between adjacent walls, ceilings and floors of combustible material and the furnace draft hood, except that furnaces listed for installation at lesser clearances may be installed in accordance with their listings. In no case shall the clearance be such as to interfere with combustion air and accessibility. (See 5.2.1 and 5.3.)

b. Unlisted duct furnaces shall be installed with clearances to combustible material in accordance with the clearances specified for unlisted furnaces and boilers in Table V. Combustible floors under unlisted duct furnaces shall be protected in an approved manner.*

6.11.2 Erection of Equipment: Duct furnaces shall be erected and firmly supported in accordance with the manufacturer's instructions.

6.11.3 Access Panels: The ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace.

6.11.4 Location of Draft Hood and Controls: The controls, combustion air inlet and draft hoods for duct furnaces shall be located

*For details of protection, refer to Appendix E of the National Building Code (1976).

outside the ducts. The draft hood shall be located in the same enclosure from which combustion air is taken.

6.11.5 Circulating Air: When a duct furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

If the duct furnace is connected to a return air duct or any other inlet air restriction, the furnace shall be installed on the positive pressure side of the circulating air blower.

6.11.6 Duct Furnaces Used with Refrigeration Systems:

a. A duct furnace shall not be installed in conjunction with a refrigeration coil when circulation of cooled air is provided by the blower, unless the blower has sufficient capacity to overcome the external static resistance imposed by the duct system, furnace and the cooling coil at the air throughput necessary for heating or cooling, whichever is greater.

b. To avoid condensation within heating elements, duct furnaces used in conjunction with cooling equipment shall be installed in parallel with or on the upstream side of cooling coils, unless the duct furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control the flow of air shall be sufficiently tight to prevent any circulation of cooled air through the unit.

c. When duct furnaces are to be located upstream from cooling units, the cooling unit shall be so designed or equipped as to not develop excessive temperatures or pressures.

d. Duct furnaces may be installed downstream from evaporative coolers or air washers if the heating element is made of corrosion-resistant material. Stainless steel, ceramic-coated steel, or an aluminum-coated steel in which the bond between the steel and the aluminum is an iron-aluminum alloy, are considered to be corrosion-resistant. Air washers operating with chilled water which delivers air below the dew point of the ambient air at the equipment are considered as refrigeration systems.

6.11.7 Installation in Commercial Garages and Aircraft Hangars: Duct furnaces installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.12 Floor Furnaces.

6.12.1 Installation:

a. Listed floor furnaces shall be installed in accordance with their listing and the manufacturer's instructions. They may be installed in combustible floors.

b. Unlisted floor furnaces shall not be installed in combustible floors.

c. Thermostats controlling floor furnaces shall not be located in a room or space which can be separated from the room or space in which the register of the floor furnace is located.

6.12.2 Temperature Limit Controls:

a. Listed automatically operated floor furnaces shall be equipped with temperature limit controls in accordance with the terms of their listing.

b. Unlisted automatically operated floor furnaces shall be equipped with a temperature limit control arranged to shut off the flow of gas to the burner in the event the temperature at the warm air outlet register exceeds 350 F above room temperature.

6.12.3 Combustion and Circulating Air: Adequate combustion and circulating air shall be provided (see 5.3).

6.12.4 Placement: The following provisions apply to furnaces that serve one story.

a. Floors: Floor furnaces shall not be installed in the floor of any doorway, stairway landing, aisle or passageway of any enclosure, public or private, or in an exitway from any such room or space.

b. Walls and Corners: The register of a floor furnace with a horizontal warm air outlet shall not be placed closer than 6 inches to the nearest wall. A distance of at least 18 inches from two adjoining sides of the floor furnace register to walls shall be provided to eliminate the necessity of occupants walking over the warm air discharge. The remaining sides may be placed not closer than 6 inches to a wall. Wall-register models shall not be placed closer than 6 inches to a corner.

c. Draperies: The furnace shall be placed so that a door, drapery or similar object cannot be nearer than 12 inches to any portion of the register of the furnace.

6.12.5 **Bracing:** The space provided for the furnace shall be framed with doubled joists and with headers not lighter than the joists.

6.12.6 **Support:** Means shall be provided to support the furnace when the floor register is removed.

6.12.7 **Clearance:** The lowest portion of the floor furnace shall have at least a 6-inch clearance from the general ground level, except that when the lower 6-inch portion of the floor furnace is sealed by the manufacturer to prevent entrance of water, the clearance may be reduced to not less than 2 inches. When these clearances are not present, the ground below and to the sides shall be excavated to form a "basin-like" pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 12-inch clearance shall be provided on all sides except the control side, which shall have an 18-inch clearance.

6.12.8 **Access:** The space in which any floor furnace is installed shall be accessible by an opening in the foundation not less than 24 by 18 inches, or a trap door not less than 24 by 24 inches in any cross section thereof, and a passageway not less than 24 by 18 inches in any cross section thereof.

6.12.9 **Seepage Pan:** When the excavation exceeds 12 inches in depth or water seepage is likely to collect, a watertight copper pan, concrete pit or other suitable material shall be used, unless adequate drainage is provided or the equipment is sealed by the manufacturer to meet this condition. A copper pan shall be made of not less than 16-ounce-per-square-foot sheet copper. The pan shall be anchored in place so as to prevent floating, and the walls shall extend at least 4 inches above the ground level with at least 6 inches clearance on all sides, except the control side which shall have at least 18 inches clearance.

6.12.10 **Wind Protection:** Floor furnaces shall be protected, where necessary, against severe wind conditions.

6.12.11 **Upper Floor Installations:** Listed floor furnaces may be installed in an upper floor provided the furnace assembly projects below into a utility room, closet, garage or similar nonhabitable space. In such installations, the floor furnace shall be enclosed completely (entirely separated from the nonhabitable space) with means for air intake to meet the provisions of 5.3, with access for servicing, the minimum furnace clearances of 6 inches to all sides and bottom, and with the enclosure constructed of portland cement plaster or metal lath or other noncombustible material.

6.12.12 **First Floor Installation:** Listed floor furnaces installed in the first or ground floors of buildings need not be enclosed unless the basements of these buildings have been converted to apartments or sleeping quarters, in which case the floor furnace shall be enclosed as specified for upper floor installations and shall project into a non-habitable space.

6.13 **Hot Plates and Laundry Stoves.**

a. Listed domestic hot plates and laundry stoves installed on combustible surfaces shall be set on their own legs or bases. They shall be installed with minimum horizontal clearances of 6 inches from combustible material.

b. Unlisted domestic hot plates and laundry stoves shall be installed with horizontal clearances to combustible material of not less than 12 inches. Combustible surfaces under unlisted domestic hot plates and laundry stoves shall be protected in an approved manner.*

c. The vertical distance between tops of all domestic hot plates and laundry stoves and combustible material shall be at least 30 inches.

6.14 **Household Cooking Appliances.**

6.14.1 **Floor-Mounted Units:**

a. **Clearance from Combustible Material:** The clearances specified below shall not interfere with combustion air, accessibility for operation and servicing.

1. Listed floor-mounted household cooking appliances, except as noted in "2" and "3" below, when installed on combustible floors shall be set on their own bases or legs and shall be installed in accordance with their listing and the manufacturer's instructions.

2. Listed household cooking appliances with listed gas room heater sections shall be installed so that the warm air discharge side shall have a minimum clearance of 18 inches from adjacent combustible material. A minimum clearance of 36 inches shall be provided between the top of the heater section and the bottom of cabinets.

3. Household cooking appliances which include a solid or liquid fuel burning section shall be spaced from combustible

*For details of protection, refer to Appendix E of the National Building Code (1976).

material and otherwise installed in accordance with the standards applying to the supplementary fuel section of the appliance.

4. Unlisted floor-mounted household cooking appliances shall be installed with at least a 6-inch clearance at the back and sides to combustible material. Combustible floors under unlisted appliances shall be protected in an approved manner.*

b. Vertical Clearance Above Cooking Top: Household cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches to combustible material or metal cabinets, except the clearance may be reduced to not less than 24 inches as follows:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0122 inch thick,† or

2. A metal ventilating hood of sheet metal not less than 0.0122 inch thick† is installed above the cooking top with a clearance of not less than ¼ inch between the hood and the underside of the combustible material or metal cabinet, and the hood is at least as wide as the appliance is and is centered over the appliance.

c. Install Level: Cooking appliances shall be installed so that the cooking top or oven racks are level.

6.14.2 Built-In Units:

a. Installation: Listed built-in household cooking appliances shall be installed in accordance with their listing and the manufacturer's instructions. Listed built-in household cooking appliances may be installed in combustible material unless otherwise marked.

The installation shall not interfere with combustion air, accessibility for operation and servicing.

Unlisted built-in household cooking appliances shall not be installed in, or adjacent to, combustible material.

b. Vertical Clearance: Built-in top (or surface) cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches to combustible material or metal cabinets,

*For details of protection, refer to Appendix E of the National Building Code (1976).

†This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

except the clearance may be reduced to not less than 24 inches as follows:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0122 inch thick† or,

2. A metal ventilating hood of sheet metal not less than 0.0122 inch thick† is installed above the cooking top with a clearance of not less than ¼ inch between the hood and the underside of the combustible material or metal cabinet, and the hood is at least as wide as the appliance is and is centered over the appliance.

c. **Horizontal Clearance:** The minimum horizontal distance from the center of the burner head(s) of a listed top (or surface) cooking appliance to vertical combustible walls extending above the top panel shall be not less than that distance specified by the permanent marking on the appliance.

d. **Install Level:** Built-in household cooking appliances shall be installed so that the cooking top, broiler pan or oven racks are level.

6.15 Illuminating Appliances.

6.15.1 Clearances for Listed Appliances: Listed illuminating appliances shall be installed in accordance with their listing and the manufacturer's instructions.

6.15.2 Clearances for Unlisted Appliances:

a. **Enclosed Type:**

1. Unlisted enclosed illuminating appliances installed outdoors shall be installed with clearances in any direction from combustible material of not less than 12 inches.

2. Unlisted enclosed illuminating appliances installed indoors shall be installed with clearances in any direction from combustible material of not less than 18 inches.

b. **Open-Flame Type:**

1. Unlisted open-flame illuminating appliances installed outdoors shall have clearances from combustible material not less than that specified in Table VIII. The distance from ground level to the base of the burner shall be at least 7 feet when installed within two feet of walkways. Lesser clearances may be used when acceptable to the authority having jurisdiction.

2. Unlisted open-flame illuminating appliances installed outdoors shall be equipped with a limiting orifice or other limiting devices which will maintain a flame height consistent with the clearance from combustible material, as given in Table VIII.
3. Appliances designed for flame heights in excess of 30 inches may be installed if acceptable to the authority having jurisdiction. Such appliances shall be equipped with a safety shutoff device or automatic ignition.
4. Unlisted open-flame illuminating appliances installed indoors shall have clearances from combustible material acceptable to the authority having jurisdiction.

Table VIII

Flame Height Above Burner Head, Inches	Minimum Clearance from Combustible Material, Feet*	
	Horizontal	Vertical
12	2	6
18	3	8
24	3	10
30	4	12

*Measured from the nearest portion of the burner head.

6.15.3 **Mounting on Buildings:** Illuminating appliances designed for wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support.

6.15.4 **Mounting on Posts:** Illuminating appliances designed for post mounting shall be securely and rigidly attached to a post.

Posts shall be rigidly mounted. The strength and rigidity of posts greater than 3 feet in height shall be at least equivalent to that of a 2½-inch-diameter post constructed of 0.064 inch thick* steel or a 1-inch Schedule 40 steel pipe. Posts 3 feet or less in height shall not be smaller than a ¾-inch Schedule 40 steel pipe.

Drain openings should be provided near the base of posts when there is a possibility of water collecting inside them.

6.15.5 **Gas Appliance Pressure Regulators:** When a gas appliance pressure regulator is not supplied with an illuminating appliance and the service line is not equipped with a service pressure regulator, an appliance pressure regulator shall be installed in the line to the

illuminating appliance. For multiple installations, one regulator of adequate capacity may be used to serve a number of illuminating appliances.

6.16 Incinerators, Commercial-Industrial.

Commercial-industrial type incinerators shall be constructed and installed in accordance with the Standard on Incinerators, Waste and Linen Handling Systems and Equipment, ANSI/NFPA 82.

6.17 Incinerators, Domestic.

6.17.1 Clearance:

a. Listed incinerators shall be installed in accordance with their listing and the manufacturer's instructions, provided that in any case the clearance shall be sufficient to afford ready accessibility for firing, clean-out and necessary servicing.

b. The clearances to combustible material above a charging door shall be not less than 48 inches. The clearance may be reduced to 24 inches provided the combustible material is protected with sheet metal not less than 0.0122 inch thick† spaced out 1 inch on noncombustible spacers, or equivalent protection. Such protection shall extend 18 inches beyond all sides of the charging door opening. Listed incinerators designed to retain the flame during loading need not comply with this paragraph.

c. Unlisted incinerators shall be installed with clearances to combustible material of not less than 36 inches at the sides, top and back and not less than 48 inches at the front, but in no case shall the clearance above a charging door be less than 48 inches. Unlisted wall mounted incinerators shall be installed on a noncombustible wall communicating directly with a chimney.

d. Domestic type incinerators may be installed with reduced clearances to combustible material in rooms, provided the combustible material is protected as described in Table VI. In partially enclosed areas, such as alcoves, clearances shall not be so reduced.

e. When a domestic type incinerator that is refractory lined or insulated with heat insulating material is encased in common

*This corresponds to No. 14 U.S. Standard gage sheet steel with all applicable minus tolerances included.

†This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

brick not less than 4 inches in thickness, the clearances may be reduced to 6 inches at the sides and rear, and the clearance at the top may be reduced to 24 inches provided that the construction using combustible material above the charging door and within 48 inches is protected with sheet metal not less than 0.0122 inch thick* spaced out 1 inch, or equivalent protection.

6.17.2 **Mounting:**

a. Listed incinerators specifically listed for installation on combustible floors may be so installed.

b. Unlisted incinerators, except as provided in "c" and "d" below, shall be mounted on the ground or on floors of noncombustible construction with noncombustible flooring or surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall extend not less than 12 inches beyond the incinerator base on all sides, except at the front or side where ashes are removed where it shall extend not less than 18 inches beyond the incinerator.

c. Unlisted incinerators may be mounted on floors other than as specified in "b" above, provided the incinerator is so arranged that flame or hot gases do not come in contact with its base and, further, provided the floor under the incinerator is protected with hollow masonry not less than 4 inches thick, covered with sheet metal not less than 0.0195 inch thick.* Such masonry course shall be laid with ends unsealed and joints matched in such a way as to provide a free circulation of air from side to side through the masonry. The floor for 18 inches beyond the front of the incinerator or side where ashes are removed and 12 inches beyond all other sides of the incinerator shall be protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick† or with equivalent protection.

d. Unlisted incinerators which are set on legs that provide not less than 4 inches open space under the base of the incinerator may be mounted on floors other than as specified in "b" above, provided the incinerator is such that flame or hot gases do not come in contact with its base and, further, provided the floor

*This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

under the incinerator is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick*. The above specified floor protection shall extend not less than 18 inches beyond the front of the incinerator or side where ashes are removed and 12 inches beyond all other sides of the incinerator.

6.17.3 **Draft Hood Prohibited:** Draft hoods shall not be installed in the vent connector of an incinerator.

6.17.4 **Venting:** Incinerators shall be vented in accordance with 7.3, 7.4, 7.6 and 7.9.

6.18 **Infrared Heaters.**

6.18.1 **Support:** Suspended type infrared heaters shall be safely and adequately fixed in position independent of gas and electric supply lines. Hangers and brackets shall be of noncombustible material.

Heaters subject to vibration shall be provided with vibration isolating hangers.

6.18.2 **Clearance:**

a. Listed heaters shall be installed with clearances from combustible material in accordance with their listing and the manufacturer's instructions.

b. Unlisted heaters shall be installed in accordance with clearances from combustible material acceptable to the authority having jurisdiction.

c. In locations used for the storage of combustible materials, signs shall be posted to specify the maximum permissible stacking height to maintain required clearances from the heater to the combustibles.

6.18.3 **Combustion and Ventilation Air:**

a. Where unvented infrared heaters are used, natural or mechanical means shall be provided to supply and exhaust at least 4 cfm per 1,000 Btu per hour input of installed heaters.

b. Exhaust openings for removing flue products shall be above the level of the heaters.

6.18.4 **Installation in Commercial Garages and Aircraft Hangars:** Overhead heaters installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.19 Open Top Broiler Units.

6.19.1 Listed Units: Listed open top broiler units shall be installed in accordance with their listing and the manufacturer's instructions.

6.19.2 Unlisted Units: Unlisted open top broiler units shall be installed in accordance with the manufacturer's instructions, but shall not be installed in combustible material.

6.19.3 Protection Above Domestic Units: Domestic open top broiler units shall be provided with a metal ventilating hood not less than 0.0122 inch thick* with a clearance of not less than ¼ inch between the hood and the underside of combustible material or metal cabinets. A clearance of at least 24 inches shall be maintained between the cooking top and the combustible material or metal cabinet, and the hood shall be at least as wide as the open top broiler unit and centered over the unit. Listed domestic open top broiler units incorporating an integral exhaust system and listed for use without a ventilating hood need not be provided with a ventilating hood if installed in accordance with 6.14.1-b(1).

6.19.4 Commercial Units: Commercial open top broiler units shall be provided with ventilation in accordance with the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, ANSI/NFPA 96.

6.20 Outdoor Cooking Appliances.

6.20.1 Listed Units: Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer's instructions.

6.20.2 Unlisted Units: Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches at the sides and back and not less than 48 inches at the front. In no case shall the appliance be located under overhead combustible construction.

6.21 Pool Heaters.

6.21.1 Location: A pool heater shall be located or protected so as to minimize accidental contact of hot surfaces by persons.

*This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

*For details of protection, refer to Appendix E of the National Building Code (1976).

6.21.2 Clearance:

a. In no case shall the clearances be such as to interfere with combustion air, draft hood or vent terminal clearance and relief, and accessibility for servicing.

b. A listed pool heater shall be installed in accordance with its listing and the manufacturer's instructions.

c. An unlisted pool heater shall be installed with a minimum clearance of 12 inches on all sides and the rear. A combustible floor under an unlisted pool heater shall be protected in an approved manner.*

6.21.3 Temperature or Pressure Limiting Devices:

a. An unlisted pool heater shall be provided with overtemperature protection or overtemperature and overpressure protection by means of an approved device(s).

b. When a pool heater is provided with overtemperature protection only, and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valving, flow nozzles, etc.), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device.

6.21.4 Bypass Valves: If an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater.

6.21.5 Venting: A pool heater listed for outdoor installation shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer's instructions. (See 7.7 and 7.14.)

6.22 Refrigerators.

6.22.1 Clearance: Refrigerators shall be provided with adequate clearances for ventilation at the top and back. They shall be installed in accordance with the manufacturer's instructions. If such instructions are not available, at least 2 inches shall be provided between the back of the refrigerator and the wall and at least 12 inches above the top.

6.22.2 Venting or Ventilating Kits Approved for Use with a Refrigerator: If an accessory kit is used for conveying air for

burner combustion or unit cooling to the refrigerator from areas outside the room in which it is located, or for conveying combustion products diluted with air containing waste heat from the refrigerator to areas outside the room in which it is located, the kit shall be installed in accordance with the refrigerator manufacturer's instructions.

6.23 **Room Heaters.**

6.23.1 **Installations in Sleeping Quarters or Bathrooms:** Unvented room heaters shall not be installed in sleeping quarters or bathrooms.*

6.23.2 **Installations in Institutions:** Room heaters shall not be installed in institutions such as homes for the aged, sanitariums, convalescent homes, orphanages, etc.

6.23.3 **Clearance:** A room heater shall be placed so as not to cause a hazard to walls, floors, curtains, furniture, doors when open, etc., and to the free movements of persons within the room. Heaters designed and marked "For use in noncombustible fireplace only," shall not be installed elsewhere. Listed room heaters shall be installed in accordance with their listings and the manufacturer's instructions. In no case shall the clearances be such as to interfere with combustion air and accessibility. (See 5.2.1 and 5.3.)

Unlisted room heaters shall be installed with clearances from combustible material not less than the following:

a. Circulating Type: Room heaters having an outer jacket surrounding the combustion chamber, arranged with openings at top and bottom so that air circulates between the inner and outer jacket, and without openings in the outer jacket to permit direct radiation, shall have clearance at sides and rear of not less than 12 inches.

b. Radiating Type: Room heaters other than those described above as of circulating type shall have clearance at sides and rear of not less than 18 inches; except that heaters which make use of metal, asbestos or ceramic material to direct radiation to the front of the heater shall have a clearance of 36 inches in front, and if constructed with a double back of metal or ceramic may be installed with a clearance of 18 inches at sides and 12

*It is recommended that space heating appliances installed in all sleeping quarters or rooms generally kept closed be of the direct vent type (see 6.28).

inches at rear. Combustible floors under unlisted room heaters shall be protected in an approved manner.†

6.23.4 **Wall-Type Room Heaters:** Wall-type room heaters shall not be installed in or attached to walls of combustible material unless listed for such installation.

6.24 **Sauna Heaters.**

6.24.1 **Location and Protection:**

a. A sauna heater shall be so located as to minimize the possibility of accidental contact by a person in the room.

b. A sauna heater shall be protected from accidental contact by a guard or barrier of material having a low coefficient of thermal conductivity. Wood is satisfactory for this application. The guard shall have no substantial effect on the transfer of heat from the heater to the room.

6.24.2 **Installation of Heater:**

a. A listed sauna heater shall be installed in accordance with its listing and the manufacturer's instructions.

b. An unlisted sauna heater shall be installed in accordance with the following:

1. The heater shall be installed on noncombustible flooring or on flooring which has been equivalently protected in an approved manner.*

2. The heater shall be installed in compliance with the manufacturer's instructions except that clearances to the sides, back and top of the heater shall be not less than 36 inches.

c. An unlisted sauna heater shall not be installed in or attached to combustible material.

d. A direct vent sauna heater shall be installed with the vent/air intake terminal in the outside atmosphere. The thickness of the wall on which the heater is mounted shall be within the range of wall thicknesses marked on the heater and covered in the manufacturer's installation instructions.

†For details of protection, refer to Appendix E of the National Building Code (1976).

e. Panels, grilles and access doors which must be removed for normal servicing operations, shall not be attached to the building.

f. A sauna heater of other than the direct vent type shall be installed generally in accordance with Figure 7. If the combustion air inlet and the draft hood are in a dressing room adjacent to the sauna room, there shall be provisions to physically prevent blocking the combustion air inlet and the draft hood inlet, and to prevent physical contact with the draft hood and vent assembly, or warning notices shall be posted to avoid such contact. Any warning notice shall be easily readable, shall contrast with its background, and the wording shall be in letters not less than ¼ inch high.

6.24.3 **Connection:** The provisions of 5.5, Equipment Connections to Building Piping, shall be observed except that when access to controls is from an adjacent room, connections shall be made in that area.

6.24.4 **Combustion and Ventilation Air:**

a. Combustion air shall not be taken from inside the sauna room.

b. Adequate combustion and ventilation air for a heater not of the direct vent type shall be provided to the area in which the combustion air inlet and draft hood are located by suitable means (see 5.3).

6.24.5 **Means for Heat or Exposure Limitation:**

a. A sauna heater shall be equipped with a thermostat which will limit room temperature to 194 F. If the thermostat is not an integral part of the heater, the heat sensing element shall be located within 6 inches of the ceiling. If the heat sensing element is a capillary tube and bulb, the assembly shall be attached to the wall or other support, and shall be protected against physical damage.

b. A timer, if provided to control main burner operation, shall have a maximum operating time of 1 hour. The control for the timer shall be located outside the sauna room.

6.24.6 **Provisions for Sauna Room Equipped with a Gas-Fired Sauna Heater:**

a. A ventilation opening into the sauna room shall be provided. This shall be not less than a 4-inch by 8-inch opening near the top of the door into the sauna room.

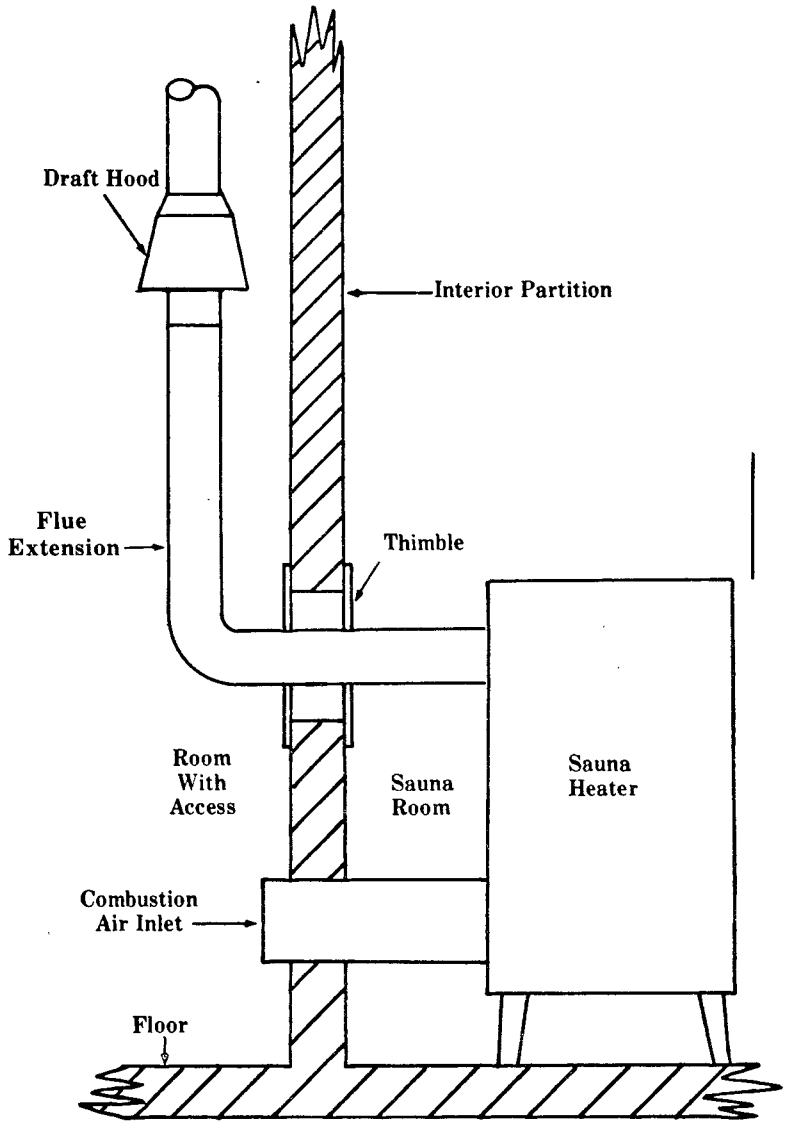


Fig. 7. Typical Sauna Heater Installation.

b. The following notice on permanent marking material shall be mechanically attached to the sauna room on the outside:

"Warning: Do not exceed 30 minutes in sauna. Excessive exposure can be harmful to health. Any person with poor health should consult a physician before using sauna."

This marking shall contrast with its background and the wording shall be in letters not less than ¼ inch high.

6.25 Stationary Gas Engines.

The installation of gas engines shall conform with the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, ANSI/NFPA 37.

6.26 Gas-Fired Toilets.

6.26.1 Clearance: A listed gas-fired toilet shall be installed in accordance with its listing and the manufacturer's instructions, provided that the clearance shall in any case be sufficient to afford ready accessibility for use, cleanout and necessary servicing.

6.26.2 Mounting: Listed gas-fired toilets specifically listed for installation on combustible floors may be so installed.

6.26.3 Installation: Vents or vent connectors which are located so they could be contacted during casual use of the room in which the toilet is installed shall be protected or shielded to prevent such contact.

6.27 Unit Heaters.

6.27.1 Support: Suspended type unit heaters shall be safely and adequately supported with due consideration given to their weight and vibration characteristics. Hangers and brackets shall be of noncombustible material.

6.27.2 Clearance:

a. **Suspended Type Unit Heaters:**

1. A listed unit heater shall be installed with clearances from combustible material of not less than 18 inches at the sides, 12 inches at the bottom and 6 inches above the top when the unit heater has an internal draft hood, or 1 inch above the top of the sloping side of a vertical draft hood.

2. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer's instructions.
3. Unlisted unit heaters shall be installed with clearances to combustible material of not less than 18 inches.
4. Clearances for servicing shall be in accordance with the manufacturer's recommendations contained in the installation instructions.

b. **Floor-Mounted Type Unit Heaters:**
1. A listed unit heater shall be installed with clearances from combustible material at the back and one side only of not less than 6 inches. When the flue gases are vented horizontally, the 6 inch clearance shall be measured from the draft hood or vent instead of the rear wall of the unit heater.
2. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer's instructions.
3. Floor-mounted type unit heaters may be installed on combustible floors if listed for such installation.
4. Combustible floors under unlisted floor-mounted unit heaters shall be protected in an approved manner.*
5. Clearances for servicing shall be in accordance with the manufacturer's recommendations contained in the installation instructions.

6.27.3 **Combustion and Circulating Air:** Adequate combustion and circulating air shall be provided (see 5.3).

6.27.4 **Ductwork:** A unit heater shall not be attached to a warm air duct system unless listed and marked for such installation.

6.27.5 **Installation in Commercial Garages and Aircraft Hangars:** Unit heaters installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.28 **Wall Furnaces.**

6.28.1 **Installation:**

a. A listed wall furnace shall be installed in accordance with its listing and the manufacturer's instructions. They may be installed in or attached to combustible material.

*For details of protection, refer to Appendix E of the National Building Code (1976).

b. Unlisted wall furnaces shall not be installed in or attached to combustible material.

c. Vented wall furnaces connected to a Type B-W gas vent system listed only for single story shall be installed only in single story buildings or the top story of multistory buildings. Vented wall furnaces connected to a Type B-W gas vent system listed for installation in multistory buildings may be installed in single story or multistory buildings. Type B-W gas vents shall be attached directly to a solid header plate which serves as a fire stop at that point and which may be an integral part of the vented wall furnace. The stud space in which the vented wall furnace is installed shall be ventilated at the first ceiling level by installation of the ceiling plate spacers furnished with the gas vent. Fire stop spacers shall be installed at each subsequent ceiling or floor level penetrated by the vent. (See Figure 8 for Type B-W gas vent installation.)

d. Direct vent wall furnaces shall be installed with the vent/air intake terminal in the outside atmosphere. The thickness of the walls on which the furnace is mounted shall be within the range of wall thickness marked on the furnace and covered in the manufacturer's installation instructions.

e. Panels, grilles and access doors which must be removed for normal servicing operations shall not be attached to the building.

6.28.2 **Location:** Wall furnaces shall be located so as not to cause a hazard to walls, floors, curtains, furniture or doors. Wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.

6.28.3 **Combustion and Circulating Air:** Adequate combustion and circulating air shall be provided (see 5.3).

6.29 **Water Heaters.**

6.29.1 **Prohibited Installations:** Water heaters, with the exception of those having direct-vent systems, shall not be installed in bathrooms, bedrooms or any occupied rooms normally kept closed.

Single-faucet automatic instantaneous water heaters, as permitted under 7.1.2 in addition to the above, shall not be installed in kitchen sections of light housekeeping rooms or rooms used by transients.

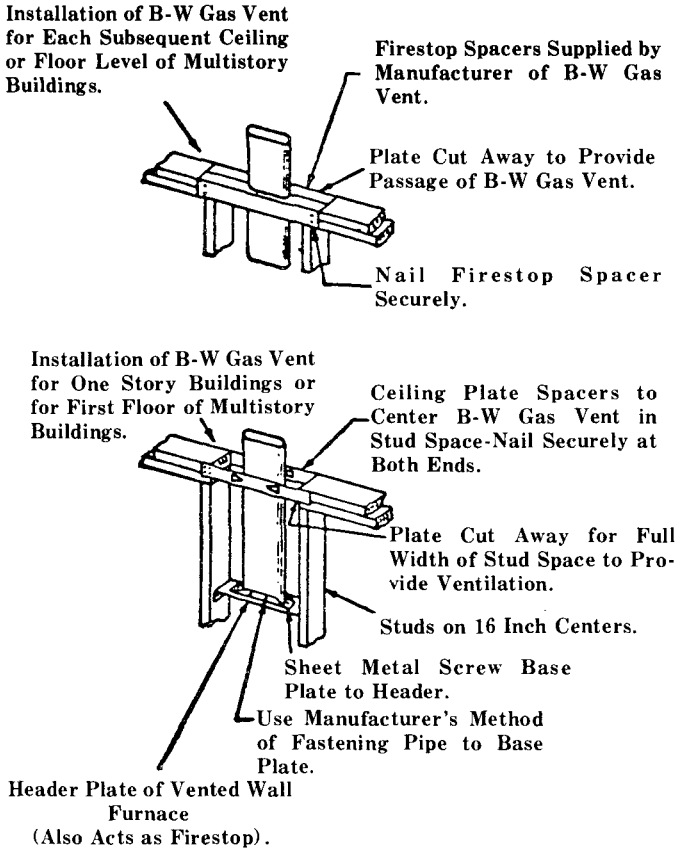


Fig. 8. Installation of Type B-W Gas Vents for Vented Wall Furnaces.

6.29.2 Location: Water heaters of other than the direct vent type shall be located as close as practicable to the chimney or gas vent.

6.29.3 Clearance:

a. In no case shall the clearances be such as to interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. Listed water heaters shall be installed in accordance with their listing and the manufacturer's instructions.

b. Unlisted water heaters shall be installed with a clearance of 12 inches on all sides and rear. Combustible floors under unlisted water heaters shall be protected in an approved manner.*

6.29.4 **Connections:** Water heaters shall be connected in a manner to permit observation, maintenance and servicing.

6.29.5 **Pressure Limiting Devices:** A water heater installation shall be provided with overpressure protection by means of an approved device constructed, listed and installed in accordance with nationally recognized standards for such devices.

6.29.6 **Temperature Limiting Devices:** An automatic storage-type water heater installation or a hot water storage vessel installation shall be provided with overtemperature protection by means of an approved device constructed, listed and installed in accordance with nationally recognized standards for such devices.

6.29.7 **Temperature, Pressure and Vacuum Relief Devices:** The installation of temperature, pressure and vacuum relief devices or combinations thereof, and automatic gas shutoff devices shall be in accordance with nationally recognized standards for such devices.

6.29.8 **Automatic Instantaneous Type:**

Cold Water Supply: The water supply to any automatic instantaneous water heater shall be such as to provide sufficient pressure to properly operate the water actuated control valve when drawing hot water from a faucet on the top floor.

6.29.9 **Circulating or Tank Types:**

a. **Connection to Boiler or Tank:** The method of connecting the circulating water heater to the tank shall provide proper circulation of water through the heater and permit a safe and useful temperature of water to be drawn from the tank. (See Figure 9.)

b. **Size of Water Circulating Piping:** The size of the water circulating piping, in general, shall conform with the size of the water connections of the heater.

c. **Sediment Drain:** A suitable water valve or cock, through which sediment may be drawn off or the tank emptied, shall be installed at the bottom of the tank.

d. **Anti-Siphoning Devices:** Means acceptable to the authority having jurisdiction shall be provided to prevent siphoning in any boiler or tank to which any circulating water heater is attached. A cold water tube with a hole near the top is commonly accepted for this purpose. (See Figure 9.)

*For details of protection, refer to Appendix E of the National Building Code (1976).

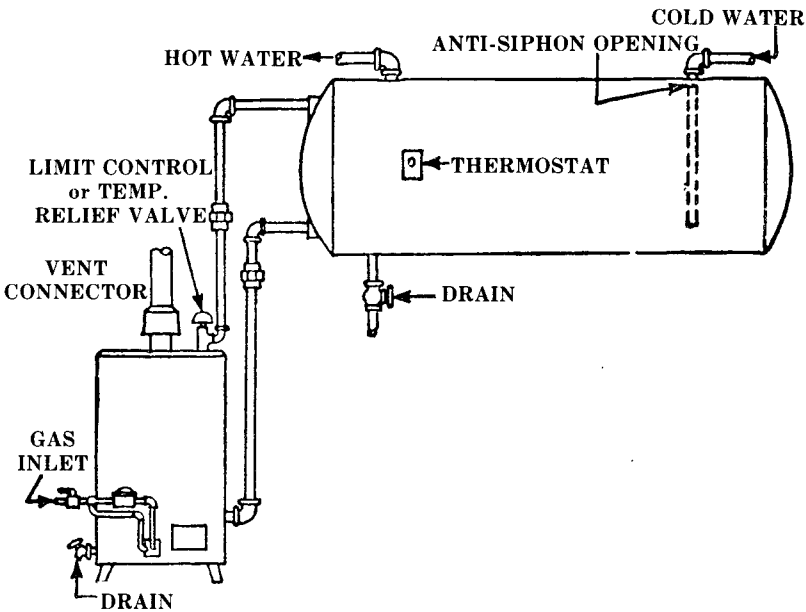


Fig. 9. Suggested Location for Anti-Siphon Opening in Cold Water Inlet.

PART 7

VENTING OF EQUIPMENT

7.1 Specification for Venting.

7.1.1 Connection to Venting Systems: Except as noted in 7.1.2, 7.1.3 and 7.1.4, all gas utilization equipment shall be connected to venting systems.

7.1.2 **Equipment Not Required to be Vented:**

a. Listed ranges.

b. Built-in domestic cooking units listed and marked for optional venting.

c. Listed hot plates and listed laundry stoves.

d. Listed Type 1 clothes dryers (see 6.4.4).

e.* A single listed booster type (automatic instantaneous) water heater when designed and used solely for the sanitizing rinse requirements of a National Sanitation Foundation Class 1, 2 or 3 dishwashing machine, provided that the input is limited to 50,000 Btu per hour, the storage capacity is limited to 12.5 gallons, and the heater is installed, with the draft hood in place and unaltered, in a commercial kitchen having a mechanical exhaust system. When installed in this manner, the draft hood outlet shall not be less than 36 inches vertically and 6 inches horizontally from any surface other than the heater.

f.* Listed refrigerators.

g.* Counter appliances.

h.* Room heaters listed for unvented use (see 6.23.1 and 6.23.2).

i.* Direct gas-fired make-up air heaters.

j.* Other equipment listed for unvented use and not provided with flue collars.

k.* Specialized equipment of limited input such as laboratory burners or gas lights.

*Information on the construction and installation of ventilating hoods may be obtained from the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, ANSI/NFPA 96.

*When any or all of this equipment is installed so the aggregate input rating exceeds 20 Btu per hour per cubic foot of room or space in which it is installed, one or more shall be provided with venting systems or other approved means for removing the vent gases to the outside atmosphere so the aggregate input rating of the remaining unvented equipment does not exceed the 20 Btu per hour per cubic foot figure. When the room or space in which the equipment is installed is directly connected to another room or space by a doorway, archway or other opening of comparable size which cannot be closed, the volume of such adjacent room or space may be included in the calculations.

7.1.3 **Ventilating Hoods:** Ventilating hoods and exhaust systems may be used to vent gas utilization equipment installed in commercial applications* and to vent industrial equipment, particularly when the process itself requires fume disposal (see 7.14.4).

7.1.4 **Well-Ventilated Spaces:** When located in a large and well-ventilated space, industrial gas utilization equipment may be operated by discharging the flue gases directly into the space.

7.2 **Minimum Safe Performance.**

7.2.1 **Adequate Draft:**

a. A venting system shall be designed and constructed so as to develop a positive flow adequate to remove flue or vent gases to the outside atmosphere.

b. A venting system serving gas utilization equipment requiring draft for proper operation shall be designed and installed to develop adequate draft so as to satisfy the draft requirements of the equipment in accordance with the manufacturer's instructions.

7.2.2 **Design and Construction:** Gas utilization equipment required to be vented shall be connected to a venting system designed and constructed in accordance with the provisions of 7.3 through 7.14.

7.2.3 **Circulating Air Ducts and Plenums:** No portion of a venting system shall extend into or pass through any circulating air duct or plenum.

7.3 **Type of Venting System to be Used.**

Venting systems are intended for venting flue gases at zero or negative pressures unless the venting system is made so as to prevent the leakage of vent gases into a building. (See 7.14.3-b.)

7.3.1 **Chimneys:** Chimneys shall be used for venting the following types of gas utilization equipment:

a. Incinerators, except as provided in 7.3.4-b and 7.14.2.

b. Equipment which may be converted to the use of solid or liquid fuels.

c. Combination gas- and oil-burning equipment.

d. Combination gas- and solid fuel-burning equipment.

e. Equipment listed for use with chimneys only.

f. Unlisted equipment.

7.3.2 **Type B Gas Vents:** Listed gas utilization equipment equipped with draft hoods and other equipment listed for use with Type B gas vents may be connected to Type B vents, except (1) as provided in 7.3.1, 7.3.3 and 7.3.7, and (2) commercial cooking equipment listed as "not suitable for connection to Type B gas vent."

7.3.3 **Type B-W Gas Vents:** Type B-W gas vents shall be used with listed vented wall furnaces when the furnace is so listed. Also see 6.28.

7.3.4 **Single Wall Metal Pipe:** Single-wall metal pipe may be used in accordance with 7.6 for venting the following:

a. Residential-type and low-heat gas utilization equipment equipped with draft hoods, except as provided in 7.3.1 and 7.3.3.

b. Incinerators used outdoors such as in open sheds, breezeways, or carports as provided in 7.6.3-c.

c. Gas-fired toilets. (See 6.26.3.)

7.3.5 **Type L Vents:** Type L vents may be used for venting gas utilization equipment listed for use with Type L vents and equipment listed as suitable for use with Type B gas vents.

7.3.6 **Plastic Piping:** Approved plastic piping may be used for venting equipment listed for use with such venting materials.

7.3.7 **Special Venting Arrangements:**

a. Direct vent equipment. (See 7.14.1.)

b. Equipment with integral vent. (See 7.14.2.)

c. Mechanical draft systems. (See 7.14.3.)

d. Ventilating hoods and exhaust systems. (See 7.14.4.)

e. Decorative appliances in vented fireplaces. (See 6.8.1-b.)

7.4 Masonry, Metal and Factory-Built Chimneys.

7.4.1 Listing or Construction:

a. Factory-built chimneys shall be installed in accordance with their listing and the manufacturer's instructions.

b. Masonry or metal chimneys shall be built and installed in accordance with nationally recognized building codes or standards.*

7.4.2 Termination:

a. A chimney for residential-type or low-heat gas utilization equipment shall extend at least 3 feet above the highest point where it passes through a roof of a building and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet. (See Figure 10.)

b. A chimney for medium-heat equipment shall extend at least 10 feet higher than any portion of any building within 25 feet.

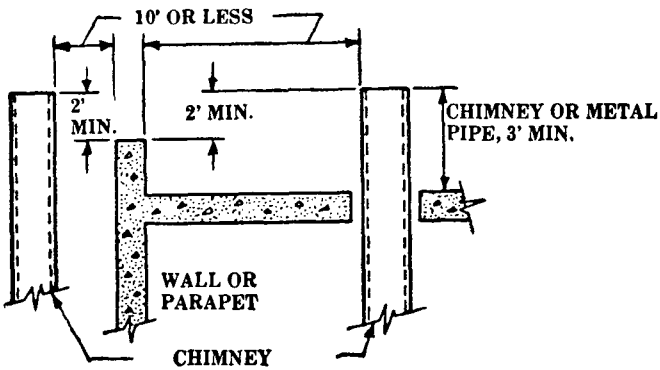
c. A chimney shall extend at least 5 feet above the highest connected equipment draft hood outlet or flue collar.

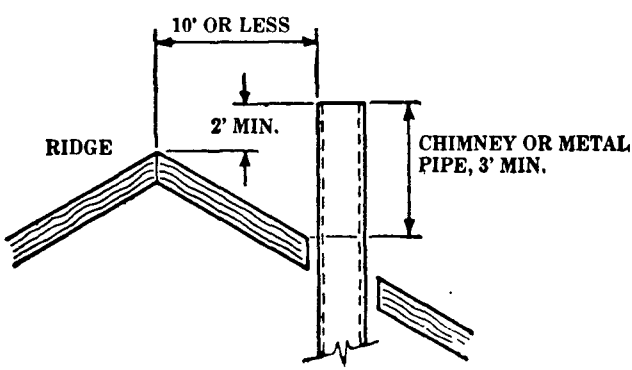
7.4.3 Size of Chimneys:

a. The effective area of a chimney venting system shall be in accordance with approved engineering methods. The sizing of a chimney for natural draft venting of one or more listed appliances equipped with a draft hood or appliances listed for use with Type B vent, installed in a single story of a building, may be in accordance with Tables G-3 and G-6 of Appendix G. As an alternate method of sizing an individual chimney venting system for a single appliance only, the effective areas of the vent connector and chimney flue shall be not less than the area of the appliance draft hood or flue outlet. As an alternate method for sizing a chimney connected to more than one appliance, the effective area of the chimney flue shall be not less than the area of the largest vent connector plus 50 percent of the area of additional draft hood or flue outlets.

*Among such nationally recognized codes and standards are Article X of the National Building Code, or the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.

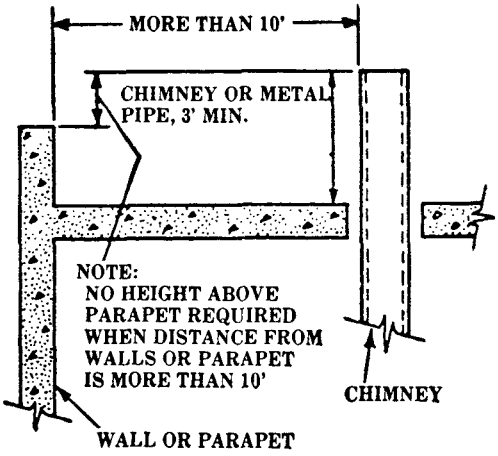
Fig. 10. Typical Termination Locations for Chimneys and Metal Pipes Serving Residential-Type and Low-Heat Equipment

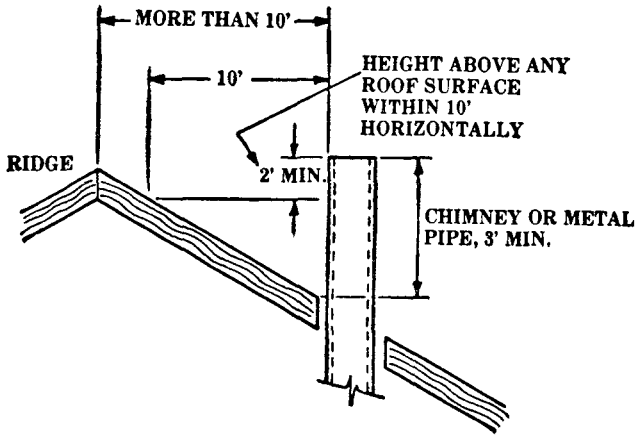




A. Termination 10 Feet or Less From Ridge, Wall or Parapet

Fig. 10 (Continued)





B. Termination More Than 10 Feet From Ridge, Wall or Parapet

b. When an incinerator is vented by a chimney serving other gas utilization equipment, the gas input to the incinerator need not be included in calculating chimney size provided the chimney flue diameter is not less than one inch larger in equivalent diameter than the diameter of the incinerator flue outlet.

7.4.4 **Inspection of Chimneys:**

a. Before connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is clear and free of obstructions.

b. Cleanouts shall be examined to determine they will remain tightly closed when not in use.

c. When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt to conform to nationally recognized standards,* lined or relined with a suitable liner, or replaced with a vent or chimney suitable for the equipment to be attached.

7.4.5 **Chimney Serving Equipment Burning Other Fuels:** See 7.9.4.

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

7.5 Type B, Type B-W and Type L Vents.

7.5.1 **Application:**

a. Type B, Type B-W and Type L vents shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

b. A Type B-W vent shall have a listed capacity not less than that of the listed vented wall furnace to which it is connected.

c. A vent passing through a roof shall extend through the roof flashing, roof jack or roof thimble.

7.5.2 **Vent Termination:**

a. A vent shall terminate above the roof surface with a listed cap or listed roof assembly in accordance with the terms of their respective listings and the manufacturer's instructions, except as provided in 7.14.

*Among such nationally recognized codes and standards are Article X of the National Building Code, or the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.

b. A vent may be connected to a chimney terminating in accordance with 7.4.2.

c. A Type B or a Type L vent shall terminate at least 5 feet in vertical height above the highest connected equipment draft hood or flue collar.

d. A Type B-W vent shall terminate at least 12 feet in vertical height above the bottom of the wall furnace.

e. A vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in 7.14.1 and 7.14.3.

7.5.3 Size of Gas Vents: Venting systems shall be sized and constructed in accordance with approved engineering methods.* The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with Type B vent, installed in a single story of a building, may be in accorance with Tables G-1, G-2, G-4 and G-5 of Appendix G. As an alternate method for sizing an individual vent for a single appliance only, the effective area of the vent connector and vent shall be not less than the area of the appliance draft hood outlet. As an alternate method for sizing a vent connected to more than one appliance, the effective area of the vent shall be not less than the area of the largest vent connector plus 50 percent of the areas of additional draft hood outlets.

7.5.4 **Vents Serving Equipment on More than One Floor:** A single or common Type B or Type L vent is permissible in multistory installations to vent gas utilization equipment located on more than one floor level provided the venting system is designed and installed in accordance with approved engineering practices.

7.5.5 **Support of Vents:** Vents shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

7.5.6 **Marking:** In those localities where solid and liquid fuels are used extensively, vents shall be plainly and permanently identified by a label attached to the wall or ceiling at a point where the vent connector enters the vent. The label shall read:

"This gas vent is for appliances which burn gas. Do not connect to incinerators or solid or liquid fuel-burning appliances."

*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

The authority having jurisdiction shall determine whether its area constitutes such a locality.

7.6 Single-Wall Metal Pipe.

7.6.1 Construction: Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304† inch thick, or other approved noncombustible corrosion-resistant material.

7.6.2 Termination:

a. Single-wall metal pipe shall terminate at least 5 feet in vertical height above the highest connected equipment draft hood outlet or flue collar.

b. Single-wall metal pipe shall extend at least 2 feet above the highest point where it passes through a roof of a building and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet. (See Figure 10.)

c. An approved cap which does not obstruct the pipe outlet shall be attached to the terminus of a single-wall metal pipe.

7.6.3 Installation With Equipment Permitted by 7.3.4:

a. Single-wall metal pipe shall be used only for runs directly from the space in which the gas utilization equipment is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket or roof thimble.

b. Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall or concealed space, or through any floor. For the installation of a single-wall metal pipe through an exterior combustible wall, see 7.9.16-b.

c. Single-wall metal pipe used for venting an incinerator shall be exposed and readily examinable for its full length and suitable clearances maintained.

d. Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table IX. The clearance from single-wall metal pipe to combustible material may be reduced when the combustible material is protected as specified for vent connectors in Table VI.

†This corresponds to No. 20 Galvanized Sheet Gage number with all applicable minus tolerances included.

Table IX (See Note 1.)

Clearances for Connectors

Equipment	Minimum Distance from Combustible Material			
	Listed Type B Gas Vent Material	Listed Type L Vent Material	Single-Wall Metal Pipe	Factory-Built Chimney Sections
Listed equipment with draft hoods and equipment listed for use with Type B Gas Vents	as listed	as listed	6 inches	as listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 inches	6 inches	9 inches	as listed
Residential appliances listed for use with Type L vents	not permitted	as listed	9 inches	as listed
Residential incinerators	not permitted	9 inches	18 inches	as listed
Listed gas-fired toilets	not permitted	as listed	as listed	as listed
Unlisted residential appliances with draft hood	not permitted	6 inches	9 inches	as listed
Residential and low-heat equipment other than those above	not permitted	9 inches	18 inches	as listed
Medium-heat equipment	not permitted	not permitted	36 inches	as listed

1. These clearances shall apply unless the listing of an appliance specifies different clearances, in which case the listed clearances shall apply.

e. When a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend at least 18 inches above and 6 inches below the roof with the annular space open at the bottom and closed only at the top. The thimble shall be sized in accordance with 7.9.16-b.

7.6.4 Size of Single-Wall Metal Pipe:

a. A venting system of single-wall metal pipe shall be sized and constructed in accordance with approved engineering methods.* As an alternate method for sizing a venting system for a single appliance only, the effective area of the connector and the pipe shall not be less than the area of the appliance draft hood outlet. As an alternate method for sizing a venting system connected to more than one appliance, the effective area of the pipe shall be not less than the area of the largest connector plus 50 percent of the area of additional draft hood outlets. The sizing of single-wall metal pipe for natural draft venting of one or more listed appliances equipped with draft hoods or appliances listed for use with Type B vents, installed in a single room, may be in accordance with Tables G-2 and G-5 of Appendix G.

b. Any shaped single-wall metal pipe may be used, provided its equivalent effective area is equal to the effective area of the round pipe for which it is substituted and provided the minimum internal dimension of the pipe is not less than 2 inches.

c. The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached.

7.6.5 Support of Single-Wall Metal Pipe: All portions of single-wall metal pipe shall be supported for the design and weight of the material employed.

7.6.6 Marking: Single-wall metal pipe shall comply with the marking provisions of 7.5.6.

7.7 Venting System Location.

a. A venting system shall terminate at least 3 feet above any forced air inlet located within 10 feet.

*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

b. The venting system of other than a direct vent appliance shall terminate at least 4 feet below, 4 feet horizontally from or 1 foot above any door, window or gravity air inlet into any building.

c. The vent terminal of a direct vent appliance with an input of 50,000 Btu per hour or less shall be located at least 9 inches from any opening through which flue gases could enter a building, and such an appliance with an input over 50,000 Btu per hour shall require a 12-inch vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least 12 inches above grade.

7.8 Outside Vents and Chimneys.

7.8.1 Materials: Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment with draft hoods.

7.8.2 Condensate Drain: When local experience indicates that condensate may be a problem, provision shall be made to drain off the condensate.

7.9 Vent Connectors.

7.9.1 When Required: A vent connector shall be used to connect gas utilization equipment to a gas vent, chimney or single-wall metal pipe, except when the gas vent, chimney or single-wall metal pipe is directly connected to the equipment.

7.9.2 Materials:

a. A vent connector shall be made of noncombustible corrosion-resistant material capable of withstanding the vent gas temperature produced by the gas utilization equipment and of sufficient thickness to withstand physical damage.

b. Vent connectors for residential-type appliances shall comply with the following:

1. Appliances Installed in Attics: Vent connectors for listed gas appliances having draft hoods and appliances listed for use with Type B vents, which are installed in attics, shall be of Type B or Type L vent material.

2. Appliances Not Installed in Attics: Vent connectors for listed gas appliances having draft hoods and for appliances having draft hoods and equipped with listed conversion burners, which are not installed in attics, shall be of Type B

or Type L vent material or metal pipe having resistance to heat and corrosion not less than that of galvanized sheet steel or aluminum not less than 0.016* inch thick.

Vent connectors for combination gas- and oil-burning appliances, residential incinerators and appliances other than those noted in "1" above, and which are not installed in attics, shall be of Type L vent material, factory-built chimney section or steel pipe having resistance to heat and corrosion not less than that of galvanized steel specified in Table X.

c. A vent connector for low-heat equipment shall be a factory-built chimney section or steel pipe having resistance to heat and corrosion equivalent to that for the appropriate galvanized pipe as specified in Table X. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturer's instructions.

Table X

Minimum Thickness for Galvanized Steel Vent Connectors for Low-Heat Appliances

Diameter of Connector, Inches	Minimum Thickness, Inch*
less than 6	0.019 (26)
6 to less than 10	0.023 (24)
10 to 12 inclusive	0.029 (22)
14 to 16 inclusive	0.034 (20)
over 16	0.056 (16)

*The figures in parentheses are the corresponding Galvanized Sheet Gage number with all applicable minus tolerances included.

d. Vent connectors for medium-heat equipment and commercial and industrial incinerators shall be constructed of factory-built medium-heat chimney sections or steel of a thickness not less than specified in Table XI, and shall comply with the following:

*This corresponds to No. 28 Galvanized Sheet Gage number with all applicable minus tolerances included.

1. A steel vent connector for equipment with a vent gas temperature in excess of 1000 F, measured at the entrance to the connector, shall be lined with medium duty fire brick (ASTM C64, Type F), or the equivalent.
2. The lining shall be at least 2½ inches thick for a vent connector having a diameter or greatest cross-section dimension of 18 inches or less.
3. The lining shall be at least 4½ inches thick laid on the 4½-inch bed for a vent connector having a diameter or greatest cross-section dimesion greater than 18 inches.
4. Factory-built chimney sections, if employed, shall be joined together in accordance with the chimney manufacturer's instructions.

7.9.3 Size of Vent Connector:

a. A vent connector for gas utilization equipment with a single draft hood shall be sized and constructed in accordance with approved engineering practices. Reference may be made to Tables G-1 through G-3 in Appendix G, depending on the construction of the connector.* As an alternate method the effective area of the connector shall be not less than the area of the draft hood outlet.

Table XI

Minimum Thickness for Steel Vent Connectors for Medium Heat Equipment and Commercial and Industrial Incinerators

Vent Connector Size		Minimum Thickness,
Diameter, In.	Area, Sq. In.	Inch*
up to 14	up to 154	0.053 (16)
over 14 to 16	154 to 201	0.067 (14)
over 16 to 18	201 to 254	0.093 (12)
over 18	Larger than 254	0.123 (10)

*The figures in parentheses are the corresponding Manufacturer's Standard Gage number with all applicable minus tolerances included.

*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

b. For a single appliance having more than one draft hood outlet, the manifold shall be constructed according to the instructions of the appliance manufacturer. If there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As a second alternate, the effective area of the manifold shall equal the combined areas of the draft hood outlets.

c. When two or more gas appliances are connected to a common vent or chimney, the effective area of each vent connector shall be in accordance with approved engineering practices. Reference may be made to Tables G-4 through G-6 in Appendix G.* As an alternate method, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected.

d. When two or more gas appliances are vented through a common vent connector or manifold, the common vent connector or manifold shall be located at the highest level consistent with available headroom or clearance to combustible material. The effective area of the common vent connector or manifold and all junction fittings shall be not less than the area of the largest vent connector plus 50 percent of the areas of additional draft hood outlets.

e. When the size of a vent connector is increased to overcome installation limitations and obtain connector capacity equal to the equipment input, the size increase shall be made at the equipment draft hood outlet.

f. The effective area of the vent connector, when connected to one or more appliances requiring draft for operation, shall be obtained by the application of approved engineering practices to perform as specified in 7.2.1.

7.9.4 **Two or More Appliances Connected to a Single Vent:**

a. Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

b. Gas utilization equipment and equipment burning liquid fuel may be connected to one chimney flue through separate openings or may be connected through a single opening if joined by a suitable fitting located as close as practical to the chimney. If two or more openings are provided into one chimney flue, they shall be at different levels. If the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device.

c. When two or more vent connectors enter a common gas vent, chimney flue or single-wall metal pipe, the smaller connector shall enter at the highest level consistent with the available headroom or clearance to combustible material.

7.9.5 **Combination Units:**

a. A listed combination gas- and solid fuel-burning appliance equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage may be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.*

b. A listed combination gas- and oil-burning appliance may be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.*

7.9.6 **Clearance:** Minimum clearances from vent connectors to combustible material shall be in accordance with Table IX, except that the clearance between a vent connector and combustible material may be reduced when the combustible material is protected as specified for vent connectors in Table VI.

7.9.7 **Avoid Unnecessary Bends:** A vent connector shall be installed so as to avoid turns or other construction features which create excessive resistance to flow of vent gases.

7.9.8 **Joints:** Vent connectors shall be firmly attached to draft hood outlets or flue collars by sheet-metal screws or other approved means, except vent connectors of listed Type B or Type L vent material which shall be assembled in accordance with the manufacturer's instructions. Joints between sections of connector piping shall be fastened by sheet-metal screws or other approved means.

7.9.9 **Slope:** A vent connector shall be installed without any dips or sags and shall slope upward at least ¼ inch per foot.

7.9.10 **Length of Vent Connector:**

a. A vent connector shall be as short as possible and the gas utilization equipment located as close as practicable to the chimney or vent.

b. Except when part of a designed venting system, the horizontal run of an uninsulated vent connector to a natural draft chimney or vent serving a single appliance shall not be more

*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

than 75 percent of the height of the vertical portion of the chimney or vent above the connector.

c. Except when part of a designed venting system, the horizontal run of an insulated vent connector to a natural draft chimney or vent serving a single gas or liquid fuel-fired appliance shall not be more than 100 percent of the height of the vertical portion of the chimney or vent above the connector.

7.9.11 **Support:** A vent connector shall be supported for the design and weight of the material employed to maintain clearances and prevent physical damage and separation of joints.

7.9.12 **Location:** When the vent connector used for gas utilization equipment having a draft hood must be located in or pass through a crawl space or other area which may be cold, that portion of the vent connector shall be of listed double-wall Type B or Type L vent material or material having equivalent insulation qualities.

7.9.13 **Chimney Connection:** In entering a passageway in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. A thimble or slip joint may be used to facilitate removal of the connector. The connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. Means shall be employed which will prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney.

7.9.14 **Inspection:** The entire length of a vent connector shall be readily accessible for inspection, cleaning and replacement.

7.9.15 **Fireplaces:** A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed.

7.9.16 **Passage Through Ceilings, Floors or Walls:**

a. A vent connector shall not pass through any ceiling, floor, fire wall or fire partition. A single-wall metal pipe connector shall not pass through any interior wall.

b. A vent connector made of a single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:

1. For listed gas utilization equipment equipped with draft hoods and equipment listed for use with Type B vents, 4 inches larger in diameter than the vent connector. When there is a run of not less than 6 feet of vent connector in the

open between the draft hood outlet and the thimble, the thimble may be 2 inches larger in diameter than the vent connector.

2. For unlisted equipment having draft hoods, 6 inches larger in diameter than the vent connector.

3. For residential incinerators and all other residential and low-heat equipment, 12 inches larger in diameter than the vent connector.

In lieu of thimble protection, all combustible material in the wall may be cut away from the vent connector a sufficient distance to provide the specified clearance from such vent connector to combustible material. Any material used to close up such opening shall be noncombustible.

c. Except as provided in "a" above, vent connectors made of listed Type B or Type L vent material and serving listed equipment with draft hoods and other equipment listed for Type B vents may pass through walls or partitions constructed of combustible material if the connectors are installed with not less than the listed clearance to combustible material.

d. Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material.

7.10 Draft Hoods and Draft Controls.

7.10.1 Equipment Requiring Draft Hoods: Vented gas utilization equipment shall be installed with draft hoods except dual oven type combination ranges, incinerators, direct vent equipment, equipment requiring chimney draft for operation, single firebox boilers equipped with conversion burners with inputs greater than 400,000 Btu per hour, equipment equipped with blast, power or pressure burners which are not listed for use with draft hoods, and equipment designed for forced venting.

7.10.2 Installation:

a. Except as noted in "b" below, a draft hood supplied with or forming a part of listed vented gas utilization equipment shall be installed without alteration, exactly as furnished and specified by the equipment manufacturer. If a draft hood is not supplied by the equipment manufacturer when one is required, a draft hood shall be installed, be of a listed or approved type and, in the absence of other instructions, be of the same size as the equipment flue collar. When a draft hood is required with a conversion burner, it shall be of a listed or approved type.

b. If it is determined that a draft hood of special design is needed or preferable for a particular installation, the advice of the gas utilization equipment manufacturer and the approval of the authority having jurisdiction shall be secured.

7.10.3 **Draft Control Devices:** When a draft control device is part of the gas utilization equipment or is supplied by the equipment manufacturer, it shall be installed without alteration in accordance with the manufacturer's instructions. In the absence of manufacturer's instructions, the device shall be attached to the flue collar of the equipment or as near to the equipment as conditions permit.

7.10.4 **Additional Devices:** Gas utilization equipment (except incinerators) requiring controlled chimney draft may be equipped with a listed double acting barometric draft regulator installed and adjusted in accordance with the manufacturer's instructions. Figure 11 shows examples of correct and incorrect locations for barometric draft regulators. A device which will automatically shut off gas to the burner in the event of sustained backdraft is recommended if such backdraft might adversely affect burner operation or if flue gas spillage might introduce a hazard.

7.10.5 **Incinerator Draft Regulator:** A listed gas-fired incinerator may be equipped with a listed single acting barometric draft regulator when recommended by the incinerator manufacturer. This draft regulator shall be installed in accordance with the instructions accompanying the incinerator.

7.10.6 **Install In Same Room:** A draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

7.10.7 **Positioning:** A draft hood or draft regulator shall be installed in the position for which it was designed with reference to the horizontal and vertical planes and shall be located so that the relief opening is not obstructed by any part of the gas utilization equipment or adjacent construction. The equipment and its draft hood shall be located so that the relief opening is accessible for checking vent operation.

7.10.8 **Clearance:** A draft hood shall be located so its relief opening is not less than 6 inches from any surface except that of the gas utilization equipment it serves and the venting system to which the draft hood is connected. When a greater or lesser clearance is indicated on the equipment label, the clearance shall not be less than that specified on the label. These clearances shall not be reduced.

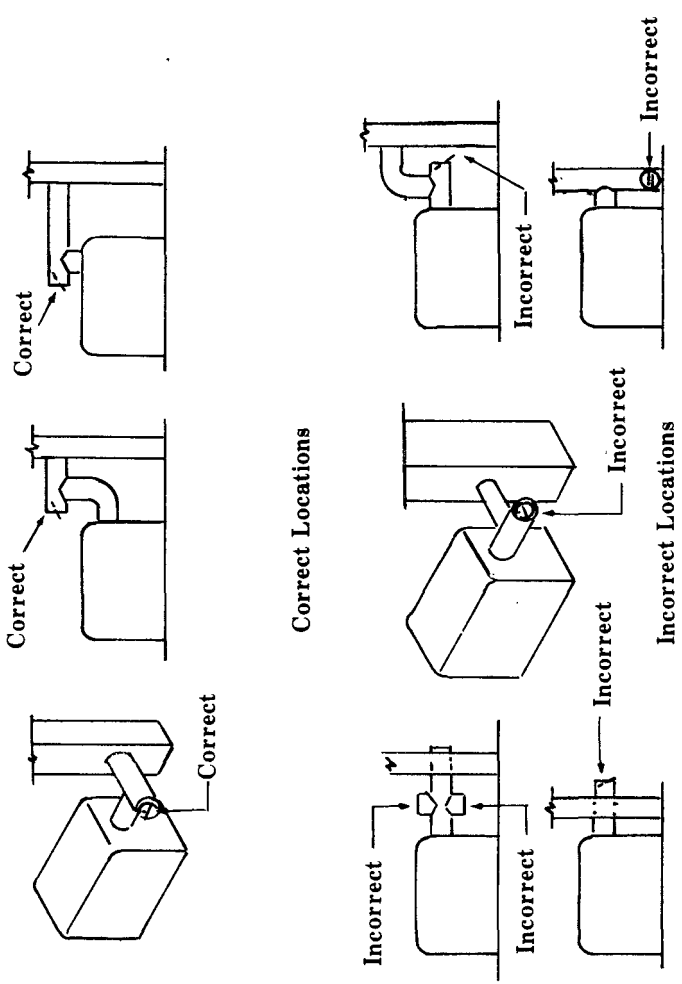


Fig. 11 Locations for Barometric Draft Regulator

7.11 Manually Operated Dampers.

A manually operated damper shall not be placed in the vent connector from any gas utilization equipment, except in a connector serving a listed gas-fired incinerator when recommended by the incinerator manufacturer and installed in accordance with the instructions accompanying the incinerator. Fixed baffles are not classified as manually operated dampers.

7.12 Automatically Operated Vent Dampers.

An automatically operated vent damper shall be of a listed type. Also see 9.3.

7.13 Obstructions.

Except as noted below, a device which will retard the flow of vent gases shall not be installed in a vent connector, chimney or vent.

a. Draft regulators and safety controls; (1) specifically listed for installation in venting systems and installed in accordance with the terms of their listing, and (2) designed and installed in accordance with approved engineering methods and approved by the authority having jurisdiction.

b. Listed automatically operated vent dampers installed in accordance with the terms of their listing.

c. Approved economizers, heat reclaimers and recuperators installed in venting systems of equipment not required to be equipped with draft hoods provided performance in accordance with 7.2.1 is obtained.

7.14 Special Venting Arrangements.

7.14.1 Direct Vent Equipment: Listed direct vent gas utilization equipment shall be considered properly vented when installed in accordance with the terms of its listing, the manufacturer's instructions and 7.7-c.

7.14.2 Equipment With Integral Vents: Gas utilization equipment incorporating integral venting means shall be considered properly vented when installed in accordance with its listing, the manufacturer's instructions and 7.7-a and -b.

7.14.3 Mechanical Draft Systems:

a. Gas utilization equipment, except incinerators, requiring venting may also be vented by means of mechanical draft systems of either forced or induced draft design.

b. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue or vent gases into a building.

c. Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.

d. When a mechanical draft system is employed, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the equipment for safe performance.

e. The exit terminals of mechanical draft systems shall be not less than 7 feet above grade when located adjacent to public walkways and shall be located as specified in 7.7-a and -b.

7.14.4 Ventilating Hoods and Exhaust Systems:*

a. Ventilating hoods and exhaust systems may be used to vent gas utilization equipment installed in commercial applications.

b. When automatically operated gas utilization equipment is vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, the gas utilization equipment control system shall be interlocked so as to permit the equipment firing only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation.

*Information on the construction and installation of ventilating hoods may be obtained from the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commerical Cooking Equipment, ANSI/NFPA 96.

PART 8

PROCEDURES TO BE FOLLOWED TO PLACE EQUIPMENT IN OPERATION

8.1 Adjusting the Burner Input.

8.1.1 **Burner Input:** Each burner shall be adjusted to its proper input in accordance with the manufacturer's instructions. Overheating of burners is prohibited.

8.1.2 **High Altitude:** Ratings of gas utilization equipment are based on sea level operation and need not be changed for operation at elevations up to 2,000 feet. For operation at elevations above 2,000 feet and, in the absence of specific recommendations from the local authority having jurisdiction, equipment ratings shall be reduced at the rate of 4 percent for each 1,000 feet above sea level before selecting appropriately sized equipment.

8.1.3 **Checking Burner Input:**

a. Checking Burner Input Using a Meter: To check the Btu input rate, the test hand on the meter should be timed for at least one revolution and the input determined from this timing. Test dials are generally marked ½, 1, 2 or 5 cubic feet per revolution depending upon the size of the meter. Instructions for converting the test hand readings to cubic feet per hour are given in Table XII.

b. Checking Burner Input Not Using a Meter: The fixed orifice size for each burner may be determined in accordance with Table F-1 for utility gases and Table F-2 for undiluted liquefied petroleum gases in Appendix F.

8.1.4 **Adjusting Input:** The input rate shall be adjusted to the proper rate by changing a fixed orifice size, changing the adjustment of an adjustable orifice, or by readjustment of the gas pressure regulator outlet pressure (when a regulator is provided). Consult the serving gas supplier.

8.2 Primary Air Adjustment.

The primary air for injection (Bunsen) type burners shall be adjusted for proper flame characteristics in accordance with the manufacturer's instructions. Normally, the primary air adjustment should first be set to give a soft blue flame having luminous tips and

then increased to a point where the yellow tips just disappear. If the burner cannot be adjusted as above, consult the manufacturer or serving gas supplier. After setting the primary air, the adjustment means shall be secured in position.

8.3 Safety Shutoff Devices.

When a safety shutoff device is provided, it shall be checked for proper operation and adjustment in accordance with the manufacturer's instructions. If the device does not function properly to turn off the gas supply in the event of pilot outage, it shall be properly serviced or replaced with new equipment.

8.4 Automatic Ignition.

Gas utilization equipment supplied with means for automatic ignition shall be checked for proper operation. If necessary, proper adjustments shall be made.

8.5 Protective Devices.

All protective devices furnished with the gas utilization equipment, such as a limit control, fan control to blower, temperature and pressure relief valve, low water cutoff device, manual operating features, etc., shall be checked for proper operation.

8.6 Checking the Draft.

Vent connected gas utilization equipment shall be operated for several minutes and checked to see that the combustion products are going up the chimney, or gas vent, properly by passing a lighted match or taper around the edge of the relief opening of the draft hood. If the chimney or gas vent is drawing properly, the match flame will be drawn into the draft hood. If not, the combustion products will tend to extinguish this flame. If the combustion products are escaping from the relief opening of the draft hood, the equipment shall not be operated until proper adjustments or repairs are made to provide adequate draft through the chimney or gas vent.

8.7 Operating Instructions.

Operating instructions shall be furnished and shall be left in a prominent position near the equipment for the use of the consumer.

TABLE XII

Gas Input to Burner in Cubic Feet Per Hour

Seconds For One Revolution	One-Half Cu. Ft.	Size of Test Meter Dial One Cu. Ft.	Two Cu. Ft.	Five Cu. Ft.
		Cubic Feet Per Hour		
10	180	360	720	1,800
11	164	327	655	1,636
12	150	300	600	1,500
13	138	277	555	1,385
14	129	257	514	1,286
15	120	240	480	1,200
16	112	225	450	1,125
17	106	212	424	1,059
18	100	200	400	1,000
19	95	189	379	947
20	90	180	360	900
21	86	171	343	857
22	82	164	327	818
23	78	157	313	783
24	75	150	300	750
25	72	144	288	720
26	69	138	277	692
27	67	133	267	667
28	64	129	257	643
29	62	124	248	621
30	60	120	240	600
31	58	116	232	581
32	56	113	225	563
33	55	109	218	545
34	53	106	212	529
35	51	103	206	514
36	50	100	200	500
37	49	97	195	486
38	47	95	189	474
39	46	92	185	462
40	45	90	180	450
41	44	88	176	440
42	43	86	172	430
43	42	84	167	420
44	41	82	164	410
45	40	80	160	400
46	39	78	157	391
47	38	77	153	383
48	37	75	150	375
49	37	73	147	367

NOTE: To convert to Btu per hour multiply by the Btu heating value of the gas used.

TABLE XII (Continued)

Gas Input to Burner in Cubic Feet Per Hour

Seconds For One Revolution	Size of Test Meter Dial: One-Half Cu. Ft.	One Cu. Ft.	Two Cu. Ft.	Five Cu. Ft.
	Cubic Feet Per Hour			
50	36	72	144	360
51	35	71	141	353
52	35	69	138	346
53	34	68	136	340
54	33	67	133	333
55	33	65	131	327
56	32	64	129	321
57	32	63	126	316
58	31	62	124	310
59	30	61	122	305
60	30	60	120	300
62	29	58	116	290
64	29	56	112	281
66	29	54	109	273
68	28	53	106	265
70	26	51	103	257
72	25	50	100	250
74	24	48	97	243
76	24	47	95	237
78	23	46	92	231
80	22	45	90	225
82	22	44	88	220
84	21	43	86	214
86	21	42	84	209
88	20	41	82	205
90	20	40	80	200
94	19	38	76	192
98	18	37	74	184
100	18	36	72	180
104	17	35	69	173
108	17	33	67	167
112	16	32	64	161
116	15	31	62	155
120	15	30	60	150
130	14	28	55	138
140	13	26	51	129
150	12	24	48	120
160	11	22	45	112
170	11	21	42	106
180	10	20	40	100

NOTE: To convert to Btu per hour multiply by the Btu heating value of the gas used.

8.8 **Notification of Completion.**

When regulations so require, the serving gas supplier or the authority having jurisdiction shall be notified that the installation has been completed.

PART 9

MODIFICATIONS TO EXISTING APPLIANCE INSTALLATIONS FOR THE PURPOSE OF FUEL CONSERVATION

9.1 Safety Inspection.

Prior to attempting any modification, a safety inspection of the existing appliance installation shall be performed by a qualified agency performing the modification. See Appendix H for a recommended procedure for such a safety inspection.

9.2 Reduction of Vent Connector Size.

If an existing vent connector is determined to be oversized for the input rate of the connected appliance, it may be resized in accordance with 7.9.3.

9.3 Automatic Vent Damper Device Installation.

A listed automatic vent damper device may be installed on an existing appliance installation provided the appliance is listed and equipped with a draft hood and provided the device is installed by a qualified agency (see 1.4) in accordance with the terms of its listing. The name of the installer and date of installation shall be marked on a label affixed to the damper device. For recommended procedures for installing automatic vent damper devices on existing appliance installations, see Appendices I, J and K.

PART 10

DEFINITIONS

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

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

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.

Air Mixer. That portion of an injection (Bunsen) type burner into which the primary air is introduced.

Air Shutter. An adjustable device for varying the size of the primary air inlet(s).

Ambient Temperature. The temperature of the surrounding medium, usually used to refer to the temperature of the air in which a structure is situated or a device operates.

Appliance (Equipment). Any device which utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.

Appliance — Automatically Controlled. Appliances equipped with an automatic burner ignition and safety shutoff device and other automatic devices which:

a. Accomplish complete turn-on and shutoff of the gas to the main burner or burners.

b. Graduate the gas supply to the burner or burners, but do not effect complete shutoff of the gas.

Appliance, Building Heating. Fuel-gas burning boilers operating at not over 50 psig pressure, central furnaces and heaters intended primarily for heating spaces having volumes exceeding 25,000 cubic feet.

Appliance, Low-Heat. An appliance such as a commercial cooking range, pressing machine boiler at any pressure, bake oven, candy furnace, sterotype furnace, drying and curing appliance, and other process appliances in which materials are heated or melted at temperatures (excluding flue-gas temperatures) not exceeding 600 F.

Appliance, Medium-Heat. An industrial appliance such as an annealing furnace (glass or metal), charcoal furnace, galvanizing furnace, gas producer, commercial or industrial incinerator, and steam boiler operating at over 50 psig pressure when such appliance is larger than 100 cubic feet in size, and other furnaces

classified as medium-heat appliances in accordance with nationally recognized good practice. Appliances otherwise classed as medium-heat appliances may be considered as low-heat appliances if not larger than 100 cubic feet in size, excluding any burner equipment and blower compartment.

Appliance, Residential-Type Heating. Fuel-gas burning heating appliances, except high-pressure steam boilers, for heating building spaces having a volume of not more than 25,000 cubic feet, and other heat producing appliances of the type mainly used in residences, such as cooking stoves and ranges, clothes dryers, fireplace stoves, domestic incinerators, laundry stoves, water heaters and heat pumps.

Approved. Acceptable to the authority having jurisdiction.

Atmospheric Pressure. The pressure of the weight of air and water vapor on the surface of the earth, approximately 14.7 pounds per square inch (psi) at sea level.

Authority Having Jurisdiction. The organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in this standard in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his delegated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Automatic Damper Regulator. A mechanically or electrically actuated device designed to maintain a constant draft on combustion equipment.

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.

Present units are customarily equipped with spring or weight loaded valves released for closure by a fusible link or by movement of bimetallic elements; they are also equipped with metallic screens for stopping the progress of a flame front.

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.

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

Backfire Preventer. (See Safety Blowout.)

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

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

Barometric Draft Regulator. A balanced damper device attached to a chimney, vent connector, breeching or flue gas manifold to protect combustion equipment by controlling chimney draft. A double acting barometric draft regulator is one whose balancing damper is free to move in either direction to protect combustion equipment from both excessive draft and backdraft.

Boiler, Low-Pressure. A self-contained gas-burning appliance for supplying steam or hot water.

a. Hot Water Heating Boiler. A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at water pressures not exceeding 160 psig and at water temperatures not exceeding 250 F at or near the boiler outlet.

b. Hot Water Supply Boiler. A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and which operates at water pressures not exceeding 160 psig and at water temperatures not exceeding 250 F at or near the boiler outlet.

c. Steam Heating Boiler. A boiler in which steam is generated and which operates at a steam pressure not exceeding 15 psig.

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

Breeching. See Vent Connector.

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

Btu. Abbreviation for British Thermal Unit which is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

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

a. Forced-Draft Burner. (See Power Burner.)

b. Induced-Draft Burner. A burner which depends on the draft induced by a fan beyond the appliance for its proper operation.

c. 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.

1. Atmospheric Injection Type Burner. A burner in which the air at atmospheric pressure is injected into the burner by a jet of gas.

d. Luminous or Yellow-Flame Burner. A burner in which secondary air only is depended on for combustion of the gas.

e. 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.

1. Premixing Burner. A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.

Carbon Steel. By common custom, steel is considered to be carbon steel when no minimum content is specified or required for aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 percent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

Central Premix System. A system which distributes flammable gas-air mixtures to two or more remote stations and is employed to provide one or more of the following:

a. Wide in-plant distribution of a centrally controlled gas-air mixture.

b. A wider range of mixture pressures (frequently in the 1 to 5 psig range) than available from other gas-air mixing equipment.

c. Close control of gas-air ratios over a wide turndown range (often 20 to 1 or more).

d. Ability to change total connected burner port area without installing new mixing devices or inserts.

Central premix systems may either proportion the flows of pressurized air and pressurized gas for subsequent mixing in a downstream tee or comparable fitting, or they may draw room air at essentially atmospheric pressure through a proportioning mixing valve and then through a blower or compressor downstream.

Chimney. (See also "Gas Vent," "Vent" and "Venting System.") One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere.

a. Factory-Built Chimney. A chimney composed of listed factory-built components assembled in accordance with the terms of their listing to form the completed chimney.

b. 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.

c. Metal Chimney. A field-constructed chimney of metal.

Clearing. The act of replacing one atmosphere with another by direct displacement so rapidly as to cause a minimum of mixing between the two atmospheres. By this means duration of any explosive mixture is reduced to a minimum, the gases are vented into a large open area high (8 feet or more) aboveground, and means of ignition are excluded.

Closed Water Piping System. A system of water piping where a check valve or other device prevents the free return of water or steam to the water main.

Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel gases. Dryer classifications are as follows:

a. Type 1. Factory-built package, multiple produced. Primarily used in family living environment. May or may not be coin-operated for public use. Usually the smallest unit physically and in function output.

b. Type 2. Factory-built package, multiple produced. 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. Not designed for use in individual family living environment. May be small, medium or large in relative size.

Combustible Material. As pertaining to materials adjacent to or in contact with heat producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts,

shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered.

Combustion. As used herein, the rapid oxidation of fuel gases accompanied by the production of heat, or heat and light. Complete combustion of a fuel is possible only in the presence of an adequate supply of oxygen.

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

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

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

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

Consumption. The maximum amount of gas per unit of time, usually expressed in cubic feet per hour, or Btu per hour, required for the operation of the appliance or appliances supplied.

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

Controls. Devices designed to regulate the gas, air, water or electrical supply to a gas appliance. These may be manual or automatic.

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

a. Firing Door Type. A conversion burner specifically for boiler or furnace firing door installation.

b. Inshot Type. A conversion burner normally for boiler or furnace ash pit installation and fired in a horizontal position.

c. Upshot Type. A conversion burner normally for boiler or furnace ash pit installation and fired in a vertical position at approximately grate level.

Counter Appliances, Gas. Appliances such as fuel-gas burning coffee brewers and coffee urns and any appurtenant water heating equipment, food and dish warmers, hot plates and griddles.

Cubic Foot (Cu. Ft.) of Gas. The amount of gas which would occupy 1 cubic foot when at a temperature of 60 F, saturated with water

vapor and under a pressure equivalent to that of 30.0 inches mercury column.

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

a. Coal Basket. An open-flame type appliance consisting of a metal basket filled with simulated coals which gives the appearance of a coal fire when in operation.

b. Fireplace Insert. Consists of an open-flame radiant-type appliance mounted in a decorative metal panel to cover the fireplace or mantel opening and having provisions for venting into the fireplace chimney.

c. Gas Log. An open-flame type appliance consisting of a metal frame or base supporting simulated logs.

d. Radiant Appliance. An open-front appliance designed primarily to convert the energy in fuel gas to radiant heat by means of refractory radiants or similar radiating materials. A radiant heater has no external jacket. A radiant appliance is designed for installation in a vented fireplace.

Decorative Appliance, Vented. A vented appliance whose only function lies in the esthetic effect of the flames.

Deep Fat Fryer, Hotel and Restaurant. 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.

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

Differential Pressure. The pressure difference between two points in a system.

Dilution Air. Air which enters a draft hood or draft regulator and mixes with the flue gases.

Direct-Fired Oven. An oven in which the flue gases flow through the oven compartment.

Direct Gas-Fired Make-Up Air Heater. A heater in which all the products of combustion generated by the fuel-gas burning device are released into the outside air stream being heated.

Direct Vent Appliances. Appliances which are constructed and installed so that all air for combustion is derived directly from the

outside atmosphere and all flue gases are discharged to the outside atmosphere.

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

Draft. The flow of gases or air through chimney, flue or equipment caused by pressure differences.

a. Mechanical or Induced. The draft developed by fan or air or steam jet or other mechanical means.

b. Natural. The draft developed by the difference in temperature of hot gases and outside atmosphere.

Draft Hood. A device built into an appliance, or made a part of the vent connector from an appliance, which 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.

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

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

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

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 which depends for air circulation on a blower not furnished as part of the furnace.

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

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

Exposed Piping. Gas piping which will be in view in the finished structure.

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

a. Masonry Fireplace. A hearth and fire chamber of solid masonry units such as bricks, stones, listed masonry units, or reinforced concrete, provided with a suitable chimney.

b. Factory-Built Fireplace. A fireplace composed of listed factory-built components assembled in accordance with the terms of listing to form the completed fireplace.

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

Flames.

a. Bunsen. The flame produced by premixing some of the air required for combustion with the gas before it reaches the burner ports or point of ignition.

b. Yellow, Luminous or Non-Bunsen. The flame produced by burning gas without any premixing of air with the gas.

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.

a. Fan Type Floor Furnace. A floor furnace equipped with a fan which provides the primary means for circulation of air.

b. Gravity Type Floor Furnace. A floor furnace depending primarily upon circulation of air by gravity. This classification also includes floor furnaces equipped with booster-type fans which do not materially restrict free circulation of air by gravity flow when such fans are not in operation.

Flue, Appliance. 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.

Flue, Chimney. The passage(s) in a chimney for conveying the flue or vent gases to the outside atmosphere.

Flue Collar. That portion of an appliance designed for the attachment of the draft hood or vent connector.

Flue Exhauster. A device installed in and made a part of the vent which will provide a positive induced draft.

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

Furnace, Central. A self-contained, gas-burning 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.

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

1. Downflow Furnace. A furnace designed with air flow discharge vertically downward at or near the bottom of the furnace.

2. Horizontal Furnace. A furnace designed for low headroom installation with air flow across the heating element essentially in a horizontal path.
3. Upflow Furnace. A furnace designed with air flow discharge vertically upward at or near the top of the furnace. This classification includes "highboy" furnaces with the blower mounted below the heating element and "lowboy" furnaces with the blower mounted beside the heating element.

b. Forced Air Furnace With Cooling Unit. A single-package unit, consisting of a gas-fired forced air furnace of one of the types listed in "a" above combined with an electrically or gas-operated summer air conditioning system, contained in a common casing.

c. Gravity Furnace. A furnace depending primarily on circulation of air by gravity.

d. Gravity Furnace With Booster Fan. A furnace equipped with a booster fan which does not materially restrict free circulation of air by gravity flow when the fan is not in operation.

e. Gravity Furnace With Integral Fan. A furnace equipped with a fan or blower as an integral part of its construction and operable on gravity systems only. The fan or blower is used only to overcome the internal furnace resistance to air flow.

Furnace, Direct Vent Central. A system consisting of (1) a central furnace for indoor installation, (2) combustion air connections between the central furnace and the outdoor atmosphere, (3) flue gas connections between the central furnace and the vent cap, and (4) vent cap for installation outdoors, 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.

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

Furnace, Separated Combustion System Central. A system for installation in nonresidential structures consisting of a central furnace and a vent cap supplied by the manufacturer, and (1) combustion air connections between the central furnace and the outside atmosphere and (2) flue gas connections between the central furnace and vent cap (of a type(s) specified by the manufacturer but supplied by the installer), constructed so that when installed in accordance with the manufacturer's instructions, air for combustion is obtained from the outside atmosphere and flue gases are discharged to the outside atmosphere.

Garage, Repair. A building, structure or portions thereof wherein major repair or painting or body and fender work is performed on motorized vehicles or automobiles, and includes associated floor space used for offices, parking and showrooms.

Garage, Residential. A building or room in which not more than three self-propelled passenger vehicles are or may be stored, and which will not normally be used for other than minor service or repair operations on such stored vehicles.

Gas. Fuel gas, such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixtures, or mixtures of these gases.

Gas Main or Distribution Main. A pipe installed in a community to convey gas to individual services or other mains.

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

Gas Utilization Equipment. Any device which utilizes gas as a fuel or raw material or both.

Gas Vent. A passageway, vertical or nearly so, composed of listed factory-built components assembled in accordance with the terms of listing for conveying vent gases from gas appliances or their vent connectors to the outside atmosphere.

a. Type B Gas Vent. A vent for venting listed gas appliances with draft hoods and other gas appliances listed for use with Type B vents.
b. Type B-W Gas Vent. A vent for venting listed gas-fired vented wall furnaces.

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

Gravity. (See Specific Gravity.)

Header. A pipe or fitting to which a number of branch pipes are connected.

Heating Value (Total). The number of British Thermal Units produced by the combustion, at constant pressure, of one cubic foot 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.

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.

Hot Plate, Commercial. (See Counter Appliances, Gas.)

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

Hot Taps. Piping connections made to operating pipelines or mains or other facilities while they are in operation. The connection of the branch piping to the operating line and the tapping of the operating line are done while it is under gas pressure.

Hotel and Restaurant Range. A self-contained fuel-gas burning range providing for cooking, roasting, baking or broiling, or any combination of these functions, and not designed specifically for domestic use.

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

a. Broiler. A unit which cooks primarily by radiated heat. Broilers are further classified as:
   1. Enclosed Broiler. A broiler in which the source of radiant heat is above the surface on which cooking is done.
   2. Open Top Broiler. A broiler in which the source of radiant heat is below the surface on which cooking is done.

b. Built-In Unit. A unit designed to be recessed into, placed upon or attached to the construction of a building, but not for installation on the floor. Built-in units are further classified as:
   1. Broiler Unit. May have an open top or be enclosed, may be a separate broiler, or may be combined with a rotisserie.
   2. Oven Unit. A unit for installation in a cabinet, wall or partition, or for installation on a counter. It may be a separate oven, may be equipped with a broiler that uses the oven burner, or the oven may serve as a broiler with a burner in the upper portion of the oven.
   3. Top or Surface Unit. A unit for installation in or on a counter top. It may have top burners, a griddle, a deep well cooker or any combination thereof.
   4. Combination of "1," "2" or "3" above, or any other household cooking device that may be for similar installation.

c. Floor Mounted Unit. A self-contained cooking appliance for installation directly on the floor. It has a top section and an oven section. It may have additional sections. Included in this classification are:
   1. Bungalow (Utility Type). A cooking appliance having a gas oven and top section, and a gas, solid or liquid fuel section for

space heating and heating a solid top section but not for oven heating.

2. Room Heater Type. A cooking appliance having a gas oven and top section, and a separate room heater section designed for gas fuel.

Incinerator, Domestic. A domestic, fuel-gas burning appliance, used to reduce refuse material to ashes, which is manufactured, sold and installed as a complete unit.

Indirect Oven. An indirect oven is one in which the flue gases do not flow through the oven compartment.

Infrared Heater. A heater which 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.

Insulating Millboard. A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F per hour.

Joint. A connection between two lengths of pipe or between a length of pipe and a fitting.

a. Adhesive. A joint made in plastic piping by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.

b. Heat Fusion. A joint made in thermoplastic piping by heating the parts sufficiently to permit fusion of the materials when the parts are pressed together.

c. Solvent Cement. A joint made in thermoplastic piping by the use of a solvent or solvent cement which forms a continuous bond between the mating surfaces.

Joint Compounds. Nonhardening materials used on pipe threads to insure a seal.

Kettle, Gas-Fired. An appliance with a cooking chamber which 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.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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.

Laundry Stove, Domestic. A fuel-gas burning appliance consisting of one or more open-top type burners mounted on high legs or having a cabinet base.

Leak Detector. An instrument for determining concentration of gas in air.

Leakage Surveys. Systematic surveys made for the purpose of locating leaks in a gas piping system.

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.

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Loads, Connected. Sum of the rated Btu input to individual gas utilization equipment connected to a piping system. May also be expressed in cubic feet per hour.

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.

Manifold, Gas. The conduit of an appliance which supplies gas to the individual burners.

Maximum Allowable Hoop Stress. The maximum hoop stress permitted by this Code for the design of a piping system.

Maximum Working Pressure. The maximum pressure at which a piping system may be operated in accordance with the provisions of this Code. It is the pressure used in determining the setting of pressure relieving or pressure limiting devices installed to protect the system from accidental over-pressuring.

Measured Gas. Gas which has passed through and the volume of which has been measured by a meter, or gas which has been otherwise measured such as by liquid volume or weight.

Mechanical Exhaust System. Equipment installed in and made a part of the vent, which will provide a positive induced draft.

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

Mixer. The combination of mixer head, mixer throat and mixer tube.

a. Mixer Head. The portion of an injection (Bunsen) type burner, usually enlarged, into which primary air flows to mix with the gas stream.

b. Mixer Throat. The portion of the mixer which has the smallest cross-sectional area and which lies between the mixer head and the mixer tube.

c. Mixer Tube. The portion of the mixer which lies between the throat and the burner head.

Mixer Face. The air inlet end of the mixer head.

Mixing Blower. A motor-driven blower to produce gas-air mixtures for combustion through one or more gas burners or nozzles on a single-zone industrial heating appliance or on each control zone of a multi-zone industrial appliance or on each control zone of a multi-zone installation. The blower shall be equipped with a gas-control valve at its air entrance so arranged that gas is admitted to the airstream, entering the blower in proper proportions for correct combustion by the type of burners employed; the said gas-control valve being of either the zero governor or mechanical ratio valve type which controls the gas and air adjustment simultaneously. No valves or other obstructions shall be installed between the blower discharge and the burner or burners.

Noncombustible Material. For the purpose of this Code, noncombustible material shall mean material which is not capable of being ignited and burned, such as materials consisting entirely of, or a combination of, steel, iron, brick, tile, concrete, slate, asbestos, glass and plaster.

Operating Stress. The stress in a pipe or structural member under normal operating conditions.

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.

Orifice Cap (Hood). A movable fitting having an orifice which permits adjustment of the flow of gas by the changing of its position with respect to a fixed needle or other device.

Orifice Spud. A removable plug or cap containing an orifice which permits adjustment of the flow of gas either by substitution of a spud with a different sized orifice or by the motion of a needle with respect to it.

Outdoor Cooking Gas Appliance. As used in this Code, a post-mounted, fuel-gas burning outdoor cooking appliance for installation directly on and attachment to a post provided as a part of the appliance by the manufacturer.

Oven, Commercial Gas Baking and Roasting. An oven primarily intended for volume food preparation which may be composed of one or more sections or units of the following types:

a. Cabinet Oven. An oven having one or more cavities heated by a single burner or group of burners.

b. Reel-Type Oven. An oven employing trays that are moved by mechanical means.

c. Sectional Oven. An oven composed of one or more independently heated cavities.

Parking Structure. A building, structure or portion thereof used for the parking of motor vehicles.

a. Basement or Underground. A parking structure or portion thereof located below grade.

b. Enclosed. Having exterior enclosing walls which have less than 25 percent of the total wall area open to atmosphere at each level using at least two sides of the structure.

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

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

Piping. As used in this Code, either pipe or tubing, or both.

a. Pipe. Rigid conduit of iron, steel, copper, brass, aluminum or plastic.

b. Tubing. Semi-rigid conduit of copper, steel, aluminum or plastic.

Piping System. All piping, valves and fittings used to connect gas utilization equipment to the point of delivery.

Plastic.

a. Thermoplastic. A plastic which is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

b. Thermosetting. A plastic which is capable of being changed into a substantially infusible or insoluble product when cured under application of heat or chemical means.

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

a. Coil Type Pool Heater. A type of pool heater whose heat exchanger surfaces are composed primarily of water tubes whose inside diameters are less than 1¼ inches.

b. Indirect Type Pool Heater. A type of pool heater that utilizes water in a primary heat exchanger to transmit heat from the gas combustion process by means of a secondary heat exchanger to the pool water.

Pressure. Unless otherwise stated, is expressed in pounds per square inch above atmospheric pressure, i.e., gage pressure (psig).

Pressure Control. Manual or automatic maintenance of pressure, in all or part of a system, at a predetermined level, or within a selected range.

Pressure Drop. The loss in static pressure of the medium (air, gas or water) due to friction or obstruction in pipe, valves, fittings, regulators and burners.

Pressure Limiting Device. Equipment which 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.

Pressure or Vacuum Limit Switch. A device in a control system actuated by pressure or vacuum within the air or gas piping system.

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

Protective Equipment. Safety devices designed to forestall the development of a hazardous or undesirable condition in the fuel supply piping, in the gas equipment, in the medium being treated, or in the combustion products.

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

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

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

Refrigerator (Using Gas Fuel). A fuel-gas burning appliance which is designed to extract heat from a suitable chamber.

Regulator, Gas Appliance. A pressure regulator for controlling pressure to the manifold of gas equipment. Types of gas appliance regulators are as follows:

a. Adjustable.

1. Spring Type, Limited Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived prin-

cipally from a spring, the loading of which is adjustable over a range of not more than ± 15 percent of the outlet pressure at the midpoint of the adjustment range.

2. Spring Type, Standard Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable. The adjustment means shall be concealed.

b. Convertible. A nonadjustable regulator for conversion between gases having different heating values whose converting mechanism can be changed from one predetermined outlet pressure setting for one gas to another predetermined outlet pressure setting for the other gas with no intermediate pressure settings and without addition, deletion or substitution of parts.

c. Multistage. A regulator for use with a single gas whose adjustment means can be positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings may be either adjustable or nonadjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.

d. Nonadjustable.

1. Spring Type, Nonadjustable. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not field adjustable.
2. Weight Type. A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

Regulator, Line Gas. A pressure regulator placed in a gas line between the service regulator and the gas appliance regulator.

Regulator, LP-Gas, First Stage. On undiluted LP-gas systems, the first pressure regulator reducing the storage container pressure.

Regulator, LP-Gas, Second Stage. A line gas pressure regulator for service on undiluted LP-gas systems, reducing an intermediate high pressure to utilization pressure.

Regulator, Monitoring. A pressure regulator set in series with another pressure regulator for the purpose of automatically taking over in an emergency the control of the pressure downstream of the regulator in case that pressure tends to exceed a set maximum.

Regulator, Pressure. A device placed in a gas line for reducing, controlling and maintaining the pressure in that portion of the piping system downstream of the device.

Regulator, Series. A pressure regulator in series with one or more other pressure regulators. The regulator nearest to the gas supply source is set to continuously limit the pressure on the inlet to the regulator downstream to some predetermined value (between the pressure of the gas supply source and the pressure of the system being controlled) which can be tolerated in the downstream system.

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

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.

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

Room Heater, Unvented. An unvented, self-contained, free-standing, nonrecessed (except as noted under "b" of the following classifications), 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. Unvented room heaters do not normally have input ratings in excess of 40,000 Btu per hour.

a. Unvented Circulator. A room heater designed to convert the energy in fuel gas to convected and radiant heat by direct mixing of air to be heated with the combustion products and excess air inside the jacket. Unvented circulators have an external jacket surrounding the burner and may be equipped with radiants with the jacket open in front of the radiants.

b. Wall Heater, Unvented Closed Front. An unvented circulator having a closed front, for insertion in or attachment to a wall or partition. These heaters are marked, "UNVENTED HEATER," and do not have normal input ratings in excess of 25,000 Btu per hour.

Room Heater, Vented. A vented, self-contained, free-standing, nonrecessed, fuel-gas burning appliance for furnishing warm air to the space in which installed, directly from the heater without duct connections.

a. Vented Circulator. A room heater designed to convert the energy in fuel gas to convected and radiant heat, by transfer of

heat from flue gases to a heat exchanger surface, without mixing of flue gases with circulating heated air. Vented circulators may be equipped with transparent panels and radiating surfaces to increase radiant heat transfer as long as separation of flue gases from circulating air is maintained. Vented circulators may also be equipped with an optional circulating air fan, but should perform satisfactorily with or without the fan in operation.

b. Vented Circulator, Fan Type. A vented circulator equipped with an integral circulating air fan, the operation of which is necessary for satisfactory appliance performance.

c. Vented Overhead Heater. A room heater designed for suspension from or attachment to or adjacent to the ceiling of the room being heated and transferring the energy of the fuel gas to the space being heated primarily by radiation downward from a hot surface, and in which there is no mixing of flue gases with the air of the space being heated.

Room Large in Comparison with Size of Equipment. Rooms having a volume equal to at least 12 times the total volume of a furnace or air conditioning appliance and at least 16 times the total volume of a boiler. Total volume of the appliance is determined from exterior dimensions and is to include fan compartments and burner vestibules, when used. When the actual ceiling height of a room is greater than 8 feet, the volume of the room is figured on the basis of a ceiling height of 8 feet.

Safety Blowout (Backfire Preventer). A protective device located in the discharge piping of large mixing machines, 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. A check valve, signaling means, or both, may also be incorporated.

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 may interrupt the flow of gas to main burner(s) only, or to pilot(s) and main burner(s) under its supervision.

Sauna Heater. A vented heater designed to raise the temperature of an occupied room to a temperature in excess of 100 F. The appliance may or may not include the means for altering the humidity within the room.

a. Direct Vent Sauna Heater. A system consisting of an appliance, combustion air and flue gas connections between the appliance and the outside atmosphere and a vent cap supplied by

the manufacturer and constructed so that all air for combustion is obtained from the outside atmosphere. The appliance should be complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, and should furnish heated air circulated directly into the space to be heated through openings in the casing. Such appliances should not be provided with duct extensions.

b. Flue-Connected Sauna Heater. An appliance designed for connection to a chimney or gas vent. All air for combustion and draft hood dilution is obtained from a room effectively sealed from the heated room but not from outside the structure containing the heated room.

Secondary Air. The air externally supplied to the flame at the point of combustion.

Secondary Stress. Stress created in the pipe wall by loads other than internal fluid pressure. For example, backfill loads, traffic loads, beam action in a span, loads at supports and at connections to the pipe.

Service Meter Set 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.

Service Pipe. The pipe which brings the gas from the gas main to the meter.

Service Regulator. (See Regulator, Service Pressure.)

Shall. Indicates a mandatory requirement.

Shutoff. (See Valve.)

Space, Confined. For the purposes of this Code, a space whose volume is less than 50 cubic feet per 1,000 Btu per hour of the aggregate input rating of all appliances installed in that space.

Space, Unconfined. For purposes of this Code, a space whose volume is not less than 50 cubic feet per 1,000 Btu per hour of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

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.

Steam Cooker. A fuel-gas burning appliance which cooks, defrosts or reconstitutes food by direct contact with steam.

Steam Generator. A separate appliance primarily intended to supply steam for use with commercial cooking equipment.

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

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

Thermostat, Electric Switch Type. A device which senses changes in temperature and controls electrically, by means of separate components, the flow of gas to the burners to maintain selected temperatures.

Thermostat, Integral Gas Valve Type. An automatic device, actuated by temperature changes, designed to control the gas supply to the burners in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.

a. Graduating Thermostat. A thermostat in which the motion of the valve is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.

b. Snap-Acting Thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.

Type B Gas Vent. (See Gas Vents.)

Type B-W Gas Vent. (See Gas Vents.)

Type L Vent. A passageway, vertical or nearly so, composed of listed factory-built components assembled in accordance with the terms of listing for conveying vent gases from listed appliances for use with Type L vents or their vent connectors to the outside atmosphere.

Unit Broiler. A broiler constructed as a separate appliance.

Unit Heater.

a. High-Static Pressure. A self-contained, automatically controlled, vented, fuel-gas burning appliance having integral means for circulation of air against 0.2 inch or greater static pressure. It is equipped with provisions for attaching an outlet air duct and, when the appliance is for indoor installation remote from the space to be heated, is also equipped with provisions for attaching an inlet air duct.

b. Low-Static Pressure. A self-contained, automatically controlled, vented, fuel-gas burning appliance, intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air, normally by a propeller fan(s), and may be equipped with louvers or face exten-

sions made in accordance with the manufacturer's specifications.

Unmeasured Gas. Gas which has not passed through and the volume of which has not been measured by a meter, or gas which has not otherwise been measured such as by liquid volume or weight.

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

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

Valve, Automatic. An automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.

Valve, Automatic Gas Shutoff. A valve used in conjunction with an automatic gas shutoff device to shut off the gas supply to a fuel-gas burning water heating system. It may be constructed integrally with the gas shutoff device, or be a separate assembly.

Valve, Individual Main Burner. A valve which controls the gas supply to an individual main burner.

Valve, Main Burner Control. A valve which controls the gas supply to the main burner manifold.

Valve, Manual Main Gas-Control. A manually operated valve in the gas line for the purpose of completely turning on or shutting off the gas supply to the appliance except to pilot or pilots which are provided with independent shutoff.

Valve, Manual Reset. 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.

Valve, Relief. 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.

a. Pressure. A valve which automatically opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

b. Temperature. A valve which automatically opens and automatically closes a relief vent, depending on whether the temperature is above or below a predetermined value.

c. Vacuum. A valve which 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.

Valve, Service Shutoff. 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.

Valve, Shutoff. A valve (located in the piping system and readily accessible and operable by the consumer) used to shut off individual equipment.

Valve, Tamperproof. Valves designed and constructed to minimize the possibility of the removal of the core of the valve accidentally or willfully with ordinary household tools.

Vent. A passageway, vertical or nearly so, used to convey flue gases from gas utilization equipment, or their vent connectors, to the outside atmosphere.

Vent Connector. The pipe or duct which connects a fuel-gas burning appliance to a vent or chimney.

NOTE: Since a vent is a vertical or nearly vertical passageway, it follows that any pipe or duct used to connect an appliance(s) to such vertical vent is a vent connector. However if the vertical vent is connected directly to an appliance draft hood or flue collar, a vent connector is not involved.

Vent Damper Device, Automatic. A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual automatically operated fuel-gas burning appliance and which 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.

a. Electrically Operated. An automatic vent damper device that employs electrical energy to control the device.

b. Mechanically Actuated. An automatic vent damper device dependent for operation upon the direct application or transmission of mechanical energy without employing any type of energy conversion.

c. Thermally Actuated. An automatic vent damper device dependent for operation exclusively upon the direct conversion of the thermal energy of the vent gases into mechanical energy.

Vent Gases. Products of combustion from fuel-gas burning appliances plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.

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. Such appliances should not be provided with duct extensions beyond the vertical and horizontal limits of the casing proper, except that boots not to exceed 10 inches beyond the horizontal limits of the casing for extension through walls of nominal thickness are permitted. When such boots are provided they shall be supplied by the manufacturer as an integral part of the appliance. This definition excludes floor furnaces, unit heaters, direct vent wall furnaces and central furnaces.

a. Fan Type Vented Wall Furnace. A wall furnace equipped with a fan.

b. Gravity Type Vented Wall Furnace. A wall furnace depending on circulation of air by gravity.

Venting. Removal of combustion products as well as noxious or toxic process fumes to the outer air by means of roof openings, natural draft chimneys or mechanical exhaust systems.

Venting System. A continuous open passageway from the flue collar or draft hood of a gas-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases.

NOTE: A venting system is usually composed of a vent or a chimney and vent connector(s), if used, assembled to form the open passageway.

Wall Furnace, Direct Vent. 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. The appliance shall be complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, mobile home or recreational vehicle and shall furnish heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. Such appliances shall not be provided with duct extensions beyond the vertical and horizontal limits of the appliance casing, except that boots not to exceed 10 inches beyond the horizontal limits of the casing for extension through walls or nominal thickness may be permitted. This definition excludes floor furnaces, unit heaters, vented wall furnaces and central furnaces as defined in appropriate American National Standards.

Water Heater. An appliance for supplying hot water for domestic or commercial purposes other than for space heating.

a. Automatic Instantaneous Water Heater. A water heater which has a rated input of at least 4,000 Btu per hour per gallon of self-stored water. Automatic control is obtained by water-actuated control, thermostatic control, or combination of water-actuated control and thermostatic control. This classification includes faucet type water heaters designed to deliver water through a single faucet integral with or directly adjacent to the appliance.

b. Circulating Heaters.
   1. Automatic Circulating Tank Water Heater. A water heater which furnishes hot water to be stored in a separate vessel. Storage tank temperatures are controlled by means of a thermostat installed on the water heater. Circulation may be either gravity or forced.
   2. Nonautomatic Circulating Tank Water Heater. A water heater which furnishes hot water to be stored in a separate vessel. Storage tank temperatures are controlled by means of a thermostat installed in the storage vessel.

c. Coil Circulation Water Heater. A water heater whose heat transfer surface is composed primarily of water tubes less than 1½ inches in internal diameter and which requires circulation.

d. Commercial Storage Heater. A water heater that heats and stores water at a thermostatically controlled temperature for delivery on demand. Input rating: 75,000 Btu per hour or more.

e. Counter Top Domestic Storage Heater.
   1. Concealed Type. A vented automatic storage heater which is designed for flush installation beneath a counter top 36 inches high, wherein the entire heater is concealed.
   2. Flush Type. A vented automatic storage water heater with flat sides, top, front and back, which is designed primarily for flush installation in conjunction with or adjacent to a counter 36 inches high, wherein the front and top of the heater casing are exposed.
   3. Recessed Type. A vented automatic storage water heater with flat sides, top, front and back, which is designed for flush installation beneath a counter 36 inches high, wherein the front of the heater casing is exposed.

f. Domestic Storage Heater. A water heater that heats and stores water at a thermostatically controlled temperature for delivery on demand. Input rating may not exceed 75,000 Btu per hour.

g. Side-Arm Type Water Heater. A water heater designed for use with auxiliary storage systems, usually containing water-carrying parts of the tubular or cast element design.

Water Heater, Direct Vent. A system consisting of (1) a water heater for indoor installation, (2) combustion air connections between the water heater and the outside atmosphere, (3) flue gas connections between the water heater and the vent cap, and (4) a vent cap for installation outdoors, supplied by the manufacturer and constructed so all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

APPENDIX A

LIST OF REFERENCE STANDARDS

(Sources for reference standards, given in A5 of this Appendix, are denoted by superscript numbers.)

A1. Standards for Equipment and Installations Not Within the Scope of This Code

ANSI/ASME Boiler and Pressure Vessel Code, 1983 Edition, Section III ("Nuclear Power Plant Components"), Division 1-Subsections NB, NC and ND, Article 3600.

ANSI/ASME Code for Pressure Piping[1]

B31.1-1983, Power Piping

B31.3-1984, Chemical Plant and Petroleum Refinery Piping

B31.4-1979, Liquid Petroleum Transportation Piping Systems

B31.5-1983, Refrigeration Piping

B31.8-1982, Gas Transmission and Distribution Piping Systems

ANSI/NFPA 51-1983, Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes[2]

ANSI/NFPA 59-1979, Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants[2]

ANSI/NFPA 59A-1979, Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)[2]

ANSI/NFPA 61B-1980, Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities[2]

A2. Reference Standards Which May Be Used in Applying This Code

ANSI A119.2-1982, Standard for Recreational Vehicles[3]

ANSI A119.4-1982, Standard for Recreational Vehicle Parks and Campgrounds[3]

ANSI A225.1-1984, Standard for Manufactured Home Installations 1982 (Manufactured Home Sites, Communities and Setups)[3]

ANSI Z21.8-1984, Standard for Installation of Domestic Gas Conversion Burners[4]

ANSI Z83.3-1971, and Addenda, Z83.3a-1972 and Z83.3b-1976, Standard for Gas Utilization Equipment in Large Boilers[4]

ANSI/ASTM D2385-81, Method of Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate—Iodometric Titration Method)[5]

ANSI/ASTM D2420-81, Method of Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method)[5]

ANSI/NFPA 30-1981, Flammable and Combustible Liquids Code[2]

ANSI/NFPA 37-1979, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines[2]

ANSI/NFPA 58-1983, Standard for the Storage and Handling of Liquefied Petroleum Gases[2]

ANSI/NFPA 68-1978, Guide for Explosion Venting[2]

ANSI/NFPA 70-1984, National Electrical Code[2]

ANSI/NFPA 82-1982, Standard on Incinerators, Waste and Linen Handling Systems and Equipment[2]

ANSI/NFPA 85A-1982, Standard for the Prevention of Furnace Explosions in Fuel Oil- and Natural Gas-Fired Single Burner Boiler-Furnaces[2]

ANSI/NFPA 85B-1978, Standard for the Prevention of Furnace Explosions in Natural Gas-Fired Multiple Burner Boiler-Furnaces[2]

ANSI/NFPA 86A-1977, Standard for Ovens and Furnaces—Design, Location and Equipment[2]

ANSI/NFPA 86B-1982, Standard for Industrial Furnaces—Design, Location and Equipment[2]

ANSI/NFPA 90A-1981, Standard for the Installation of Air Conditioning and Ventilating Systems[2]

ANSI/NFPA 90B-1980, Standard for the Installation of Warm Air Heating and Air Conditioning Systems[2]

ANSI/NFPA 96-1980, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment[2]

ANSI/NFPA 211-1980, Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances[2]

ANSI/NFPA 409-1979, Standard on Aircraft Hangars[2]

API Std. 1104-1983, Standard for Welding Pipelines and Related Facilities (16th edition)[6]

ASHRAE Handbook and Product Directory, Equipment Volume, 1983[7]

Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280[8]

National Building Code, 1976[9]

NFPA 88A-1979, Standard for Parking Structures[10]

NFPA 88B-1979, Standard for Repair Garages[10]

A3. Reference Standards for Material Specifications

Steel Pipe and Tubing

ANSI A21.52-1982, Standard for Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Gas[3]

ANSI B36.10-1979, Standard for Welded and Seamless Wrought-Steel Pipe[3]

ANSI/ASTM A254-79, Standard Specification for Copper Brazed Steel Tubing[5]

ANSI/ASTM A539-79, Standard Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines[5]

ASTM A53-83, Specification for Black and Hot-Dipped, Zinc Coated Welded and Seamless Steel Pipe[11]

ASTM A106-83, Specification for Seamless Carbon Steel Pipe for High-Temperature Service[11]

ASTM A120-83, Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses[11]

ASTM A377-79, Specification for Gray Iron and Ductile Iron Pressure Pipe[11]

Copper and Brass Pipe and Tubing (For all standards.)[11]

ASTM B88-83, Specification for Seamless Copper Water Tube

ASTM B280-83, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

Aluminum Pipe and Tubing (For all standards.)[11]

ASTM B210-82a, Specification for Aluminum-Alloy Drawn Seamless Tubes

ASTM B241-83a, Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

Plastic Pipe, Tubing and Fittings (For all standards.)[11]

ASTM D2513-82, Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings

ASTM D2517-81, Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

Flanges

ANSI B16.1-1975, Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800[3]

ANSI B16.5-1981, Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys[3]

ANSI B16.20-1973, Standard for Ring-Joint Gaskets and Grooves for Steel Pipe Flanges[3]

ANSI/AWWA C111/A21.11-1980, Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings[12]

MSS SP-6-1980, Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings[13]

Miscellaneous

ANSI/ASME B1.20.1-1983, Standard for Pipe Threads, General Purpose (Inch)[1]

ANSI/ASME Boiler and Pressure Vessel Code (1983 Edition)[1]

ANSI/MSS SP-58-1983, Standard Practice for Pipe Hangers and Supports—Materials, Design and Manufacture[14]

A4. Reference Standards for Equipment and Accessories

Equipment (For all standards.)[4]

ANSI Z21.1-1982, and Addenda, Z21.1a-1982, Household Cooking Gas Appliances

ANSI Z21.5.1-1982, Gas Clothes Dryers, Volume I, Type 1 Clothes Dryers

ANSI Z21.5.2-1979, and Addenda, Z21.5.2a-1981 and Z21.5.2b-1982, Gas Clothes Dryers, Volume II, Type 2 Clothes Dryers

ANSI Z21.10.1-1981, and Addenda, Z21.10.1a-1982 and Z21.10.1b-1983, Gas Water Heaters, Volume I, Automatic Storage Water Heaters With Inputs of 75,000 Btu Per Hour or Less

ANSI Z21.10.3-1981, and Addenda, Z21.10.3a-1982 and Z21.10.3b-1983, Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage Water Heaters

ANSI Z21.11.1-1983, Gas-Fired Room Heaters, Volume I, Vented Room Heaters

ANSI Z21.11.2-1983, Gas-Fired Room Heaters, Volume II, Unvented Room Heaters

ANSI Z21.13-1982, and Addenda, Z21.13a-1983, Gas-Fired Low-Pressure Steam and Hot Water Boilers

ANSI Z21.19-1983, Refrigerators Using Gas Fuel

ANSI Z21.40.1-1981, and Addenda, Z21.40.1a-1982, Gas-Fired Absorption Summer Air Conditioning Appliances

ANSI Z21.42-1971, and Addenda, Z21.42a-1973 and Z21.42b-1981, Gas-Fired Illuminating Appliances

ANSI Z21.44-1981, and Addenda, Z21.44a-1982 and Z21.44b-1982, Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces

ANSI Z21.47-1983, Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Central Furnaces)
ANSI Z21.48-1982, and Addenda, Z21.48a-1982, Gas-Fired Gravity and Fan Type Floor Furnaces
ANSI Z21.49-1982, and Addenda, Z21.49a-1982, Gas-Fired Gravity and Fan Type Vented Wall Furnaces
ANSI Z21.50-1982, and Addenda, Z21.50a-1982, Vented Decorative Gas Appliances
ANSI Z21.56-1983, and Addenda, Z21.56a-1984, Gas-Fired Pool Heaters
ANSI Z21.57-1982, and Addenda, Z21.57a-1982, Recreational Vehicle Cooking Gas Appliances
ANSI Z21.58-1982, and Addenda, Z21.58a-1982, Outdoor Cooking Gas Appliances
ANSI Z21.60-1981, and Addenda, Z21.60a-1982, Decorative Gas Appliances for Installation in Vented Fireplaces
ANSI Z21.61-1983, Gas-Fired Toilets
ANSI Z21.64-1978, and Addenda, Z21.64a-1980 and Z21.64b-1982, Direct Vent Central Furnaces
ANSI Z83.4-1980 and Addenda, Z83.4a-1982 and Z83.4b-1983, Direct Gas-Fired Make-Up Air Heaters
ANSI Z83.6-1982, Gas-Fired Infrared Heaters
ANSI Z83.8-1981, and Addenda, Z83.8a-1982 and Z83.8b-1983, Gas Unit Heaters
ANSI Z83.9-1982, and Addenda, Z83.9a-1983, Gas-Fired Duct Furnaces
ANSI Z83.10-1982, and Addenda, Z83.10a-1983, Separated Combustion System Central Furnaces
ANSI Z83.11-1980, and Addenda, Z83.11a-1983, Gas Food Service Equipment - Ranges and Unit Broilers
ANSI Z83.12-1980, and Addenda, Z83.12a-1983, Gas Food Service Equipment - Baking and Roasting Ovens
ANSI Z83.13-1980, and Addenda, Z83.13a-1983, Gas Food Service Equipment - Deep Fat Fryers
ANSI Z83.14-1980, and Addenda, Z83.14a-1983, Gas Food Service Equipment - Counter Appliances
ANSI Z83.15-1980, and Addenda, Z83.15a-1983, Gas Food Service Equipment - Kettles, Steam Cookers and Steam Generators
ANSI Z83.16-1982, Unvented Commercial and Industrial Heaters

Accessories (For all standards.)[4]
ANSI Z21.2-1983, Gas Hose Connectors for Portable Indoor Gas-Fired Equipment

ANSI Z21.12-1981, and Addenda, Z21.12a-1983, Draft Hoods
ANSI Z21.15-1979, and Addenda, Z21.15a-1981, Manually Operated Gas Valves
ANSI Z21.17-1984, Domestic Gas Conversion Burners
ANSI Z21.18-1981, and Addenda, Z21.18a-1982, Gas Appliance Pressure Regulators
ANSI Z21.20-1979, and Addenda, Z21.20a-1979 and Z21.20b-1982, Automatic Gas Ignition Systems and Components
ANSI Z21.21-1974, and Addenda, Z21.21a-1977 and Z21.21b-1981, Automatic Valves for Gas Appliances
ANSI Z21.22-1979, and Addenda, Z21.22a-1983, Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems
ANSI Z21.23-1980, Gas Appliance Thermostats
ANSI Z21.24-1981, and Addenda, Z21.24a-1983, Metal Connectors for Gas Appliances
ANSI Z21.35-1969, Gas Filters on Appliances
ANSI Z21.41-1978, and Addenda, Z21.41a-1981 and Z21.41b-1983, Quick-Disconnect Devices for Use With Gas Fuel
ANSI Z21.45-1979, and Addenda, Z21.45a-1981 and Z21.45b-1983, Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI Z21.54-1979, and Addenda, Z21.54a-1983, Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances
ANSI Z21.66-1977, and Addenda, Z21.66a-1981 and Z21.66b-1982, Electrically Operated Automatic Vent Damper Devices for Use With Gas-Fired Appliances
ANSI Z21.67-1978, and Addenda, Z21.67a-1981 and Z21.67b-1982, Mechanically Actuated Automatic Vent Damper Devices for Use With Gas-Fired Appliances
ANSI Z21.68-1978, and Addenda, Z21.68a-1981 and Z21.68b-1982, Thermally Actuated Automatic Vent Damper Devices for Use With Gas-Fired Appliances
ANSI Z21.69-1979, and Addenda, Z21.69a-1983, Connectors for Movable Gas Appliances
ANSI/UL 144-1977, Pressure Regulating Valves for LP-Gas[15]

A5. Sources for Reference Standards

1. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

2. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.
3. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
4. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209, or the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
5. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
6. American Petroleum Institute, 2101 L Street, N.W., Washington, D.C. 20037
7. American Society of Heating, Refrigerating and Air-Conditoning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, Georgia 30329.
8. Department of Housing and Urban Development, Washington, D.C. 20410.
9. American Insurance Association, 85 John Street, New York, New York 10038.
10. National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.
11. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
12. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Water Works Association (Utilities), 6666 W. Quincy Avenue, Denver, Colorado 80235.
13. Manufacturers Standardization Society of the Valve & Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, Virginia 22041.
14. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the Manufacturers Standardization Society of the Valve & Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, Virginia 22041.
15. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or Underwriters Laboratories Inc., Publication Stock, 333 Pfingsten Rd., Northbrook, Illinois 60062.

APPENDIX B

COORDINATION OF GAS UTILIZATION EQUIPMENT DESIGN, CONSTRUCTION AND MAINTENANCE

(This Appendix is informative and is not a part of the Code. This check list may be helpful in the design and selection of gas utilization equipment.)

B1. Coordination.

B1.1 Because industrial gas applications are so varied in nature, many agencies are jointly involved with their safe and satisfactory use. Prior to installation, the specific assignments should be agreed upon by the parties concerned. A typical, but not mandatory, delineation of assignments is given in B1.2 through B1.5, and a detailed check list is given in B2.

B1.2 Person or agency planning an installation of gas equipment:

B1.2.1 Verifies the adequacy of the gas supply, volume, pressure and meter location.

B1.2.2 Determines suitability of gas for the process.

B1.2.3 Notifies gas suppliers of significant changes in requirements.

B1.3 Upon request, the gas supplier furnishes the user complete information on:

B1.3.1 Combustion characteristics and physical or chemical properties such as specific gravity, heating value, pressure and the approximate analysis of the gas.

B1.3.2 Conditions under which an adequate supply of gas at suitable pressure can be brought to the site.

B1.3.3 Continuity of the gas supply.

B1.4 The gas equipment manufacturer or builder provides:

B1.4.1 Design and construction of all gas equipment or assemblies shipped from its plant.

B1.4.2 Design and construction of all gas equipment fabricated, erected or assembled by the gas equipment manufacturer or builder in the field.

B1.4.3 A statement of the maximum hourly Btu input, type of gas and design pressure range.

B1.4.4 Written installation and operating instructions for the user.

B1.5 The person or agency making and the person or agency authorizing the installation of gas equipment (purchaser) jointly:

B1.5.1 Select, erect, or assemble gas equipment, components or designs purchased or developed by that person or agency.

B1.5.2 Assure conformance to codes, ordinances or regulations applicable to the installation.

B1.5.3 Provide adequate means of disposal of products of combustion.

B1.5.4 Initially operate the gas equipment in a safe manner.

B2. Gas Equipment Design and Construction Check List.

B2.1 The basic design and installation should consider:

B2.1.1 Suitability of equipment for process requirements.

B2.1.2 Adequate structural strength and stability.

B2.1.3 Reasonable life expectation.

B2.1.4 Conformance to existing safety standards.

B2.1.5 Adequate combustion space and venting.

B2.1.6 Means for observation and inspection of combustion.

B2.2 Materials of construction used, other than pipe, fittings and valves, should provide reasonable life expectancy for the service intended and be capable of satisfactorily withstanding:

B2.2.1 Operating temperatures.

B2.2.2 Chemical action.

B2.2.3 Thermal shock.

B2.2.4 Load stresses.

B2.3 Combustion systems should be selected for the characteristics of the available gas so that they will operate properly at the elevation at point of use and produce:

B2.3.1 Proper heat distribution.

B2.3.2 Adequate operating temperature range.

B2.3.3 Suitable flame geometry.

B2.3.4 Flame stability.

B2.3.5 Operating flexibility.

B2.3.6 Desired heating chamber atmosphere.

B2.4 Pipe, fittings and valves shall conform to applicable American National Standards as indicated in 2.6. Piping, bushings and material in fittings should not be selected nor used until the following factors have been considered:

B2.4.1 Correct size to handle required volume (consideration of pressure drop in controls and manifolds is particularly important in low pressure systems).

B2.4.2 Material specifications suitable for pressures and temperatures encountered.

B2.4.3 Adequate supports and protection against physical damage.

B2.4.4 Tight assembly and thorough leak inspection.

B2.4.5 Use of sufficient unions and flanges, where permitted, for convenient field replacement or repair.

B2.4.6 Arrangement of piping to provide accessibility for equipment adjustments and freedom from thermal damage.

B2.5 Information concerning the characteristics of the gas and electricity available at the point of utilization should be specific and complete. Gas controls and electrical equipment should be selected to conform to these characteristics which include:

B2.5.1 Gas characteristics: heat content, pressure, specific gravity and approximate analysis.

B2.5.2 Electrical characteristics: voltages, number of phases and frequencies for both control and power circuits.

B2.5.3 Location of electrical equipment and wiring to avoid thermal damage and excessive concentrations of dust, dirt or foreign material.

B2.5.4 Requirements of applicable electrical codes and standards, with particular reference to Article 500 of the National Electrical Code, ANSI/NFPA 70.

B2.6 Temperature controls, if used, should be carefully selected considering:

B2.6.1 Range and type of instruments and sensing elements.

B2.6.2 Type of control action.

B2.6.3 Suitability for service required.

B2.6.4 Correlation of control instruments with operating equipment.

B2.7 In enclosed chambers, the accumulation of gas-air or solvent-air mixtures which may be accidentally ignited constitutes a potential hazard to life and property. For this reason, consideration shall be given to the selection and installation of suitable protective equipment. The selection of a satisfactory protective system and components not otherwise covered by existing codes or standards should be based on the requirements of each individual installation after consultation with the various interested parties, including user, designer, insurance company and local authorities having jurisdiction. Some of the factors and considerations involved in the selection of protective equipment are:

B2.7.1 Feasibility of its installation.

B2.7.2 Its adaptability to process and control requirements.

B2.7.3 Conformance to existing standards, ordinances, requirements and other regulations which apply. (See Appendix A for listing of standards and specifications.)

B3. Maintenance of Gas Equipment.

B3.1 These recommendations are prepared for maintenance of gas equipment. Special types of equipment demand special attention.

B3.2 Burners and pilots should be kept clean and in proper operating condition. Burner refractory parts should be examined at frequent regular intervals to assure good condition.

B3.3 When automatic flame safeguards are used, a complete shutdown and restart should be made at frequent intervals to check the components for proper operation.

B3.4 Other Safeguard Equipment.

B3.4.1 Accessory safeguard equipment, such as manual reset valves with pressure or vacuum switches, high temperature limit switches, draft controls, shutoff valves, air flow switches, door switches and gas valves, should be operated at frequent regular intervals to insure proper functioning. If inoperative, they should be repaired or replaced promptly.

B3.4.2 When fire checks are installed in gas-air mixture piping to prevent flashbacks from traveling farther upstream, the pressure loss across the fire checks should be measured at regular intervals. When excessive pressure loss is found, screens should be removed and cleaned. Water type backfire checks should be inspected at frequent regular intervals and liquid level maintained.

B3.4.3 All safety shutoff valves should be checked for leakage and proper operation at frequent regular intervals.

B3.5 Auxiliary Devices.

B3.5.1 A necessary part of the gas equipment maintenance should be the proper maintenance of auxiliary devices. Maintenance instructions as supplied by the manufacturers of these devices should be followed.

B3.5.2 Gas combustion equipment, including blowers, mechanical mixers, control valves, temperature control instruments, air valves and air filters, should be kept clean and should be examined at frequent regular intervals.

B3.5.3 Necessary repairs and replacements should be made promptly.

B3.6 Regulator and zero governor vents and impulse or control piping and tubing should be kept clear. Regulator valves which operate improperly should be cleaned, repaired or replaced promptly.

B3.7 A necessary part of the gas equipment maintenance should be the proper maintenance of the gas piping system. It is recommended that gas piping be inspected and tested for leakage at regular intervals in accordance with the provisions of 4.1.5. Air piping should be kept internally clean to prevent accumulation of dust, lint and grease in air jets and valves. Where conditions warrant, filters should be installed at the intake to the fans.

B3.8 Stand-by or substitute fuel equipment and systems for gas equipment should be kept in good operating condition and tested periodically.

B3.9 An adequate supply of repair parts should be maintained.

APPENDIX C

SIZING AND CAPACITIES OF GAS PIPING

(This Appendix is informative and is not a part of the Code.)

In order to determine the size of piping to be used in designing a gas piping system, the following factors must be considered:

a. Allowable loss in pressure from point of delivery to equipment.
b. Maximum gas demand.
c. Length of piping and number of fittings.
d. Specific gravity of the gas.
e. Diversity factor.

For any gas piping system, for special gas utilization equipment or for conditions other than those covered by Tables C-3 through C-6, C-16 or C-17, such as longer runs, greater gas demands or greater pressure drops, the size of each gas piping system should be determined by standard engineering practices acceptable to the authority having jurisdiction.

Description of Tables

a. The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from the manufacturer's Btu input rating of the equipment which will be installed. In case the ratings of the equipment to be installed are not known, Table C-1 shows the approximate consumption of average appliances of certain types in Btu per hour.

To obtain the cubic feet per hour of gas required, divide the total Btu input of all equipment by the average Btu heating value per cubic foot of the gas. The average Btu per cubic foot of the gas in the area of the installation may be obtained from the serving gas supplier.

b. Capacities for gas at low pressures (0.5 psig or less) in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables C-3 and C-4 for iron pipe or equivalent rigid pipe and in Tables C-5 and C-6 for semi-rigid tubing. Tables C-3 and C-5 are based upon a pressure drop of 0.3 inch water column, whereas Tables C-4 and C-6 are based upon a pressure drop of 0.5 inch water column. In using these Tables no additional allowance is necessary for an ordinary number of fittings.

c. Capacities in thousands of Btu per hour of undiluted liquefied petroleum gases based on a pressure drop of 0.5 inch water column for different sizes and lengths are shown in Table C-16 for iron pipe or equivalent rigid pipe and in Table C-17 for semi-rigid tubing. In using these tables, no additional allowance is necessary for an ordinary number of fittings.

d. Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from Tables C-3 through C-6, unless the authority having jurisdiction specifies that a gravity factor be applied. When the specific gravity of the gas is greater than 0.70, the gravity factor shall be applied.

Application of the gravity factor converts the figures given in Tables C-3 through C-6 to capacities with another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in Tables C-3 through C-6 by the multipliers shown in Table C-15. In case the exact specific gravity does not appear in the Table, choose the next higher value specific gravity shown.

Use of Capacity Tables

To determine the size of each section of gas piping in a system within the range of the capacity tables, proceed as follows: (Also see sample calculation at end of Appendix C.)

1. Determine the gas demand of each appliance to be attached to the piping system. When Tables C-3 through C-6 are to be used to select the piping size, calculate the gas demand in terms of cubic feet per hour for each piping system outlet. When Tables C-16 or C-17 are to be used to select the piping size, calculate the gas demand in terms of thousands of Btu per hour for each piping system outlet.

2. When the piping system is for use with other than undiluted liquefied petroleum gases, determine the design system pressure, the allowable loss in pressure (pressure drop), and the specific gravity of the gas to be used in the piping system.

3. Measure the length of piping from the point of delivery to the most remote outlet in the building.

4. In the appropriate capacity table, select the column showing the measured length, or the next longer length if the table does not give the exact length. This is the only length used in determining the size of any section of gas piping. If the gravity factor is to be applied, the values in the selected column of the table are multiplied by the appropriate multiplier from Table C-15.

Capacities may also be determined by using the following formulae:*

High Pressure (1.5 psig and above):

$$Q = 181.6 \sqrt{\frac{D^5 \cdot (P_1^2 - P_2^2) \cdot Y}{Cr \cdot fba \cdot L}}$$

$$= 2237\, D^{2.623} \left[\frac{(P_1^2 - P_2^2) \cdot Y}{Cr \cdot L} \right]^{0.541}$$

Low Pressure (less than 1.5 psig):

$$Q = 187.3 \sqrt{\frac{D^5 \cdot \Delta H}{Cr \cdot fba \cdot L}}$$

$$= 2313\, D^{2.623} \left(\frac{\Delta H}{Cr \cdot L} \right)^{0.541}$$

where

Q = Rate, cu ft per hr at 60 F and 30 in. mercury column

D = Inside diameter of pipe, in.

P_1 = Upstream pressure, psia

P_2 = Downstream pressure, psia

Y = Superexpansibility factor† = 1/supercompressibility factor

Cr = Factor for viscosity, density and temperature

*For further details on the formulae, refer to "Polyflo Flow Computer," B. C. Shebeko, 1974, available from Polyflo Computer Company, Box 50126, Dallas, Texas 75250.

†For values for natural gas, refer to "Manual for Determination of Supercompressibility Factors for Natural Gas," available from American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

For values for liquefied petroleum gases, refer to "Engineering Data Book," available from Gas Processors Association, 1812 First Place, Tulsa, Oklahoma 74102.

$$= 0.00354\ ST\left(\frac{Z}{S}\right)^{.152}$$

S = Specific gravity of gas at 60 F and 30 in. mercury column

T = Absolute temperature, F or

= t + 460

t = Temperature, F

Z = Viscosity of gas, centipoise (0.012 for natural gas, 0.008 for propane), or

= 1488 μ

μ = Viscosity, pounds per second ft

fba = Base friction factor for air at 60 F (CF = 1)

L = Length of pipe, ft

ΔH = Pressure drop, in. water column (27.7" H_20 = 1 psi)

CF = Factor CF $= \left(\frac{fb}{fba}\right)$

fb = Base friction factor for any fluid at a given temperature, F

5. Use this vertical column to locate ALL gas demand figures for this particular system of piping.

6. Starting at the most remote outlet, find in the vertical column just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.

7. Opposite this demand figure, in the first column at the left, will be found the correct size of gas piping.

8. Proceed in a similar manner for each outlet and each section of gas piping. For each section of piping determine the total gas demand supplied by that section.

Table C-1

Approximate Gas Input for Typical Appliances

Appliance	Input Btu per hr. (Approx.)
Range, Free Standing, Domestic	65,000
Built-In Oven or Broiler Unit, Domestic	25,000
Built-In Top Unit, Domestic	40,000
Water Heater, Automatic Storage	
30 to 40 Gal. Tank	45,000
Water Heater, Automatic Storage	
50 Gal. Tank	55,000
Water Heater, Automatic Instantaneous	
(2 gal. per minute	142,800
Capacity (4 gal. per minute	285,000
(6 gal. per minute	428,400
Water Heater, Domestic, Circulating or Side-Arm	35,000
Refrigerator	3,000
Clothes Dryer, Type 1 (Domestic)	35,000
Gas Light	2,500
Incinerator, Domestic	35,000

For specific appliances or appliances not shown above, the input should be determined from the manufacturer's rating.

Table C-2

Equivalent Lengths, in Feet of Straight Pipe, of Bends, Fittings and Valves

The equivalent lengths in feet shown in Table C-2* have been computed on a basis that the inside diameter corresponds to that of Schedule 40 (standard-weight) steel pipe which is close enough for most purposes involving other schedules of pipe. Where a more specific solution for equivalent length is desired, this may be made by multiplying the actual inside diameter of the pipe in inches by n/12, or the actual inside diameter in feet by n. N can be read from the table heading. The equivalent length values can be used with reasonable accuracy for copper or brass fittings and bends. For copper or brass valves, however, the equivalent length of pipe should be taken as 45 percent longer than the values in the table which are for steel pipe. Resistance per foot of copper or brass pipe is less than that of steel.

*From PIPING HANDBOOK, by Sabin Crocker, 4th Ed., Copyright, 1945 by McGraw-Hill, Inc., Table XIV, pp. 100-101. Used by permission of McGraw-Hill Book Company.

Table C-2

		Screwed fittings[2]				90° welding elbows and smooth bends[3]					
		45° ell	90° ell	180° close return bends	Tee	$R/d = 1$	$R/d = 1\frac{1}{2}$	$R/d = 2$	$R/d = 4$	$R/d = 6$	$R/d = 8$
k factor =		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36
L/d' ratio[4] n =		14	30	67	60	16	12	9	7	9	12
Nominal pipe size, in.	Inside diam. d, in., Sched. 40[5]										
		L = equivalent length in feet of Schedule 40 (standard weight) straight pipe[3]									
½	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62
¾	0.824	0.96	2.06	4.60	4.12	1.10	0.82	0.62	0.48	0.62	0.82
1	1.049	1.22	2.62	5.82	5.24	1.40	1.05	0.79	0.61	0.79	1.05
1¼	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38
1½	1.610	1.88	4.02	8.95	8.04	2.14	1.61	1.21	0.94	1.21	1.61
2	2.067	2.41	5.17	11.5	10.3	2.76	2.07	1.55	1.21	1.55	2.07
2½	2.469	2.88	6.16	13.7	12.3	3.29	2.47	1.85	1.44	1.85	2.47
3	3.068	3.58	7.67	17.1	15.3	4.09	3.07	2.30	1.79	2.30	3.07
4	4.026	4.70	10.1	22.4	20.2	5.37	4.03	3.02	2.35	3.02	4.03
5	5.047	5.88	12.6	28.0	25.2	6.72	5.05	3.78	2.94	3.78	5.05
6	6.065	7.07	15.2	33.8	30.4	8.09	6.07	4.55	3.54	4.55	6.07
8	7.981	9.31	20.0	44.6	40.0	10.6	7.98	5.98	4.65	5.98	7.98
10	10.02	11.7	25.0	55.7	50.0	13.3	10.0	7.51	5.85	7.51	10.0
12	11.94	13.9	29.8	66.3	59.6	15.9	11.9	8.95	6.96	8.95	11.9
14	13.13	15.3	32.8	73.0	65.6	17.5	13.1	9.85	7.65	9.85	13.1
16	15.00	17.5	37.5	83.5	75.0	20.0	15.0	11.2	8.75	11.2	15.0
18	16.88	19.7	42.1	93.8	84.2	22.5	16.9	12.7	9.85	12.7	16.9
20	18.81	22.0	47.0	105	94.0	25.1	18.8	14.1	11.0	14.1	18.8
24	22.63	26.4	56.6	126	113	30.2	22.6	17.0	13.2	17.0	22.6

1. Values for welded fittings are for conditions where bore is not obstructed by weld spatter or backing rings. If appreciably obstructed, use values for "Screwed Fittings."
2. Flanged fittings have three-fourths the resistance of screwed elbows and tees.
3. Tabular figures give the extra resistance due to curvature alone to which should be added the full length of travel.
4. Small size socket-welding fittings are equivalent to miter elbows and miter tees.

Table C-2 (Continued)

Miter elbows[4] (No. of miters)					Welding tees		Valves (screwed, flanged, or welded)			
1–45°	1–60°	1–90°	2–90°	3–90°	Forged	Miter[4]	Gate	Globe	Angle	Swing check
0.45	0.90	1.80	0.60	0.45	1.35	1.80	0.21	10	5.0	2.5
15	30	60	20	15	45	60	7	333	167	83
										

L = equivalent length in feet of Schedule 40 (standard weight) straight pipe[7]

0.78	1.55	3.10	1.04	0.78	2.33	3.10	0.36	17.3	8.65	4.32
1.03	2.06	4.12	1.37	1.03	3.09	4.12	0.48	22.9	11.4	5.72
1.31	2.62	5.24	1.75	1.31	3.93	5.24	0.61	29.1	14.6	7.27
1.72	3.45	6.90	2.30	1.72	5.17	6.90	0.81	38.3	19.1	9.58
2.01	4.02	8.04	2.68	2.01	6.04	8.04	0.94	44.7	22.4	11.2
2.58	5.17	10.3	3.45	2.58	7.75	10.3	1.21	57.4	28.7	14.4
3.08	6.16	12.3	4.11	3.08	9.25	12.3	1.44	68.5	34.3	17.1
3.84	7.67	15.3	5.11	3.84	11.5	15.3	1.79	85.2	42.6	21.3
5.04	10.1	20.2	6.71	5.04	15.1	20.2	2.35	112	56.0	28.0
6.30	12.6	25.2	8.40	6.30	18.9	25.2	2.94	140	70.0	35.0
7.58	15.2	30.4	10.1	7.58	22.8	30.4	3.54	168	84.1	42.1
9.97	20.0	40.0	13.3	9.97	29.9	40.0	4.65	222	111	55.5
12.5	25.0	50.0	16.7	12.5	37.6	50.0	5.85	278	139	69.5
14.9	29.8	59.6	19.9	14.9	44.8	59.6	6.96	332	166	83.0
16.4	32.8	65.6	21.9	16.4	49.2	65.6	7.65	364	182	91.0
18.8	37.5	75.0	25.0	18.8	56.2	75.0	8.75	417	208	104
21.1	42.1	84.2	28.1	21.1	63.2	84.2	9.85	469	234	117
23.5	47.0	94.0	31.4	23.5	70.6	94.0	11.0	522	261	131
28.3	56.6	113	37.8	28.3	85.0	113	13.2	629	314	157

5. Equivalent resistance in number of diameters of straight pipe computed for a value of $f = 0.0075$ from the relation $n = k/4f$.
6. For condition of minimum resistance where the center-line length of each miter is between d and $2\frac{1}{2}$ d.
7. For pipe having other inside diameters, the equivalent resistance may be computed from the above n values.

Table C-3

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
3/8	.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
1/2	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
3/4	.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1 1/4	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1 1/2	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2 1/2	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

Table C-4

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.5 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
¼	.364	43	29	24	20	18	16	15	14	13	12	11	10	9	8
⅜	.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
½	.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
¾	.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1¼	1.380	1,400	950	770	660	580	530	490	460	430	400	360	325	300	280
1½	1.610	2,100	1,460	1,180	990	900	810	750	690	650	620	550	500	460	430
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400	1,300	1,220	1,150	1,020	950	850	800
2½	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100	7,500	7,200	6,700	6,000	5,500	5,000	4,600

Table C-5

Maximum Capacity of Semi-Rigid Tubing in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Outside Diameter, Inch	Length of Tubing, Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	20	14	11	10	9	8	7	7	6	6	5	5	4	4
1/2	42	29	23	20	18	16	15	14	13	12	11	10	9	8
5/8	86	59	47	40	36	33	30	28	26	25	22	20	18	17
3/4	150	103	83	71	63	57	52	49	46	43	38	35	32	30
7/8	212	146	117	100	89	81	74	69	65	61	54	49	45	42

Table C-6

Maximum Capacity of Semi-Rigid Tubing in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.5 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Outside Diameter, Inch	Length of Tubing, Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	27	18	15	13	11	10	9	9	8	8	7	6	6	5
1/2	56	38	31	26	23	21	19	18	17	16	14	13	12	11
5/8	113	78	62	53	47	43	39	37	34	33	29	26	24	22
3/4	197	136	109	93	83	75	69	64	60	57	50	46	42	39
7/8	280	193	155	132	117	106	98	91	85	81	71	65	60	55

Table C-7

Pipe Sizing Table for Pressures Under 1 Pound Approximate Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour With Pressure Drop of 0.3 Inch Water Column and 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	215	148	119	102	90	82	70	62	43	34	29
1.25	1.380	442	304	244	209	185	168	143	127	87	70	60
1.50	1.610	662	455	366	313	277	251	215	191	131	105	90
2.00	2.067	1275	877	704	602	534	484	414	367	252	203	173
2.50	2.469	2033	1397	1122	960	851	771	660	585	402	323	276
3.00	3.068	3594	2470	1983	1698	1505	1363	1167	1034	711	571	488
3.50	3.548	5262	3616	2904	2485	2203	1996	1708	1514	1041	836	715
4.00	4.026	7330	5038	4046	3462	3069	2780	2380	2109	1450	1164	996
5.00	5.047	13261	9114	7319	6264	5552	5030	4305	3816	2623	2106	1802
6.00	6.065	21472	14758	11851	10143	8990	8145	6971	6178	4246	3410	2919
8.00	7.981	44118	30322	24350	20840	18470	16735	14323	12694	8725	7006	5997
10.00	10.020	80130	55073	44225	37851	33547	30396	26015	23056	15847	12725	10891
12.00	11.938	126855	87187	70014	59923	53109	48120	41185	36501	25087	20146	17242

Table C-8

Pipe Sizing Table for Pressures Under 1 Pound Approximate Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour With Pressure Drop of 0.5 Inch Water Column and 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	284	195	157	134	119	108	92	82	56	45	39
1.25	1.380	583	400	322	275	244	221	189	168	115	93	79
1.50	1.610	873	600	482	412	366	331	283	251	173	139	119
2.00	2.067	1681	1156	928	794	704	638	546	484	333	267	229
2.50	2.469	2680	1842	1479	1266	1122	1017	870	771	530	426	364
3.00	3.068	4738	3256	2615	2238	1983	1797	1538	1363	937	752	644
3.50	3.548	6937	4767	3828	3277	2904	2631	2252	1996	1372	1102	943
4.00	4.026	9663	6641	5333	4565	4046	3666	3137	2780	1911	1535	1313
5.00	5.047	17482	12015	9649	8258	7319	6632	5676	5030	3457	2776	2376
6.00	6.065	28308	19456	15624	13372	11851	10738	9190	8145	5598	4496	3848
8.00	7.981	58161	39974	32100	27474	24350	22062	18883	16735	11502	9237	7905
10.00	10.020	105636	72603	58303	49900	44225	40071	34296	30396	20891	16776	14358
12.00	11.938	167236	114940	92301	78998	70014	63438	54295	48120	33073	26559	22731

Table C-9

Pipe Sizing Table for 1 Pound Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 1.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	717	493	396	338	300	272	233	206	142	114	97
1.25	1.380	1471	1011	812	695	616	558	478	423	291	234	200
1.50	1.610	2204	1515	1217	1041	923	836	716	634	436	350	300
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222	840	674	577
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947	1338	1075	920
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442	2366	1900	1626
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039	3464	2781	2381
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020	4825	3875	3316
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701	8729	7010	6000
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566	14135	11351	9715
8.00	7.981	146849	100929	81049	69368	61479	55705	47676	42254	29041	23321	19960
10.00	10.020	266718	183314	147207	125990	111663	101175	86592	76745	52747	42357	36252
12.00	11.938	422248	290209	233048	199459	176777	160172	137087	121498	83505	67057	57392

Table C-10

Pipe Sizing Table for 2 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 2.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1112	764	614	525	466	422	361	320	220	177	151
1.25	1.380	2283	1569	1260	1079	956	866	741	657	452	363	310
1.50	1.610	3421	2351	1888	1616	1432	1298	1111	984	677	543	465
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896	1303	1046	896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022	2077	1668	1427
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342	3671	2948	2523
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821	5375	4317	3694
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895	7488	6013	5147
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711	13547	10879	9311
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917	21936	17616	15077
8.00	7.981	227906	156638	125786	107657	95414	86452	73992	65578	45071	36194	30977
10.00	10.020	413937	284497	228461	195533	173297	157020	134389	119106	81861	65737	56263
12.00	11.938	655315	450394	361682	309553	274351	248582	212754	188560	129596	104070	89071

Table C-11

Pipe Sizing Table for 5 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 5.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1989	1367	1098	940	833	755	646	572	393	316	270
1.25	1.380	4084	2807	2254	1929	1710	1549	1326	1175	808	649	555
1.50	1.610	6120	4206	3378	2891	2562	2321	1987	1761	1210	972	832
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391	2331	1872	1602
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405	3715	2983	2553
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556	6568	5274	4514
3.50	3.548	48623	33418	26836	22968	20356	18444	15786	13991	9616	7722	6609
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490	13396	10757	9207
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261	24235	19461	16656
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095	39241	31512	26970
8.00	7.981	407692	280204	225014	192583	170683	154651	132361	117309	80626	64745	55414
10.00	10.020	740477	508926	408686	349782	310005	280887	240403	213065	146438	117595	100646
12.00	11.938	1172269	805694	647001	553749	490777	444680	380588	337309	231830	186168	159336

Table C-12

Pipe Sizing Table for 10 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 10.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	3259	2240	1798	1539	1364	1236	1058	938	644	517	443
1.25	1.380	6690	4598	3692	3160	2801	2538	2172	1925	1323	1062	909
1.50	1.610	10024	6889	5532	4735	4197	3802	3254	2884	1982	1592	1362
2.00	2.067	19305	13268	10655	9119	8082	7323	6268	5555	3818	3066	2624
2.50	2.469	30769	21148	16982	14535	12882	11672	9990	8854	6085	4886	4182
3.00	3.068	54395	37385	30022	25695	22773	20634	17660	15652	10757	8638	7393
3.50	3.548	79642	54737	43956	37621	33343	30211	25857	22916	15750	12648	10825
4.00	4.026	110948	76254	61235	52409	46449	42086	36020	31924	21941	17620	15080
5.00	5.047	200720	137954	110782	94815	84033	76140	65166	57755	39695	31876	27282
6.00	6.065	325013	223379	179382	153527	136068	123288	105518	93519	64275	51615	44176
8.00	7.981	667777	458959	368561	315440	279569	253310	216800	192146	132061	106050	90765
10.00	10.020	1212861	833593	669404	572924	507772	460078	393767	348988	239858	192614	164853
12.00	11.938	1920112	1319682	1059751	907010	803866	728361	623383	552493	379725	304933	260983

Table C-13

Pipe Sizing Table for 20 Pounds Pressure
Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 20.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	5674	3900	3132	2680	2375	2152	1842	1633	1122	901	771
1.25	1.380	11649	8006	6429	5503	4877	4419	3782	3352	2304	1850	1583
1.50	1.610	17454	11996	9633	8245	7307	6621	5667	5022	3452	2772	2372
2.00	2.067	33615	23103	18553	15879	14073	12751	10913	9672	6648	5338	4569
2.50	2.469	53577	36823	29570	25308	22430	20323	17394	15416	10595	8509	7282
3.00	3.068	94714	65097	52275	44741	39653	35928	30750	27253	18731	15042	12874
3.50	3.548	138676	95311	76538	65507	58058	52604	45023	39903	27425	22023	18849
4.00	4.026	193187	132777	106624	91257	80879	73282	62720	55538	38205	30680	26258
5.00	5.047	349503	240211	192898	165096	146322	132578	113470	100566	69118	55505	47505
6.00	6.065	565926	388958	312347	267329	236928	214674	183733	162840	111919	89875	76921
8.00	7.981	1162762	799160	641754	549258	486797	441074	377502	334573	229950	184658	158043
10.00	10.020	2111887	1451488	1165596	997600	884154	801108	685645	607674	417651	335388	287049
12.00	11.938	3343383	2297888	1845285	1579326	1399727	1268254	1085462	962025	661194	530962	454435

Table C-14

Pipe Sizing Table for 50 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 50.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	12993	8930	7171	6138	5440	4929	4218	3739	2570	2063	1766
1.25	1.380	26676	18335	14723	12601	11168	10119	8661	7676	5276	4236	3626
1.50	1.610	39970	27471	22060	18881	16733	15162	12976	11501	7904	6348	5433
2.00	2.067	76977	52906	42485	36362	32227	29200	24991	22149	15223	12225	10463
2.50	2.469	122690	84324	67715	57955	51365	46540	39832	35303	24263	19484	16676
3.00	3.068	216893	149070	119708	102455	90804	82275	70417	62409	42893	34445	29480
3.50	3.548	317564	218260	175271	150009	132950	120463	103100	91376	62802	50432	43164
4.00	4.026	442393	304054	244166	208975	185211	167814	143627	127294	87489	70256	60130
5.00	5.047	800352	550077	441732	378065	335072	303600	259842	230293	158279	127104	108784
6.00	6.065	1295955	890703	715266	612175	542559	491598	420744	372898	256291	205810	176147
8.00	7.981	2662693	1830054	1469598	1257785	1114752	1010046	864469	766163	526579	422862	361915
10.00	10.020	4836161	3323866	2669182	2284474	2024687	1834514	1570106	1391556	956409	768030	657334
12.00	11.938	7656252	5262099	4225651	3616611	3205335	2904266	2485676	2203009	1514115	1215888	1040643

Table C-15

Multipliers To Be Used with Tables C-3 through C-14 When the Specific Gravity of the Gas Is Other Than 0.60

Specific Gravity	Multiplier	Specific Gravity	Multiplier
.35	1.31	1.00	.78
.40	1.23	1.10	.74
.45	1.16	1.20	.71
.50	1.10	1.30	.68
.55	1.04	1.40	.66
.60	1.00	1.50	.63
.65	.96	1.60	.61
.70	.93	1.70	.59
.75	.90	1.80	.58
.80	.87	1.90	.56
.85	.84	2.00	.55
.90	.82	2.10	.54

Table C-16

Maximum Capacity of Pipe in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure)

(Based on a Pressure Drop of 0.5 Inch Water Column)

Nominal Iron Pipe Size, Inches	Length of Pipe, Feet											
	10	20	30	40	50	60	70	80	90	100	125	150
½	275	189	152	129	114	103	96	89	83	78	69	63
¾	567	393	315	267	237	217	196	185	173	162	146	132
1	1071	732	590	504	448	409	378	346	322	307	275	252
1¼	2205	1496	1212	1039	913	834	771	724	677	630	567	511
1½	3307	2299	1858	1559	1417	1275	1181	1086	1023	976	866	787
2	6221	4331	3465	2992	2646	2394	2205	2047	1921	1811	1606	1496

Table C-17

Maximum Capacity of Semi-Rigid Tubing in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure)

(Based on a Pressure Drop of 0.5 Inch Water Column)

Outside Diameter, Inch	Length of Tubing, Feet									
	10	20	30	40	50	60	70	80	90	100
3/8	39	26	21	19	—	—	—	—	—	—
1/2	92	62	50	41	37	35	31	29	27	26
5/8	199	131	107	90	79	72	67	62	59	55
3/4	329	216	181	145	131	121	112	104	95	90
7/8	501	346	277	233	198	187	164	155	146	138

Example of Piping System Design:

Determine the required pipe size of each section and outlet of the piping system shown in Exhibit 1, with a designated pressure drop of 0.50 inch water column. Gas to be used has 0.65 specific gravity and a heating value of 1,000 Btu per cubic foot.